

# Semantics

An International Handbook of  
Natural Language Meaning

Volume 3

Edited by

**Claudia Maienborn**  
**Klaus von Heusinger**  
**Paul Portner**

Handbooks of Linguistics and Communication Science  
*Handbücher zur Sprach- und Kommunikationswissenschaft*

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Semantics

HSK 33.3

# Handbücher zur Sprach- und Kommunikations- wissenschaft

Handbooks of Linguistics  
and Communication Science

Manuels de linguistique et  
des sciences de communication

Mitbegründet von Gerold Ungeheuer (†)  
Mitherausgegeben 1985–2001 von Hugo Steger

Herausgegeben von / Edited by / Edités par  
Herbert Ernst Wiegand

Band 33.3

De Gruyter Mouton

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ISBN 978-3-11-025337-5  
e-ISBN 978-3-11-025338-2  
ISSN 1861-5090

*Library of Congress Cataloging-in-Publication Data*

A CIP catalog record for this book has been applied for at the Library of Congress

*Bibliographic information published by the Deutsche Nationalbibliothek*

The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

© 2012 Walter de Gruyter GmbH, Berlin/Boston

Cover design: Martin Zech, Bremen

Typesetting: Apex CoVantage, LLC, Madison, WI, USA

Printing: Hubert & Co. GmbH & Co. KG, Göttingen

⊗ Printed on acid-free paper

Printed in Germany

[www.degruyter.com](http://www.degruyter.com)

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## 77. Semantics of intonation

1. Introduction: between prosody/intonation and meaning
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4. Other tune meanings and related issues
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### Abstract

*This article concentrates on the meaning of intonation contours in English. It presents and combines results of Pierrehumbert and Hirschberg (1990) and Bartels (1999), among others, and adds new suggestions to issues that are unresolved there. In the resulting account, the  $H^*$  tone (often found in a falling contour) requires a salient proposition that the speaker is adding to the common ground; the  $H$ -tone (often found in a rising contour) requires a salient proposition that the speaker is putting up for question. The speaker- and addressee parameters employed by the intonation are shared with the interpretation of pronouns. The discussion concentrates on intonation in declaratives and in a range of interrogatives. It includes the role of intonation in vocatives and in echo questions.*

### 1. Introduction: between prosody/intonation and meaning

Section 1.1. introduces to the mediating role of syntax between prosody and meaning. Section 1.2. places intonation in this picture and introduces to the analysis of intonation. The remainder of the article concentrates on the meaning of intonation contours in English.

#### 1.1. Prosody and meaning

When we parse a sentence, prosody and intonation seem to have a variety of effects on the interpretation of the sentence. Consider the prosodic divisions ‘|’ in the example (1) from Hirschberg (2004). (1a) has a compound reading of *rice wine*, i.e. a total of two ingredients are to be stirred in. In (1b), three ingredients, i.e. rice and wine and seasonings, are to be stirred in.

- (1)    a. Stir in rice wine | and seasonings.  
      b. Stir in rice | wine | and seasonings.

Yet in the classical conception of generative grammar in (2) (e.g. Chomsky 1981, 1995) there is no direct connection between prosody/intonation and semantics. Instead, the





(5). The prosodic consequence, according to Jackendoff, is attraction of sentence stress, as in (5). The semantic interpretation has later been developed in the influential work of Rooth (1992). F requires the contextual presence of one or more alternatives that semantically share the background of the focus (in the cases discussed here: the non-focused parts of the sentence). In (5), they must share the background [x invited John] and be alternatives insofar they differ in x from the focus. These alternatives are in (5) alternative possible answers to the question: *Jane invited John, Sue invited John*, etc. Given Jackendoff's analysis in terms of the syntactic feature F, the analysis fits into the architecture of grammar in (2) in the same way as the analysis of (1) in (3): Syntactic elements (XPs, F) have consequences for prosody and have consequences for semantics. Different prosody ((1a)/(1b)), ((4)/(5)) reflects different syntax, which feeds into different semantic interpretations. Next to F(ocus), other information structure related features that have been argued to mediate between prosody and semantics are C(ontrastive) T(opic) (Büring 2003) and G(ivenness) (Féry & Samek-Lodovici 2006). Independent evidence for the syntactic nature of these features comes from their interaction with syntactic phenomena. For example, a natural class of focus movement and wh-movement to the same position is often analyzed in terms of the feature F (Haida 2007; see Truckenbrodt in press, to appear for the prosodic consequences of such a generalized F).

These information structure categories can show complex interactions with the semantic interpretation. Büring (1995: 109ff) accounts for the example (6) from Jacobs (1984) (the additions on the right are added here). With stress-placement as shown, the sentence only has a scope reconstruction reading (not all politicians are corrupt), while other stress-patterns also allow surface scope (e.g. *alle Politiker sind NICHT korrupt*, 'all politicians are NOT corrupt').

- (6) ALLE<sub>F</sub> Politiker sind NICHT<sub>F</sub> korrupt    [aber MANCHE ... SCHON ...]    (German)  
 ALL<sub>F</sub> politicians are NOT<sub>F</sub> corrupt    [but SOME ... ARE ...]

For the purpose at hand, the insight of Büring's account is rendered in a simplified form that employs only F (as marked in (6)), not the topics of Jacobs' and Büring's discussion. The reconstructed reading leads to an implicature that provides the required alternatives to the focused elements: *Not all ...* implicates that *some ... are ...*. In this implicature, the complex focus <all, not> finds the required contextual alternative <some, VERUM/are> with pairwise contrast (*all* vs. *some*, *not* vs. *verum/ARE*). The surface scope reading does not lead to a comparable implicature that would provide alternatives to the focus <all, not>. It is therefore ruled out by the alternative semantics of focus, which requires that the focus have contextual alternatives.

Pronoun interpretation also interacts with stress assignment, as in the classical example (7) from Lakoff (1971).

- (7) a. JOHN<sub>i</sub> called BILL<sub>k</sub> a REPUBLICAN and then he<sub>i</sub> INSULTED him<sub>k</sub>.  
 b. JOHN<sub>i</sub> called BILL<sub>k</sub> a REPUBLICAN and then HE<sub>k</sub> insulted HIM<sub>i</sub>.

Lakoff's idea was that (7a) shows the unmarked construal, parallel between second and first clause, while stress on the pronouns leads to a marked interpretation, here the choice of inverse antecedents (see also Hirschberg & Ward 1991). The alternative semantics of focus leads to a more comprehensive account of the marked case (7b). A complex focus

$\langle \text{HE}, \text{HIM} \rangle$  is formed with the background  $[x \text{ insulted } y]$ . The context must provide this background  $[x \text{ insulted } y]$  with an instantiation of  $\langle x, y \rangle$  different from the focus, i.e. an alternative to the focus. The context provides  $[x \text{ insulted } y]$  on the assumption that John's calling Bill a republican constitutes an insult, with  $\langle x, y \rangle = \langle \text{John}, \text{Bill} \rangle$ . Under parallel binding of the pronouns, the alternative  $\langle \text{John}_i, \text{Bill}_k \rangle$  would be referentially identical to the focus  $\langle \text{HE}_i, \text{HIM}_k \rangle$ . Under inverse binding, the alternative  $\langle \text{John}_i, \text{Bill}_k \rangle$  differs in reference from the focus  $\langle \text{HE}_k, \text{HIM}_i \rangle$  as required by the alternative semantics of focus.

For semantic stress-effects of this kind, we do not seem to require additional connections between prosody/intonation and semantics in the grammar. It seems that the correct way of analyzing them is in terms of a modular account that relies on the indirect prosody-semantics connection given to us in the theory of F and CT and G. See also Baltazani (2002) and Ishihara (2010) for investigations in this domain.

## 1.2. Intonation and meaning

The remainder of this article is about the meanings of intonation contours, largely concentrating on English. I primarily draw on Pierrehumbert & Hirschberg (1990) and Bartels (1999), who (building on Gussenhoven 1984) treat intonational meaning at a level of abstraction that is high and interesting enough for a semantics handbook. They show a number of differences in their conclusions and a range of open issues. I discuss what I think are the best parts of both and add some new elements, including a more detailed formalization in terms of presuppositions. I concentrate on  $H^*/L^*$  and  $H-/L-$ , central elements of the English intonation system for which a formal semantic account is within reach.

To begin with, consider (8), which shows that rising intonation  $[/]$  turns an elliptical utterance into a question and falling intonation leads to an interpretation as an assertion.

- (8) John and Mary are taking a break from work. John is getting up and looks at Mary.
- a. John: Coffee  $[/]$  (expressing: 'Do you want coffee?')
  - b. Mary: Coffee  $[\backslash]$  (expressing: 'I want coffee.')

I assume the intonation analysis of English in Pierrehumbert (1980), Beckman & Pierrehumbert (1986). It has become the starting point for many investigations across languages, see Gussenhoven (2004), Ladd (2008). In this approach intonation contours are analyzed in terms of discrete H(igh) and L(ow) tones. The rise as in (8a) will stand for the sequence of tones  $L^*H-H\%$ , the fall in (8b) for the sequence  $H^*L-L\%$ . English contours from the nuclear stress to the right edge of an intonation phrase are composed of three tonal elements: First, a *pitch accent* on the nuclear stress; I concentrate on  $H^*$  and  $L^*$  in this article (see section 4.3 for other pitch accents). The same pitch accent often also occurs on preceding stressed elements as in (9) in section 2 below. The nuclear pitch accent is followed by a sequence of two edge tones. The first edge tone,  $H-$  or  $L-$ , is found in the area in between the nuclear stress and the end of the intonation phrase. The second edge tone,  $H\%$  or  $L\%$  is found at the right edge of the intonation phrase. The high and low regions defined by these tones can be seen separated in time in (10) and (12) below.  $H-/L-$  are analyzed as edge tones of the intermediate phrase, a smaller prosodic unit. They can also occur without the following  $H\%/L\%$  as in (13).

These tonal elements are conceived of as abstract morphemes (Gussenhoven 1984: ch. 6, Pierrehumbert & Hirschberg 1990, Bartels 1999, see also Bolinger 1957, 1989). The phonological side of these are the H or L tones that define high and low areas of the sentence melody. The semantic side is the semantic impact they bring to the utterance. What we want to get out of the semantic side is that (8a) constitutes a question and (8b) an assertion. I believe that these intonational morphemes need to be attached to the syntactic structure to fit into the architecture described here: As part of the syntactic structure, their semantic and phonological specifications are fed into the LF and PF components for interpretation. A specific suggestion for syntactic attachment is formulated in section 3.2.

There is a large array of descriptive observations in the literature about tunes that can be used on English example sentences and the nuances they seem to convey. The work of Bolinger (1957, 1986, 1989) in particular shows the great flexibility of tune choices. There are interactions with the syntactic sentence type, but the intonation often follows what the speaker wants to express. Gussenhoven (1984: ch. 6) initiated a search for more abstract meanings of elements of intonation contours in terms of the *common ground* (see Stalnaker 1978, 2002 and Clark 1996 on the notion common ground, though Gussenhoven employed a somewhat more narrow concept). The more specific suggestions of this search that I employ as a starting point are developed by Pierrehumbert & Hirschberg (1990), in the following PH90, and by Bartels (1999), in the following B99. We will see that B99 provides an approach to the flexibility of tune assignment. I often focus on cornerstone observations that seem to be promising for inferences about the tune meanings.

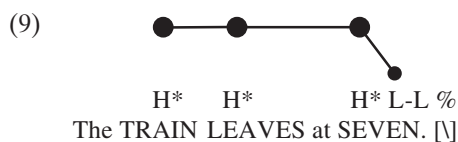
The intonation of declaratives is discussed in section 2, and the intonation of interrogatives in section 3. Related issues of tune meanings are addressed in section 4. The terms *declarative* and *interrogative* are here employed for syntactic sentence forms. The term *question* will sometimes also refer to the speech act.

## 2. Intonation in declaratives

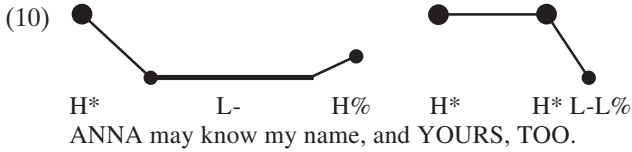
In this section the intonation of declaratives is discussed. Section 2.1. is about falling (H\*L-) and rising (L\*H-) intonation in declaratives. Section 2.2. is about low intonation (L\*L-) and section 2.4. about high intonation (H\*H-) in declaratives. These latter two sections are separated by section 2.3. on the nature of intonational meanings, which will be crucial at that point.

### 2.1. H\*L- as assertive, L\*H- as non-assertive

Bolinger (1957) distinguishes three pitch accents. His A accent, which he calls ‘assertive’, has two versions that would be analyzed as H\*L-L% and H\*L-H% in Pierrehumbert’s analysis. PH90: 290 also see these two as “neutral declarative intonation”, “appropriate when S’s goal is to convey information”. H\*L-L% marks the standard assertion, as in (9) (PH90: 286).

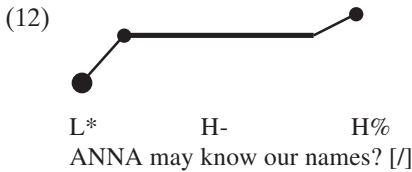


H\*L-H% conveys assertion plus something else. The ‘something else’ may be plain continuation as in (10) (Beckman & Ayers 1993). The contour is also called *continuation rise*. However, it may also occur at the end of an utterance and add a note of uncertainty to what is asserted, as in (11) (B99: 34).

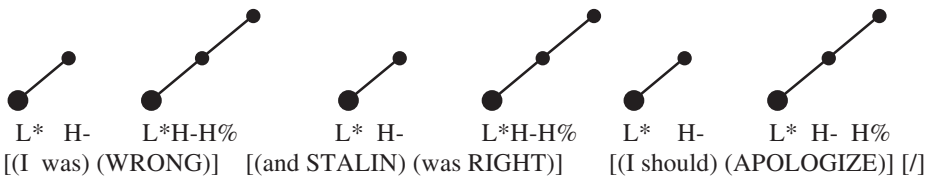


- (11) A: What's your opinion—can we leave the car parked here?  
           H\*        L-        H%  
 B: I THINK it's alright.

The inverse contour, the rise, has its prototypical instantiation in L\*H-(H%). L\*H- is close to the C accent of Bolinger (1957), which he calls “anti-assertive”. L\*H- is possible in declarative questions like (12) (Beckman & Ayers 1993, see also Bartels 1999: 228ff). The example (13) (PH90: 292) shows particularly clearly how the speaker can distance himself from the content with L\*H-(H%) by turning declaratives into questions. (In this example, intermediate phrases are marked by round brackets, intonation phrases by square brackets.)



- (13) Russian émigré joke; a staunch old Bolshevik is forced to confess publicly and reads:



The assertiveness of the fall resides in the H\*L- combination according to Gussenhoven (1984), in the H\* according to PH90, and in the L- according to B99. I find the position of PH90 convincing and review their motivation in connection with the additional combinations L\*L- and H\*H- on declaratives in the following sections. In addition, I develop a modification of the suggestion of B99. In the modification, H- has a question-related meaning. To begin with, (12) and (13) are questions and are marked by H-, while (9)–(11) are not questions and are marked by L-.

## 2.2. L\*L- on declaratives: not new and not questioning

The examples with L\*L- in (14) and (15) differ from both groups H\*L- and L\*H- above.

- (14) [Question about wishes for birthday presents, where the desire for a Pavoni espresso machine is already mutually believed]

L\*            L\*            L\* L-H%

WELL, I'd LIKE a PAVONI ... [\_\_\_]

- (15) A: Let's order Chateaubriand for two.

●                    ●                    ●

L\*                    L\* L-H%

B: I DON'T eat BEEF [\_\_\_]

[conveys that A should have had this in mind]

These examples from PH90: 292f share with the H\*L- cases in (9)–(11), with which they share the L-, that they are not question-like utterances. This separates them from the H- cases in (12) and (13), which have a clearly questioning flavor.

The L\*L- cases also differ from the H\*L- cases in (9)–(11). As pointed out by PH90, the H\* in regular assertions like (9)–(11) correlates with the newness of the propositions presented there. The L\* in (14) and (15), on the other hand, signals that the proposition is already given in the common ground. Thus, (14) is the repetition of an already jointly known wish. The reply in (15) could be said with H\*L-L% in which case it would present this information as new. The realization with L\* in (15) has an insulting effect according to PH90, because it suggests that the addressee should have had this in mind.

Adapting the suggestion that Gussenhoven (1984: ch. 6) makes for the fall, PH90 make the notion of newness conveyed by H\* more precise in suggesting that the speaker seeks to add this information to the common ground, the shared beliefs or shared knowledge of speaker and addressee. This means that it must be new relative to the common ground. For example, in (16), (PH90: 290), the speaker may assume that the information is not new to the addressee. The speaker may still suggest to add this to the common ground in the sense that it is then also mutually believed. For this to work, the information must be new in the common ground, i.e. not already mutually believed.

- (16)
- ●

H\*            L-L%

You TURKEY [V]

●                    ●                    ●                    ●

H\*                    H\*                    H\* L-L%

You DELIBERATELY DELETED my FILES [V]

There are then two reasons not to mark something as new in that sense and to choose L\* instead: it may not be believed by the speaker at the time of the utterance, as in (12) and (13), or it may be believed by the speaker but taken to be in the common ground already, as in (14) and (15). In both cases it makes sense that the speaker does not want to instruct the addressee to add the proposition to the common ground.

### 2.3. Greetings and vocatives: relevance of salient propositions

This section makes a digression concerning the domain on which intonational meanings operate, by way of preparation for the discussion of H\*H- on declaratives in the following

section. What do intonational meanings operate on? PH90: 289 illustrate their idea with the example [George(H\*) likes pie(H\*)]. Here an open expression [x likes y] is formed into which x = George(H\*) and y = pie(H\*) are instantiated. The meaning of H\* operates on the instantiation of the elements carrying H\*. It is not easy to distinguish this suggestion from that of Hobbs (1990), who simply assumes that intonational meanings operate on the propositional content.

An important innovation was argued for by B99. She postulated it for the assertive meaning she assigns to L-. This assertive meaning, she argued, operates on a salient proposition (rather than on the compositional at-issue content). While her assertive meaning for L- is not adopted here, her discovery that intonational meaning can operate on salient propositions is generally assumed for all intonational meaning here. Many of Bartels' arguments carry over to the current account, as will be seen in section 3. In the current section initial motivation for it is shown in connection with vocatives and greetings. For these the deployment of salient propositions leads to an arguably better fit of these cases with the meaning of H\* in PH90 than the discussion by PH90 (with different propositions to modify) was able to provide.

According to PH90, the contour involving L\* in (17) is chosen because there is no content of the greeting that could be added to the common ground. They call these elements 'extrapositional'.

- (17) L\*    L\*    L-H%  
GOOD MORNING [\_\_\_/]

Notice, however, that greetings with H\* as in (18) are entirely possible. A talk show host would greet his audience with the intonation in (18b). This would be excluded by PH90's treatment, where there is no propositional content to be added to the common ground.

- (18) a. H\*            H\*    L-L%    b.    H\*    H\*    L-L%  
GOOD MORNING [∅]            GOOD EVENING [∅] ladies and gentlemen!

Employing salient proposition, we can say that the intonational meanings operate on the salient propositions 'I wish you a good morning' and 'I wish you a good evening' in these cases. This is marked as to be added to the common ground in (18). In (17), we could adopt PH90's original explanation, assuming the presence of content is optional. However, it is also possible that the speaker presents his wishing a good morning as given in the sense of predictable from the context: 'We both knew that I would wish you a good morning'. It might be taken to be predictable from the time of day and the fact of the encounter, or from similar greetings on earlier days. This may lead to the conventionalized flavor of the intonation pattern in (17).

I turn to vocatives. PH90: 293f point out that *Anna* is spoken with H\* as in (19a) in case the speaker does not yet have Anna's attention, and with L\* as in (19b) if the speaker already has Anna's attention. When the vocative follows the clause as in (19c), L\* is the only choice.

- (19) a. H\* L-            H\*    L-L%    b.    L\* H-            H\*    L-L%  
ANNA [∅] your LUNCH is ready            ANNA [/] your LUNCH is ready



- c.            H\*            L- L\*L-L%  
           Your LUNCH is ready, ANNA [\_\_]

PH90's analysis of this is preliminary: The frequent use of L\* harmonizes with their understanding that L\* here marks an extrapositional element. However, the use of H\* in (19a) is not compatible with a more precise analysis. An extrapositional element would not provide propositional content that the addressee could be instructed to add to the common ground.

A more complete account can be given in terms of salient propositions. The salient proposition is the one that underlies the interpretation of the vocative: 'Anna is the addressee of the utterance', or, more informally, 'I am talking to you, Anna'. Where this is common ground, the speaker has Anna's attention. Where the speaker does not have Anna's attention, it is not common ground that Anna is the addressee: Anna may not be aware of being the addressee, or the speaker may not realize that Anna is aware of being the addressee. In (19a), then, Anna's being the addressee is not common ground initially. H\* is used as an instruction to add this proposition to the common ground. Notice that the addition of this to the common ground is typically equivalent to getting Anna's attention in two ways: (a) by way of H\* marking 'I am talking to you' as to be added to the common ground, and (b) by making her listen (i.e. getting her to add something to the common ground in the first place). If the proposition is already in the common ground, i.e. if the speaker already has Anna's attention as in (19b), L\* is used. (We may take the medial H- in (19b) to convey continuation, see section 4.2.) For the analysis of (19c), a context in the sense of Kaplan (1989) for the interpretation of the sentence is assumed. It is taken to include the parameters S(peaker) and A(ddressee). This context is relevant (a) to the interpretation of pronouns, for example 2nd person is [+A, -S], (b) for the identification of the addressee of the utterance in the meaning of the vocative and (c) for the identification of S and A in the intonational meanings (more on this in section 3.2). In (19c) the sentence that precedes the vocative is addressed to Anna. Anna is the addressee A of that sentence. We know this because addressee-reference to Anna is possible with second-person pronouns in that sentence. This happens to be illustrated with the pronoun 'your' in (19c). Therefore, by the end of the sentence, Anna's being the addressee can not be presented as new information any more. L\* is therefore the only choice on the final vocative.

Portner (2007) assigns to vocatives expressive meaning in the sense of Potts (2005) (see also article 94 (Potts) *Conventional implicature*): either a request for attention ('calls') or a reiteration of addresseehood ('tags' and 'addresses', the latter with an additional expressive element). He assumes that the classification rests on the intonation. In current terms the requests for attention are the vocatives marked H\*. The current discussion is compatible with Portner's basing the distinction on the intonation. It seems that the intonation can derive the request for attention and the reiteration of addresseehood from a single underlying vocative meaning, as shown above. See Portner (2007) for other aspects of vocatives.

In summary, the pitch accents on simple greetings and vocatives fit with the analysis of H\* in PH90, if the analysis is cast in terms of salient propositions. Since they are still assertion-like and not questions (cf. also the L- in (17)), the motivation for choosing L\* is that the relevant proposition is already in the common ground, or presented that way.



Equipped with a notion of what intonational meanings operate on, we now return to the discussion of declaratives. After H\*L-, L\*H- and L\*L- we will now address H\*H- on declaratives. We apply our understanding of what intonational meanings operate on to declaratives as follows. In declaratives, the most salient proposition is the content of the declarative. It is therefore the first choice for intonational meanings to operate on. However, other choices are not excluded, in particular where the first choice is blocked, as we will see.

## 2.4. H\*H-: news and a question

Consider then the sequence H\*H- on declaratives. H\* asserts the content of the declarative and H- adds a separate question. In (20), the impact of the utterance is paraphrased by PH90: 290 as ‘My name is Mark Liberman, and are you expecting me, or, am I in the right place?’. Similarly, (21) is an utterance by a young woman who was asked after a movie whether she liked it. It conveys, according to PH90: 290, ‘I thought it was good, but do you agree with me?’

- (20) M. L. approaches a receptionist to find out  
whether he is in the right place for his appointment:



H\*      H\*    H- H%

My name is MARK LIBERMAN [-]

- (21)        H\*                      H\* H-H%  
I THOUGHT it was GOOD [-]

PH90 point out that the impact is different from L\*H-H% (lacking the assertive H\*). Use of L\*H-H% in (20) would suggest that Mark Liberman has forgotten his name, and in (21) that the speaker has forgotten her impression of the movie. This supports the assertive role of H\* in (20) and (21).

Hirschberg & Ward (1995) discuss similar cases of H\*H-H% on declaratives, including the contrast in (22). In (22a) the caller, in addition to asserting her whereabouts, asks the DJ something along the lines of whether the DJ has heard of Skokie. A similar question is not possible in (22), since everyone has heard of Chicago.

- (22) Chicago radio station DJ: Good morning Susan. Where are you calling from?

- a.                                      H\*H-H%  
   Caller: I'm calling from SKOKIE? [-]  
b. #                                      H\*H-H%  
   Caller: I'm calling from CHICAGO? [-]

Hirschberg & Ward (1995) suggest that H\*H-H% is employed (in addition to the assertion) “to elicit information about whether the hearer can relate this propositional content to the hearer’s own private belief space” (Hirschberg & Ward 1995: 410). They suggest that this component (though not the assertive part) is also present in the

L\*H-H% contour. I adopt the suggestion that the rise (here: H-) seeks to “elicit information”, i.e. generates a question. I also agree in regard to the content of the question that arises in the examples at hand. I differ from Hirschberg & Ward (1995) only in that I think that we need to leave the choice of what is asked partly to the pragmatics. In (12) and in (13), the question that is posed is not about the connection to the addressee’s knowledge. Rather, the content of the proposition is put up for question there. I suggest that H- puts up a salient proposition for question. In (12) and (13), this is the content of the declarative. In (20)–(22), the content of the declarative is marked as to be added to the common ground by H\*, and so cannot be simultaneously put up for question. Another salient proposition is therefore marked as put up for question. It is contextually chosen. Since utterances generally call on the addressee to connect what is being said to their beliefs, and since questions generally elicit addressee beliefs or knowledge, it seems reasonable that the most salient proposition that might be recoverably asked about is typically one in the connection between what is being asserted and the addressee’s relation to it, as in (20)–(22a). In the absence of such a salient proposition, as in (22b), it is not recoverable what proposition H- might mark, and infelicity results. I will return to this infelicity below.

Notice that (20)–(22) add striking support for Bartels’ discovery of intonational meaning in terms of salient propositions. The propositions on which the meaning of H- operates are very clearly not the literal meanings of these utterances, and are very clearly contextually chosen in these cases.

In comparison with other contours, H\*H- in (20)–(22) shares with H\*L- in (9)–(11) the newness of the asserted proposition, in contrast to the L\* cases in (12) and (13) (not believed) and in (14), (15), and (19b) (given). Thus H\* plausibly marks a proposition as new in the sense of ‘to be added to the common ground’.

H\*H- in (20)–(22) shares with L\*H- in (12) and (13) the questioning impact. This is here attributed to the H- that these cases share. The L- examples in (9)–(11) and in (14), (15), and (19c) do not show the questioning impact.

## 2.5. Summary: intonation in declaratives

The preceding cases motivate an assignment of meanings to the H tones as in (23). The L tones may be meaningless.

- (23) a. H\* marks a salient proposition as new in the sense of an instruction by the speaker to add the proposition to the common ground of speaker and addressee.  
 b. H- marks a salient proposition as put up for question by the speaker.

(23) applies as follows to the four classes we saw. The H\*L- assertions in (9)–(11) are marked as to be added to the common ground by H\* (and are not put up for question). The L\*H- questioning utterances in (12) and (13) are put up for question by H- (and not marked as to be added to the common ground). The L\*L- weak assertions in (14), (15) and (19c) are not put up for question (and thus remain statements, perhaps due to the declarative form); they are not marked as to be added to the common ground because their content is assumed to be given. The H\*H- cases in (20)–(22) are marked as to be added to the common ground by H\*, and a second salient proposition in the context is marked as put up for question by H-.

### 3. Intonation in interrogatives

The intonation of interrogatives is a complex area. The following sections navigate it by going back and forth between observations from the literature that give the account empirical support and formal semantic suggestions that make the analysis more precise.

Section 3.1. introduces to an elementary puzzle concerning the intonation in interrogatives. It shows how the suggestion about H- developed above approaches this. Section 3.2. offers an implementation of the meanings of H- and H\* in terms of presuppositions. Section 3.3. applies the presuppositional analysis to the cases in 3.1. in detail and to other instances of yes/no-questions. Section 3.4. shows how the implicature that there is a true answer to a question is often crucial for an understanding of intonation in interrogatives. Section 3.5. discusses the high-rise in yes/no-questions. Section 3.6. addresses the accommodation of the presuppositional question meanings. Sections 3.7. and 3.8. treat the rise in echo-wh-questions and the friendly rise in wh-questions.

#### 3.1. First interrogative intonation and the relevance of salient propositions

Let us begin the discussion of interrogative intonation with an old puzzle. Yes/no-questions are felt to be typical with rising intonation as in (24a). Wegener (1885) called German rising intonation “*Verwunderungston*”, ‘tone of wondering’, which we may read as a suggestion that the rise is inherently related to a question. I partly agree. In examples like the elliptical (8a) and the declaratives (12), (13), and (20)–(22), the intonation that includes H- seems to add questioning impact. There is no other source of the questioning impact in sight. However, as pointed out by Kretschmer (1938) in Vienna with comparable German examples, questions are of course not generally marked with a rise. Wh-questions as in (24b) are often felt to be typical with a fall, and alternative questions as in (24c) require the final fall. Thus it would be wrong to tie rising intonation too closely to the questioning speech act. Notice that the interpretation of the alternative question in (24c) has the possible answers {you went to Berlin, you went to Potsdam}. ‘Yes’ and ‘no’ are not possible answers. Rising intonation as in (24d) turns this into a yes/no-question with the possible answers {you went to Berlin or to Potsdam (“yes”), you didn’t go to Berlin or to Potsdam (“no”)}. The use of rising intonation in (24d) is parallel to (24a), except that the proposition that is put up for question in (24d) happens to contain a disjunction.

- (24) a. Did you go to BERLIN [/] L\*H-(H%)  
       b. Where did you GO [∨] H\*L-(L%)  
       c. Did you go to BERLIN or to POTSDAM [∨] H\*L-(L%)  
       d. Did you go to BERLIN or to POTSDAM [/] L\*H-(H%)

Deviating from most previous literature (apart from Wegener 1885) I suggest that H- carries questioning meaning after all. My suggestion draws on Bartels’ analysis of the contours in (24) to which I return, and on Bartels’ insight of the relevance of salient propositions. Implementing the questioning meaning in terms of salient proposition, H- does not mark questions more generally. It only marks a salient proposition as put up for question. It is a primitive question indicating and question generating device that does not have the complexity to keep up with the semantics of interrogatives, which employs

sets of propositions (see e.g. Karttunen 1977). Nor does it always come into play when there is a questioning speech act. In (24a) then, the salient proposition ‘you went to Berlin’ is put up for question, and can be marked as such by H-. Similarly in the yes/no-question (24d), where the salient proposition ‘you are going to Berlin or to Potsdam’ is put up for question. In (24b) and (24c), no salient proposition is put up for question in a similar fashion. In a first approximation, there is therefore no motivation for employing H- in these cases. The move to assign the stronger questioning meaning (rather than absence of assertion) to H- is motivated by cases like the elliptical (8a) and the declaratives (12), (13), and (20)–(22), all of which are turned into questions by the intonation, without another source of the questioning impact in sight.

For further developing this picture below, I employ a more formal implementation of the relevance of salient propositions. This is developed in the following section.

### 3.2. A formal implementation of intonational meanings

The relevance of salient propositions in intonational meanings is reminiscent of the relevance of salient individuals to the interpretation of definite descriptions. In the formalization of Heim (1982), this arises for definite descriptions from a presupposition over the referent of a syntactic index. The presupposition can only be satisfied if the index has an antecedent for which the presupposition is true (unless it is accommodated). A salient and unique index is required (Heim 1982: 165, 233–236 for uniqueness). In such an account, the meaning of definite descriptions is stated as in (25). Here  $g$  is a variable assignment and  $i$  is a syntactic index. Using this as a point of orientation, we may define the meanings of H\* and H- in English in (26). S and A stand for speaker and addressee.

(25)  $\llbracket [\text{the NP}]_i \rrbracket^g$  is defined as  $g(i)$  iff  $g(i) \in \llbracket \text{NP} \rrbracket^g$

(26) Let English have the intonational morphemes  $\langle H^*, \text{new}_j \rangle$  and  $\langle H-, \text{question}_j \rangle$ , where  $j$  is an index of type proposition. Let these morphemes right-adjoin to a syntactic constituent  $\alpha$ . Then (ignoring the phonology in the semantic interpretation):

- a.  $\llbracket [\alpha \langle \text{new}_j \rangle] \rrbracket^{g,S,A}$  is defined as  $\llbracket \alpha \rrbracket^{g,S,A}$  iff S is adding  $g(j)$  to the common ground of S and A.
- b.  $\llbracket [\alpha \langle \text{question}_j \rangle] \rrbracket^{g,S,A}$  is defined as  $\llbracket \alpha \rrbracket^{g,S,A}$  iff S is putting up  $g(j)$  for question.

The interpretations are presuppositions on the interpretation of  $\alpha$ . In the typical case,  $\alpha$  is an unembedded sentence, the intonational morphemes are taken to be syntactically attached to it, and to contribute a presupposition to its interpretation by (26). The content that the intonational meanings modify is not the meaning of  $\alpha$ , but a salient proposition,  $g(j)$  in (26). Just as the definite description ‘the book’ will look for a unique salient antecedent that is a book in the context, so  $\langle H^*, \text{new}_j \rangle$  will now look for a unique salient antecedent proposition in the context that S adds to the common ground of S and A. The presupposition is satisfied, and the meaning of its sister  $\alpha$  defined, if  $\langle H^*, \text{new}_j \rangle$  finds such an antecedent. (I return to accommodation in section 3.6.) Similarly,  $\langle H-, \text{question}_j \rangle$  will look for a unique salient antecedent proposition that S puts up for question. We must assume that  $\alpha$  is linearly ordered before the intonational morphemes and is interpreted first, so that the salient propositional antecedents for  $p$  are those that are salient *after* the

interpretation of  $\alpha$ . The linear order of course corresponds to the fact that the edge tone H- is a tone of the right, rather than the left edge.

Notice that the logic of search for an antecedent proposition comes out in a more specific way in (26) than in Bartel's more general suggestion that salient propositions are relevant. Consider first our comparison case. In the interpretation of *the book*, the antecedent must be a uniquely salient book. It need not be a uniquely salient individual as such, nor the most salient individual of all. Similarly, the consequence of (26) is that an antecedent proposition for H\* is a uniquely salient *speaker-asserted* proposition, not a uniquely salient proposition as such, nor the most salient proposition of all. Similarly, an antecedent proposition for H- is a uniquely salient *proposition put up for question by the speaker*. It need not be the most salient of all salient propositions. This seems to be very reasonable. For example, in *I'm calling from SKOKIE?* in (22a), H\* finds a uniquely salient proposition that can be taken to be asserted by the speaker, namely the content of the declarative. H- finds a uniquely salient proposition that can be taken to be put up for question by the speaker, namely something along the lines of *You know Skokie*.

This suggestion is applied to the cases of section 3.1. in the following section and is further pursued after that. Notice for now that there is good evidence that the parameters S and A in (26) are shared between the intonational interpretation and the interpretation of  $\alpha$ . This aspect of (26) adequately restricts the interaction of intonation with embedded clauses. I take S and A to be the part of a context in the sense of Kaplan (1989), which also serves for the interpretation of personal pronouns. This correctly restricts intonational meanings to be interpreted relative to the actual speaker and addressee of an utterance, unless S and A shift in case of quotations. Thus in (27a) the final rise cannot be triggered by the embedded question, because its proposition is put up for question by John, not by the speaker. (The parameters S and A have not shifted here: John is still referred to in the third person in the embedded clause.) This is different in (27b), where the quotation can be marked by intonation (Bolinger 1946, Bolinger 1989: 40f). Here the rise is triggered by the embedded yes/no-question "Should I bring a present". With quotational embedding, the parameters S and A shift to those of the quote, as can be seen by the use of a first person pronoun for John in the quote. Thus, the intonational meaning can here be adjoined to the quote (the quote is then  $\alpha$  in (26)). The shifted speaker-parameters in the quote (with S = John) then license H-, since the shifted speaker John is putting this proposition up for question. Consider then also (27c). In the first person present, a rise is marginally licensed by such an embedded question, even though the most unmarked intonation would employ a fall that corresponds to the assertive character of the entire utterance. Where the marginal rise is used, the embedded proposition 'I should bring a present' is an antecedent that can be taken to be put up for question by the speaker. The speaker shows by the rising intonation that s/he is not just reporting about her wondering, but putting this proposition up for question in the context of the utterance.

- (27) a. John wondered if/whether he should bring a present [N] #[/]  
       b. John wondered: "Should I bring a present" [/]  
       c. I wonder if I should bring a present [N] (#) [/]

In short, (26) correctly captures that intonational meanings are interpreted relative to the referents of 'I' and 'you'.

Are the presuppositions in (26) normally satisfied by independent speech act components or do we need to assume that they are typically accommodated? The answer depends on ones favorite assumptions about such independently established speech act components. There are suggestions about them since at least Ross (1970). More recent work includes Gunlogson (2001), Krifka (2001, 2011) and, for German, Gärtner (2000, 2002), Schwabe (2007a,b) and Truckenbrodt (2006a,b). Since there is no established consensus, the issue is largely left open here. I will advance on the following assumptions: Declaratives carry the seeds of assertions in them. Syntactic interrogatives carry the seeds of question speech acts in them. Furthermore, I will argue below that accommodation of the presuppositions in (26) is fairly straightforward. Where it occurs, it will be seen to *establish* a speech act. I will often ignore the issue of presupposition satisfaction vs. accommodation. The presuppositional analysis is primarily motivated indirectly in the parallel to definite descriptions that allows us to make sense of the relevance of salient propositions. An alternative implementation might pursue conventional implicatures in the sense of Potts (2005).

I nevertheless think that there are cases that are suggestive of a search for unique and recoverable antecedents, in the way familiar from definite descriptions. For one thing, we can now analyze (22b) as a failed search for an antecedent that results in presupposition failure. It is infelicitous in its context in the same way in which a definite description without an identifiable referent/antecedent is infelicitous in a given context ('Hi Susan, where are you calling from? I am calling from Skokie. # I like the cat.'). For another thing, consider again alternative questions. Why isn't a rise permitted in (24c), given that two propositions are put up for question, 'you went to Berlin' and 'you went to Potsdam'? A plausible answer is that they are parallel and both put up for question, and thus neither of them is uniquely recoverable. This is comparable to definite descriptions. *The raven* in (28) has no unique salient antecedent, since the two antecedents in question are parallel.

- (28) A small raven and a large raven were sitting on a fence. # *The raven* opened its wings and . . .

In summary, a formal implementation of intonational meanings was given in which Bartels' relevance of salient propositions finds its place. H\* presupposes that the speaker is adding a proposition to the common ground. H- presupposes that the speaker is putting up a proposition for question. The context parameters S and A are shared with the interpretation of personal pronouns. The relation to these propositions is comparable to the relation between a definite description and its antecedent.

### 3.3. Applications to the three 'standard' cases and to further yes/no-questions

Let us then account for (24a-c) in the presuppositional analysis. The examples are repeated here as (29a-c).

- (29) a. Did you go to BERLIN [/] L\*H-(H%)  
 b. Where did you GO [∅] H\*L-(L%)  
 c. Did you go to BERLIN or to POTSDAM [∅] H\*L-(L%)

H- in (29a) now looks for a proposition put up for question by the speaker. It finds ‘you went to Berlin’, which can be taken to be put up for question due to the sentence form. The presupposition of H- is then satisfied for this proposition as its antecedent.

The absence of H- in (29b) corresponds to the absence of an obvious proposition put up for question here. However, what is asserted by H\* here? According to Bartels, the intonation of (29b) (for her: the L- tone) asserts the existential implicature of the wh-question, here: ‘you went somewhere’. In the current account: By (26a), H\* looks for a speaker-asserted proposition. It finds the implicature that ‘you went somewhere’ is true. (The difference in strength of commitment between the actual implicature and the assertion that is required by the presupposition of H\* may well be accommodated; see section 3.6. on accommodation.)

What is asserted by H\* in (29c)? According to Bartels, the intonation here asserts the uninverted interrogative ‘you went to Berlin or to Potsdam’. In the current account: H\* in (26c) looks for a speaker-asserted proposition, and finds the speaker assumption ‘you went to Berlin or to Potsdam’. (I return to the nature of this assumption.)

There are also uses of the syntactic yes/no-question form in which the salient proposition is asserted by H\*. An example from Bartels:

- (30) A: Let’s start the meeting. John called to say he’d be late because he had trouble getting his car started.

H\* L-L%

B: Does John have a CAR now [∨] I didn’t know that. (Bartels 1999: 128)

Here the speaker deploying H\* seems to add to the common ground ‘John has a car now’.

In a different use of [∨] in yes/no-questions, it contributes a sense of “cross-examination” or of “keeping someone to the point” (Schubiger 1958: 63f) as in the examples (31a) and (32a) (B99: 127). Bartels relates this to a salient disjunction of the two possible answers ‘yes’ and ‘no’ which she calls *alternative-proposition*. [∨] here marks the endorsement of this alternative-proposition, as shown in (31b) and (32b). Bartels (1999: 135) points out that the falling intonation in (33b) has a similar effect of insistence as the addition in (33c), where the disjunction is overt in an alternative question. The salient propositions operated on by the intonation are shown on the right.

- (31) a. Prosecutor to witness in court:

H\*                      L-L%

Do you KNOW the defendant? [∨]

- b. B99: Due to L-, S asserts: ‘A knows the defendant or A doesn’t know the defendant’

- (32) a. A: I’m sure of it. I have heard it said many times.

H\*L-L%

B: Yes, but did you see it YOURSELF? [∨]

- b. B99: Due to L-, B asserts: ‘A saw it himself or A didn’t see it himself’

- (33) a. Did you buy it? [∨]

(p = A bought it)

- b. Did you buy it [∨]

(p = A bought it or A didn’t buy it)

- c. Did you buy it or didn’t you [∨]

(p = A bought it or A didn’t buy it)



When does the alternative-proposition come into play? The classical analysis of yes/no-questions  $[q?]$  is that they are hidden alternative questions, i.e. their possible answers are  $\{q, \text{not } q\}$ , see e.g. Karttunen (1977). Bolinger (1978b) presented interesting arguments against this. His suggestion, put in these terms, is that their set of possible answers is the singleton set  $\{q\}$ . For embedded questions, he distinguishes whether-questions  $\{q, \neg q\}$  from if-questions  $\{q\}$ . Bartels suggests that unembedded yes/no-questions can similarly have either the meaning  $\{q\}$  or the meaning  $\{q, \neg q\}$ . In the former case,  $q$  is particularly salient, in the latter case, ' $q \vee \neg q$ ' is particularly salient. Bartels suggests that (31), (32) and (33b) are of the latter kind. The intonation here endorses the alternative proposition, with a sense of "keeping the addressee to the point." These suggestions are adopted here.

Is there some way of adding stability to the assumptions about salient propositions with interrogatives? I believe there is. Showing this in the following section will require another formal excursion.

### 3.4. The implicature that there is a true answer

A question is a request for the truth among the possible answers defined by the question (Karttunen 1977, Groenendijk & Stokhof 1997). In posing a question, the speaker will normally assume that there is a truth to the matter, i.e. that there is a true answer. In wh-questions, the existential implicature that we saw above is exactly this assumption. In (34a), for example, Mary can be taken to implicate that there is a true answer, i.e. that Bill brought something to the party. This assumption is attributed to the person asking the question, i.e. to Mary in (34a). In (34b), it is still attributed to Mary. It seems that the speaker of the utterance (34b), who here reports Mary's question, need not share that assumption.

- (34) a. Mary to John: What did Bill bring to the party?  
 b. Mary asked John what Bill brought to the party.

The implicature is formulated in a general form in (35), due to Sigrid Beck (p.c.).

- (35) If  $T$  is the set of true answers of a question  $Q$  (i.e.  $T$  is the meaning of  $Q$  according to Karttunen 1977), then a person asking  $Q$  implicates  $T \neq \emptyset$ .

(35) is applied to a wh-question meaning following Karttunen in (36). It derives the existential implicature that we saw.

- (36)  $Q$  in  $w$ : Who does John like?  
 $T = \{p \mid p(w) \wedge \exists x p = \lambda w' \text{ likes}'(w')(j,x)\}$   
 Implicature:  $\{p \mid p(w) \wedge \exists x p = \lambda w' \text{ likes}'(w')(j,x)\} \neq \emptyset$   
 $\Leftrightarrow \exists p, p(w) \wedge \exists x p = \lambda w' \text{ likes}'(w')(j,x)$   
 $\Leftrightarrow \exists x \exists p, p(w) \wedge p = \lambda w' \text{ likes}'(w')(j,x)$   
 $\Leftrightarrow \exists x \text{ likes}'(w)(j,x)$   
 'John likes someone in  $w$ .'

(37) shows the application of (35) to the meaning of an alternative question, again following Karttunen. It derives that the disjunction of the alternatives is implicated.



(37) Q in w: Did you go to Berlin or to Potsdam?

$T = \{p \mid p(w) \wedge (p = \lambda w' \text{ went}'(w')(A, \text{Ber}) \vee p = \lambda w' \text{ went}'(w')(A, \text{Pots}) )\}$

Implicature:  $\{p \mid p(w) \wedge (p = \lambda w' \text{ went}'(w')(A, \text{Ber}) \vee p = \lambda w' \text{ went}'(w')(A, \text{Pots}) )\} \neq \emptyset$

$\Leftrightarrow \exists p, p(w) \wedge (p = \lambda w' \text{ went}'(w')(A, \text{Ber}) \vee p = \lambda w' \text{ went}'(w')(A, \text{Pots}) )$

$\Leftrightarrow \text{went}'(w)(A, \text{Ber}) \vee \text{went}'(w)(A, \text{Pots})$

"You went to Berlin or you went to Potsdam."

For yes/no-questions I follow Bartels and assume that they are ambiguous between singleton question meaning (Bolinger 1978b) and hidden alternative question meaning (e.g. Karttunen 1977). For the singleton case  $\{q\}$ , (35) leads to the implicature that  $q$  is true. For the hidden alternative question meaning  $\{q, \neg q\}$ , the implicature that follows from (35) is ' $q \vee \neg q$ '. This is derived in a parallel fashion to the alternative question in (37) and is not shown for reasons of space.

The implicatures are summed up in (38).

(38) *Implicature that there is a true answer*

- |                             |                                                       |
|-----------------------------|-------------------------------------------------------|
| a. Did you go to B?         | i. (singleton) You went to B.                         |
|                             | ii. (hidden alternative) You went to B or you didn't. |
| b. Where did you go?        | You went somewhere.                                   |
| c. Did you go to B or to P? | You went to B or to P. (alternative question)         |

We now see that for all falling interrogatives discussed up to here, in particular those in (29)–(33), the proposition marked by the intonational meanings is identical to the implicature that there is a true answer. The singleton proposition 'you went to Berlin' that is asserted by  $H^*$  in (30) is the implicature that there is a true answer by (38a.i). In the hidden alternative cases (31), (32) and (33b), Bartels 'alternative-proposition' turns out to also be an implicature that there is a true answer as in (38a.ii). 'You went somewhere' is asserted in the wh-question (29b) and is implicated by (38b). 'You went to Berlin or to Potsdam' is asserted in the alternative question (29c) and is implicated by (38c).

We can therefore add stability to the assumptions about salient propositions by hypothesizing:

(39) In the interpretation of a standard interrogative the implicature that there is a true answer is a particularly salient speaker-endorsed proposition.

The implicature that there is a true answer is thus a likely and salient proposition for intonational marking by  $H^*$  in an unembedded question.

Notice that this implicature is not the only salient proposition that we want to assume even for the core cases discussed up to here. However, it so happens that the other salient propositions in the interrogatives discussed up to here are identical to the implicatures that there is a true answer. First, it is sometimes suggested that the disjunction of the alternatives in alternative questions, which is identical to the implicature in (38c), is independently a presupposition of the alternative question (Karttunen 1977: 176 "in the intuitive sense of the term 'presuppose' ", Bartels 1999, Truckenbrodt to appear). Thus, there may be a second source for the same proposition here. However, this is not detrimental to the current account.

The second case involves the singleton yes/no-questions, which we now need to review with our assumptions further evolved. *Did you go to Berlin?* in (29a), for example, puts up for question 'you went to Berlin'. At the same time, 'you went to Berlin' is the implicature of this question by (38a) on a singleton meaning. How might this be reconciled? The assignment of H-, which additionally puts up for question 'you went to Berlin', may be taken as a way of backgrounding, suppressing or weakening this implicature, by foregrounding the questioning aspect. By contrast, in the singleton question (30), the implicature 'John has a car now' is not put up for question by the intonation. It is endorsed by H\* which we may here take to be an endorsement of the implicature that John has a car now. In this case the seeds of the questioning speech act that come from the interrogative sentence form seem to be overridden.

For the questions in (31), (32), and (33b), we follow Bartels in treating them as hidden alternative questions. Deriving Bartels' 'alternative-proposition' from (35) not only gives this proposition a non-arbitrary source. It also seems to complete Bartels' analysis. The question that did not receive a full answer there is why the presence of the alternative-proposition (overtly or covertly) brings with it the impact of 'keeping the addressee to the point'. Deriving it from (35) seems to fill this gap: The alternative-proposition is the existence of a true answer. It can also be paraphrased 'there is a true answer'. Where the speaker highlights this element, s/he highlights that s/he is out for the truth. This is plausibly the source of the effect of 'keeping the addressee to the point'.

We have now made Bartels' discovery of the relevance of salient propositions precise in two respects. For one thing, we have a presuppositional account (with a formal parallel in definite descriptions) that calls salient propositions on the plan to begin with. For another, we were able to identify a recurrent source of salient propositions in connection with falling interrogatives, namely their implicatures that there is a true answer. With this, let us turn to additional empirical observations.

### 3.5. High-rise in yes/no-questions

Yes/no-questions also allow a H\*H-H% rising pattern. PH90: 291 give the example in (40). They note that the H\*H-H% is more likely when the expected answer is 'yes', while a choice of L\*H-H%, according to them, transports more of a sense that the issue is really open to S.

- (40)                    H\*    H-H%  
May I INTERRUPT you? [-]

Two examples from B99: 126 are shown in (41) and (42).

- (41)                    H\*            H-H%  
You're BACK already? [-]

- (42) A: (Showing B how to make a blouse) This is the left sleeve; and here is the right one.  
B:                    H\*                                    H-H%  
Is there any DIFFERENCE between them? [-]

The remarks by PH90: 290f about this case are tentative. The assumed contribution of H\* goes in the expected direction, insofar a weakly assertive impact is added by H\*. However, it would seem to be too strong to assume that the speaker of these questions instructs the addressee to add a full yes-answer to the common ground. This would seem to be in conflict with the questioning impact. The current extensions allows us to develop a more detailed understanding of the weak effect at hand.

Recall first from the discussion of H\*H-H% on declaratives in section 2.4. that H\* and H- cannot operate on the same proposition because they would require incompatible speech-acts of this proposition. In declaratives, the primary speech act is that of an assertion, and the context supports an assertion interpretation in (20)–(22). It is plausible that H\* identifies this as a salient speaker-asserted proposition and takes it as its antecedent, so that H- then has to look for another proposition, one put up for question by the speaker, to mark. That is what we saw. In the interrogative sentences in (40)–(42), a question-interpretation is supported by the context (and in (40) and (42) by the sentence form). Here it is plausible that H- finds the proposition put up for question as its antecedent. In this case, then, H\* is left to look for a (different) speaker-asserted proposition to modify. We look for this proposition in the neighborhood of the implicature of a true answer. We assume that (40)–(42) are singleton yes/no-questions, i.e. the content of their implicature is identical to the proposition put up for question. We must independently assume that this implicature can at best survive the questioning impact in a weaker form. It is compatible with the questioning impact, for example, that the speaker assumes, or supposes, that the answer is ‘yes’. Let us assume that this is what remains of the implicature. In (42), then, the *content* of the implicature is ‘there is a difference between them’, but the *fact* of the implicature would be ‘I suppose that there is a difference between them’. Since endorsing the content of the implicature by H\* would lead to an interpretation that conflicts with the questioning intention, it is reasonable to maintain that H\* instead operates on the proposition that corresponds to the *fact* of the implicature, i.e. ‘I suppose that there is a difference between them’. This would correctly represent the weak effect of H\* in yes/no-questions.

### 3.6. Accommodation

The suggestion that H- has a meaning connected to simple question speech acts is motivated by the way this separates the declarative examples with H- (questioning) from those without (not questioning). It is also motivated by examples like (8), repeated here as (43) with additions. In both kind of cases, it seems likely that the question-meaning comes directly from the intonation, since there is no other source for it in sight. In the current account, intonational meaning can induce a question meaning with the help of presupposition accommodation. In (43) the meanings presupposed by the intonation are shown on the right. We get the correct results if the intonational presuppositions are accommodated here. I make the standard assumption that unembedded presuppositions are requirements over the common ground, and that their accommodation is addition to this common ground (Stalnaker 1978, 2002). The result of accommodation in (43a) is then that it is part of the common ground of John and Mary that (as presupposed) John is putting up for question whether Mary wants coffee. In other words, it is then established in the common ground that John is asking this question. Similarly in (43b).

- (43) John and Mary are taking a break from work. John is getting up and looks at Mary.
- a. John: Coffee [ / ] L\*H-H%      H-: John presupposes:  
John is putting up for question whether Mary wants coffee
  - b. Mary: Coffee [ \ ] H\*L-L%      H\*: Mary presupposes:  
Mary is adding to the common ground: Mary wants coffee

Lewis (1979) argues that for presuppositions not otherwise satisfied, accommodation is the normal case. Here I discuss the two possible obstacles to accommodation that I am aware of and where they might intervene with accommodation in (43). (i) Accommodation may be refused for reasons of plausibility. *My brother* or *my cat* may be accommodated, but *my palace* or *my elephant* are more likely to prompt questioning. Similarly, *my desire to ask you a question* is likely to be accommodated, but *my desire to live on the moon* is not. This criterion does not seem to interfere with accommodation in (43), since putting up something for question or asserting something are harmless, expected actions in a conversation. (ii) Accommodation generally works well where the speaker is the expert on the matter to be accommodated. In the standard example of accommodation of *my brother*, the speaker is the expert on the existence of such a brother. The addressee will typically be trusting enough to go along. The addressee will, on the other hand, not normally accommodate something s/he is the expert on and didn't know about, such as the referent of *your brother*. Similarly, in 'Did I tell you about my satisfaction with the outcome of the case?', the satisfaction is easily accommodated, since it is in the realm of the speaker's thoughts, of which the speaker alone is an expert. On the other hand, *your satisfaction with the outcome of the case* cannot normally be accommodated since the addressee's feelings are in the expertise of the addressee. For this criterion, the questioning meaning of H- is unproblematic: It is in the realm of the speaker's thoughts what he may intend to put up for question. No addressee-contribution beyond listening seems to be required for this speech act to succeed. Matters are more complex for the presupposition of H\* that the speaker is adding a specific proposition to the common ground. While the speaker's intention of doing so is straightforward to accommodate, satisfaction of this presupposition also requires the addressee's accepting the relevant proposition into the common ground. The supposition that the addressee will do so is embedded in the mutual knowledge about the relation between the two, on the basis of which the speaker also offers his information. This will typically include assumptions about the accepted expertise of the speaker in the issue he talks about. It therefore does not seem to be out of place in most cases. Notice in support of this that 'your trust in me' or 'your learning this from me' are not unreasonable presuppositions to offer for accommodation in many contexts. At the same time, the presupposition is a strong one. If such presuppositions occur, addressee objection to them is certainly a possibility and does of course occur.

It may be interesting in a more general way that the assertive impact that is attributed to H\* in (26a) can derive the notion of assertion of Stalnaker (1978). Stalnaker's notion of assertion is that the content of the assertion is added to the common ground, unless the addressee objects. This is what results if the presuppositional meaning of H\* is accommodated. First, the accommodation of (26a) requires the addition of the content to the common ground. Second, accommodation is more generally subject to the possibility of

The exact formulation in PB90 is that H\* marks the relevant proposition as ‘to be added to’ the common ground (e.g. PB90: 290). The formulation in (26a) is slightly stronger: H\* *presupposes* that the relevant proposition is *being* added to the common ground. We don’t have enough evidence to choose between the formulations, but it is perhaps worth knowing that the stronger formulation is also coherent and that its effect amounts to Stalnaker’s notion of assertion.

Echo wh-questions show the interesting intonational contrast in (44) (Bolinger 1978a: 108, Rando 1980: 250, Bartels 1999: 211). The obligatory rising intonation in (44a) is found in two readings: the speaker of the echo question may not have understood the object of the preceding utterance or may be in surprised disbelief about the object referent. The clear preference for a fall in (44b) occurs with definite pronouns in the echoed utterance.

- b. A: Where did he go?  
H\*L-L%  
B: Where did WHO go [N]

(45) you: When you visited John ...  
me: I visited WHO? [/]

With this, I now return to (44). Rando (1980: 256) notes that cases like (44a) ask for a repetition of the preceding information while cases like (44b) ask for new information.

Let us pursue the difference in these terms. Asking for new information is the normal case. Here we find the fall of *wh*-questions, as in (44b). I return to this case below. For now, let us pursue (44a). How do you ask for a repetition of preceding information? Consider (46), without rising intonation. Why is it odd for B to ask this question? What seems to be at work is a default assumption that the preceding utterance has become part of the common ground after it occurred, in the absence of an objection. Furthermore, that B's question with a fall in (46) does not count as an objection, i.e. it is not enough of a sign that the preceding utterance was not understood. Therefore, B's question is infelicitous because the answer to it is already in the common ground, and no sensible intention of the question can be inferred.

- (46) A: Rita married Jim Montague.  
 B: # WHO did Rita marry? [↓]

This would mean that asking for a repetition of a preceding utterance requires a clear sign that the default assumption (that the preceding utterance has been added to the common ground) does not apply. It seems plausible that the rise somehow generates this sign. How might this work? My answer is tentative and leaves some issues unresolved. For the reading of (44a) in which the echoed utterance is understood but not believed, a plausible antecedent proposition for H- is 'You asked where John went'. Put up for question by H-, this amounts to 'Are you asking where John went?'. This is the clearest possible sign that the echoed utterance has not become part of the common ground. We must leave open where exactly this antecedent proposition comes from: It might be the echoed speech act (a non-local antecedent of H-) or it might be the true answer of the echo question (a local antecedent of H-). For the reading of (44a) in which the echoed utterance was not completely understood, a plausible antecedent proposition for H- is 'You asked where someone went'. Put up for question by H-, this amounts to 'Are you asking where someone went?'. This is still a very clear sign that the preceding utterance was not understood. The source is again not uniquely clear: The antecedent proposition might be the echoed speech act, perhaps with existential closure for the non-understood part. Or it might be the implicature of the existence of a true answer to the echo question, which would be derived from the echo question interpretation 'Of which *x* are you asking where *x* went?'. In all these interpretations, it seems that the presupposition of H- must be accommodated.

We will not settle what distinguishes signs of objection to the preceding utterance from non-signs. A reasonable hypothesis is that challenges to the preceding utterance becoming common ground must in some sense be 'direct attacks'. Choosing H- to signal 'Are you asking where John/someone went?' is a direct challenge to the preceding speech act. In (46), on the other hand, the relation is more indirect: B's question would make sense if it was assumed that A's utterance has not become common ground. This is not a 'direct attack'. It may also play a role in (46) that the H\* of the fall most likely endorses the implicature of a true answer, 'Rita married someone'. Thus part of the preceding utterance is acknowledged. In addition, the chance to signal with the use of H- that the preceding utterance was not understood was not taken.

Notice that there is independent support for the notion that the true answer to a question can be marked by the intonation. This seems to be the case in rhetorical questions like (47) (B99: 128). In rhetorical yes/no-questions the answer that is recognizably assumed

to be true is typically the negation of the uninverted interrogative. Here the use of H\* can be seen as endorsement of that negated (and indirectly asserted) proposition.

- (47) H\*L-L%  
 Why should I pay for that? Am I my brother's KEEPER? [ ]  
 (H\* operates on the salient true answer 'I am not my brother's keeper')

Let us then complete the analysis of (44b). We now assume that the preceding speech act is becoming part of the common ground, despite the inability of B to resolve the reference of the pronoun. We may assume for concreteness that this is possible with a temporary e-type interpretation of the pronoun (Evans 1980, Heim 1990), here: 'the one Rita married'. No sign is therefore required that the preceding speech act has not become part of the common ground. H\* might endorse 'you asked where someone went'. Thus, the difference between (44a) and (44b) can be made sense of in the current account: In (44a), but not in (44b), the rising intonation with H- is required to generate a sign that the preceding utterance has not become part of the common ground.

B99: chs. 5, 6 pursues a different idea about the rise in echo-questions. She suggests that in cases like (48) the rise has the motivation and effect of not asserting the existential implicature because the addressee knows it already. However, this would wrongly predict that the rise is also obligatory in (49), where the addressee also already knows the existential implicature. Examples like (16) also support the suggestion of PH90 that assertive addition to the common ground is possible where the addressee already knows the proposition.

- (48) A: Rita married Jim Montague on Sunday  
L\*      H-H%  
 B: Rita married WHO on Sunday [ ]
- (49) A: Rita married someone.  
 B: Who did Rita marry [ ] (or [ / ])

In summary, it seems that the function of the rise in echo-questions is to generate a sign that the echoed utterance has not become part of the common ground, and thus to clarify that the echo-question asks for a repetition or clarification of that utterance.

### 3.8. The friendly rise in wh-questions

We took the fall to be the default intonation in wh-questions. However, a friendly rise is optionally also possible as in (49) and many other cases. The variation between fall and friendly rise contrasts with the obligatory echo-question rise in (44a) and (48). It also contrasts with a strong preference for a fall in sentences in which the echo-questions seeks to clarify the reference of a pronoun as in (44b) and in (50), which does not have echo-question syntax.

- (50) A: Rita married him.  
H\*              L-L%  
 B: WHO did Rita marry [ ]



This friendly rise is also seen in the examples (51) and (52) from Schubiger (1958: 59). She describes the connotation as “regardful; interested request for information” (Schubiger 1958: 58).

- (51) a. A: I was on holiday last month.

L\*H-H%

B: Where did you GO [/]

- b. A: Ireland.

L\*H-H%

B: How did you LIKE it [/]

- (52) To somebody showing a new purchase:

L\* H-H%

How much did it COST you [/]

Let us develop an analysis. Notice first that something similar to ‘keeping the addressee to the point’ with a [/] also occurs with wh-questions, as in (53). Here ‘keeping the addressee to the point’ blocks the option of the friendly rise.

- (53) a. Tell me the truth. Who left? [/] #[/]

b. Well, SOMEONE left. Who is it [/] #[/]

I suggest the following understanding of these choices. First, since the typical fall in wh-questions presupposes a speaker-assertion of the existential implicature, it presupposes a speaker-assertion that there is a true answer (see section 3.4). In (53), this point is in the foreground. In other falling wh-questions and in alternative questions, where the fall similarly signals the existence of a true answer, the pragmatic effect of the fall is not as strong as with yes/no-questions: Only yes/no-questions have a standard alternative choice, namely highlighting by H- that a salient proposition is put up for question. The pragmatic effect of insisting on the existence of a true answer is here more striking, because an alternative without it would have been among the standard choices.

Second, we need to add a further source of salient propositions for the friendly rise. We obtain a plausible result if we take the speech act of the question into account. Following Hintikka (1975) the interpretation of ‘Where did you go?’ would be ‘Bring it about that I know where you went’. Putting a propositional form of this up for question results in ‘Will you bring it about that I know where you went?’. This would seem to add friendliness. It would show that it is up to the addressee to answer. (The addressee might prefer not to share the answer or might not know it.) I suggest that the source of the friendly rise in (51) and (52) is to be sought along these lines. We may assume that this is not a ‘standard’ choice in the sense of the preceding paragraph, because it accesses the speech act, unlike the two choices available for yes/no-questions.

An indication that it’s up to the addressee to answer would not be appropriate in (53), where the speaker of the question is clearly out for the truth, and thus also for an answer that makes the truth known.

In (49), then, the friendly rise also signals that it’s up to the addressee whether s/he wants to answer, i.e. whether s/he wants to share this information. Here the addressee



used an indefinite object in the preceding utterance. Revealing the individual behind it would be a further step in sharing information. It now correctly follows that the friendly rise is a less likely intonation pattern in (50) and (44b), where the referent of a personal pronoun is asked for. Here the addressee of the question has already tried to share the relevant information in the use of the personal pronoun (even though unsuccessfully, since the referent of the pronoun was not recovered). There is no point then in signaling with the friendly rise that the addressee may prefer to keep this information to herself.

I sum up the discussion of the intonation in interrogatives. It seems that the meanings for H\* and for H- that were first motivated with declaratives also fare well in the analysis of interrogative meanings. In the course of developing this point, a range of formal aspects were addressed: Presuppositional meanings for H\* and H- were suggested, their accommodation was discussed, and it was motivated that the implicature that there is a true answer is a particularly salient proposition with interrogatives.

## 4. Other tune meanings and related issues

This section briefly raises a number of issues not addressed above: Do English L\* and L- carry meaning (section 4.1.)? What about continuation rises (section 4.2.)? What meanings do English complex pitch accents carry (section 4.3.)? Can the intonation encode the distinction between declaratives and interrogatives (section 4.4.)?

### 4.1. Do English L\* and L- carry meaning?

L\* does not seem to carry any discernible meaning in English. However, there is no harm in assigning it meaning that is the negation of the meaning of H\*, as in PH90. If no meaning is assigned to L\*, we must ensure that L\* is only chosen where H\* is not appropriate. This would follow if the choice between L\* and H\* is subject to presupposition maximization (Heim 1991), so that H\* with its presupposition is chosen for modification of the most salient available proposition where the context allows it.

The issue is more complex with L-, for which B99 postulates assertive meaning. The examples discussed here are compatible with adding a weakly assertive meaning to L-. However, the account above also leaves no clear motivation for such a move. Consider first declaratives. In many cases, H\*, the standard choice, will contribute an assertive impact independently. Where it does not and where we still want some assertive impact in a weaker sense (speaker endorsement), as in (14) and (15), L- might in principle provide it. However, it is not clear whether it could not also come from morphosyntactic elements of the declarative sentence form or from the pragmatics, given the propositional meaning of the declarative. In various interrogatives, Bartels suggests that L- corresponds to an endorsement of different salient propositions by the speaker. Given the revisions above, however, (a) these salient propositions are all independently implicatures that there is a true answer, and thus, as implicatures, independently endorsed by the speaker and (b) they are often endorsed by the speaker with the H\* that accompanies the L- in these cases and that signals assertion of the implicature in the current analysis. At this point, there is no clear motivation for additional speaker-endorsement of these propositions by L-.

In summary, the current account is compatible with assigning L\* a meaning that is the negation of H\* and with assigning L- a meaning of speaker endorsement, but there is no clear evidence for either of these moves.

## 4.2. Continuation

High right edges are also known to signal continuation. PH90: 302ff show that this applies to both H- and H% in English. They suggest that H- “indicates that the current phrase is to be taken as forming a part of a larger composite interpretative unit with the following phrase” (PH90: 302) and that H% indicates that the utterance is to be interpreted “with particular attention to subsequent utterances” (PH90: 305). The direction pursued here is that there is an H- morpheme with questioning meaning and a separate H- morpheme with continuation meaning. This is compatible with the discussion in Gussenhoven (2004: ch. 5) where different paralinguistic motivation is suggested for the H/L-contrast in its relation to questions vs. statements (‘size code’) and in relation to continuation (‘production code’). In English, the typical continuation rise in statements is the H\*L-H% (without H-) seen in (10) while the yes/no-question contour is L\*H-H% (with H-). The continuation-marking function of H- is seen on H- tones at the end of intermediate phrases that are not also intonation phrase boundaries (PH90: 302ff). There are some open issues in regard to the H\*H-L% contour as in (54) from PH90: 291. In this particular occurrence, H- is not questioning or non-assertive, but its final occurrence also does not indicate continuation.

(54) Mostly they just sat around and knocked stuff. You know.

|                |                  |
|----------------|------------------|
| H*H-L%         | H*H-L%           |
| The SCHOOL [—] | Other PEOPLE [—] |

One might explore a definition of the ‘continuation’ H- in which the relevant proposition *forms part of a larger interpretative unit*, though not necessarily with following material. It might be typically used for indicating such a unit with following material. On the other hand, its occurrence in (54) could highlight that ‘they talked about the school’ and ‘they talked about other people’ also form part of a larger interpretative unit, ‘they knocked stuff’, regardless of whether this includes following material.

## 4.3. English complex pitch accents

In addition to H\* and L\*, English also has the complex pitch accents L\*+H, L+H\*, H\*+L and H+L\*. The starred tone is more narrowly associated with the stressed syllable, and the other tone precedes or follows it, not necessarily on the same syllable. These differences carry pragmatic meaning in English. For example, the L+H\* seems to be more often used when the new (H\*) element is also contrasted. The L\*+H L-H% contour can be used to express uncertainty or incredulity (Hirschberg & Ward 1992). A range of observations and hypotheses can be found in PH90. In their account, the meanings of H\* (new) and L\* (not new) are retained in the complex pitch accents. In addition, the L+H accents (L\*+H and L+H\*) invoke a semantic scale on which the accented element is located. The H+L accents (H\*+L, H+L\*) indicate that support for what is expressed should be inferable in the common ground. See also Hobbs (1990) for suggested revisions. Parallels to German modal particles are explored in Schubiger (1965, 1980).

## 4.4. Declarative/interrogative

In many languages yes/no-questions are not distinguished from declaratives by morphosyntactic means. The distinction rests on the intonation. One such case, Brazilian

Portuguese (BP) is investigated in Truckenbrodt, Sandalo & Abaurre (2009). The Campinas variety investigated shows H+L\* L- on assertions, L+H\* L- on yes/no-questions and L\*+H L- on *surprise questions* which seem to be functionally equivalent to English declarative questions (Gunlogson 2001):

|         |                                    |                                                  |
|---------|------------------------------------|--------------------------------------------------|
| BP H+L* | is like English declarative+[H*]   | (declarative with assertion: It was raining[\\]) |
| BP L+H* | is like English interrogative+[H-] | (yes/no-question: Was it raining[/])             |
| BP L*+H | is like English declarative+[H-]   | (declarative question: It was raining[/])        |

The paper offers a decomposition of the Brazilian Portuguese tunes in which the L\*+H surprise/declarative question contour of BP shares the L\* with the BP declarative (with assertion) and shares the L+H with the BP yes/no-question. The analysis thus identifies the star on the BP L\* as the contribution that is provided by the English sentence form declarative, and the BP sequence L+H as the contribution that is provided by the English yes/no-question intonation (with a meaningful English H- in the current analysis). The study is limited in scope, and other question types were not investigated.

Aboh & Pfau (2011) present a final floating L tone that distinguishes unembedded yes/no-questions from declaratives in Gungbe. They show that the floating L also appears in embedded yes/no-questions and not in embedded declaratives. In embedded position the two clause types are additionally distinguished by different conjunctions.

## 5. Summary

The connection between intonational meaning and semantics is partly provided by the notion of an intonational morpheme. If this is attached to the syntactic structure as in (26), it can be interpreted in phonology and in semantics. The element shared with the semantic interpretation is the context in the sense of Kaplan (1989), which includes the parameters speaker and addressee. The intonational interpretation arguably shares these with the interpretation of personal pronouns.

According to (26), the intonational meanings do not operate on the meaning of the constituent they attach to, but on a salient proposition. The relevance of salient propositions, discovered by Bartels (1999), is here implemented in terms of presuppositional meanings of intonational elements.

The English H\* is hypothesized to presuppose that the salient proposition is being added to the common ground by the speaker. This is a minimally strengthened version of the suggestion for H\* in Pierrehumbert & Hirschberg (1990) and the suggestion of Gus-senhoven (1984) for the fall. In its strengthened form, its accommodation (which is assumed to be allowed up to addressee objection) generates an assertion in the sense of Stalnaker (1978).

The English H- is hypothesized here to presuppose that the salient proposition is being put up for question by the speaker. This is a suggested revision of earlier accounts that treat (L\*)H- as non-assertive. The strengthened version generates (by presupposition accommodation) a questioning speech act. This is seen as an advantage in particular with rising elliptical utterances and with declaratives marked with H-. These show no other source for a questioning impact. It also correctly accounts for the typical deployment of H- in yes/no-questions as opposed to wh- and alternative questions. This specific

suggestion for H- necessitates the assumption of a second H- morpheme with 'continuation' meaning.

Throughout a case was made that these meanings are adequate insofar they account for a range of renditions of declaratives and interrogatives with their pragmatic impact. The salient propositions employed in the discussion were: the content of a declarative, the connection of what is asserted to the addressee's knowledge, the propositional interpretation of vocatives and of greetings, the implicature that there is a true answer of an interrogative, the true answer, and contextually salient propositions (you want *coffee*). It was also hypothesized that the fact of a weakened implicature (the speaker supposes that there is a true answer) and question speech acts can serve as salient propositions.

*This research was funded in part by the Federal Ministry of Education and Research (BMBF) of Germany (Grant Nr. 01UG0711).*

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Hubert Truckenbrodt, Berlin (Germany)



# 78. Semantics of inflection

- 1. Inflectional categories
- 2. Person, number and gender
- 3. Case
- 4. Evidentials
- 5. References

## Abstract

*This article presents a typology of inflection and discusses recent work on the semantics of number, person, gender, case, and evidentiality. Cross-linguistic evidence is brought to bear on the relationship between inflections and lexical classes and the typology of semantic case, and motivates an analysis of number inflections as expressing associative meanings. The article addresses semantic markedness in number, person and case paradigms, and analyses of inflections at the syntax-semantics interface.*

## 1. Inflectional categories

This article presents a typology of inflection and discusses recent work on the semantics of number, person, gender, case, and evidentiality. Separate articles in the handbook cover the semantics of other inflections, including tense (articles 57 (Ogihara) *Tense* and 97 (Smith) *Tense and aspect*), mood (article 50 (Portner) *Verbal mood*), aspect (articles 48 (Filip) *Aspectual class and Aktionsart*, 49 (Portner) *Perfect and progressive* and 97 (Smith) *Tense and aspect*), and definiteness (article 41 (Heim) *Definiteness and indefiniteness*).

Inflectional morphemes assign values of functional features, whereas derivational morphemes form new lexical items. Thus, inflectional morphemes are bound functional heads (or their morphological equivalents, in lexicalist theories), while derivational morphemes are bound lexical heads. This basic distinction accounts for a characteristic cluster of properties given in Tab. 78.1 that distinguish derivation and inflection (see also article 79 (Lieber) *Semantics of derivational morphology*).

From a semantic perspective, inflections are a heterogeneous set. Jakobson (1985) noted that inflectional categories are intrinsically related to specific word classes (see section 2.4. below). He proposed a set of semantically defined features into which

Tab. 78.1: Inflection versus derivation

| <i>Inflection</i>                    | <i>Derivation</i>          |
|--------------------------------------|----------------------------|
| Specifies functional features        | Forms new lexical items    |
| Endocentric (non-category-changing)  | May be exocentric          |
| Typically outside derivation         | Closer to stem             |
| Typically paradigmatic               | Often non-paradigmatic     |
| Non-recursive                        | May be recursive           |
| Portmanteau morphemes occur          | No portmanteau morphemes   |
| Assigned by government and agreement | Not assigned syntactically |

inflectional categories are decomposed. Each feature is binary and privative, i.e. has a positively characterized MARKED value and a negatively characterized UNMARKED (default) value, forming a two-point Horn (1989) scale. Jakobson (1957/1971: 136) puts semantic markedness this way:

The general meaning of a marked category states the presence of a certain property A; the general meaning of the corresponding unmarked category states nothing about the presence of A and is used chiefly but not exclusively to indicate the absence of A.

On this view, morphological markedness is grounded in semantics, but has consequences in syntax, morphological form, and even in phonology. The most important formal reflex of markedness is that exponents of marked categories tend to be more complex and have a more restricted distribution. The convergence of semantic and formal markedness is widely assumed in grammatical theories (cf. the Monotonicity Hypothesis, Koontz-Garboden 2007).

Jakobson's analysis has four primitives: the speech event ( $E^s$ ), the speech participants ( $P^s$ ), the narrated eventuality ( $E^n$ , i.e. the eventuality denoted by an utterance) and the participants of the narrated eventuality ( $P^n$ ); see Emonds (1985): ch. 5 for an alternative approach. These primitives combine to define three binary features:

- (1) a. PARTICIPANT-ORIENTED (involves  $P^n$ ) vs. NOT PARTICIPANT-ORIENTED.
- b. CONNECTOR (connects two narrated items, e.g.  $E^nE^n$ ) vs. DESIGNATOR.
- c. SHIFTER (OR DEICTIC,  $P^s$  or  $E^s$ , refers to the speech event) vs. NON-SHIFTER.

The three features cross-classify to specify the eight verbal categories in Tab. 78.2.

Tab. 78.2: Jakobson's (1957/1971: 136) classification of Russian verbal inflections

|                    | <i>P involved</i>      |                     | <i>P not involved</i>  |                              |
|--------------------|------------------------|---------------------|------------------------|------------------------------|
|                    | <i>Designator</i>      | <i>Connector</i>    | <i>Designator</i>      | <i>Connector</i>             |
| <i>Non-shifter</i> | $P^n$ (gender, number) | $P^nE^n$ (voice)    | $E^n$ (status, aspect) | $E^nE^n$ (taxis)             |
| <i>Shifter</i>     | $P^n/P^s$ (person)     | $P^nE^n/P^s$ (mood) | $E^n/E^s$ (tense)      | $E^nE^{ns}/E^s$ (evidential) |

According to this classification, gender and number characterize an eventuality participant  $P^n$ , and person characterizes an eventuality participant  $P^n$  with respect to a speech participant  $P^s$ . Status (affirmative, presumptive, negative, interrogative, . . . ) and aspect characterize an eventuality  $E^n$ , while tense characterizes an eventuality  $E^n$  with respect to the speech event  $E^s$ . Voice characterizes the relation between the eventuality  $E^n$  and its participants  $P^n$ , irrespective of  $E^s$  or  $P^s$ , while mood characterizes the relation between the eventuality  $E^n$  and its participants  $P^n$  with reference to the speech participants  $P^s$ . Taxis characterizes the relation between two eventualities  $E^n$  (dependent/relative tense, causality) and evidentiality characterizes the relation between two eventualities  $E^n$  (one a narrated speech event  $E^{ns}$ ) with reference to the speech event  $E^s$ .

Not surprisingly, Jakobson's analysis requires revisions in the light of more recent findings of formal semantics, and the study of typologically diverse languages. Aspect is now often treated as a relation between the narrated event and the (contextually given)



reference time (Reichenbach 1947; Kamp & Reyle 1993; Klein 1994) and evidentials encode “a speaker’s (type of) *grounds* for making a speech act” (Faller 2002: 2). Inflections thought to pertain to a particular word class have been observed for others, such as tense/aspect for nouns, and number for verbs (section 2.4.). Still, every one of the basic questions addressed by Jakobson remains on the agenda: Are inflectional categories universal? Which meanings do they express? How do these meanings combine, and how can they be categorized? Which inflectional categories are relevant to which word classes, and why?

Many of his answers remain appealing as well. Regarding the universality of inflectional categories, although Jakobson’s structuralism privileges the obligatory inflections of a language, he recognized that unexpressed categories may play a covert role in the grammar (as evidentiality does in Russian, or definiteness in Finnish case assignment, see section 3.2.). A more recent view holds that all languages specify the same functional categories, whether they are detectable in the grammar or not. Matthewson (2006), for instance, argues that tense meanings are observable in languages without overt tenses (but see e.g. Bohnemeyer 2002; Bittner 2005; Bittner 2008). This view has to be reconciled with the commonplace observation that adult language learners have considerable difficulty mastering inflectional distinctions that are not relevant in the grammar of their native language.

An attractive feature of Jakobson’s theory of inflectional meanings is that it takes into account conventional meaning, the contribution made by contextual factors, and the relation between the two. Further, it makes predictions about the kinds of meanings realized by inflections. For instance, it excludes (correctly, it seems) inflections that denote a property of the speech event or a speech participant, inflections that denote a relation between two speech events, and “anti-shifters”, i.e. inflections whose meaning is to characterize the speech event or a speech participant in relation to a narrated event or a participant of a narrated event.

Jakobson’s approach to the classification and combinatorics of inflectional categories has also proved fruitful. For example, his natural classes predict relationship between gender and number, and in turn between these and person, a correct result as shown below. Finally, Jakobson’s core formal proposal that all categories, including those usually treated as having three or more values, are built on binary features, and that these binary features are privative, has received increasing support in recent research, as outlined in section 2.2. below.

## 2. Person, number and gender

### 2.1. Semantic and structural features

The inflectional categories *person*, *number* and *gender* typically but not invariably encode semantic information about the speech act participants, the cardinality of the referent and the (biological) sex of the referent, respectively (cf. article 16 (Bierwisch) *Semantic features and primes*). In addition to semantic properties, phonological, morphological, and lexical factors also play a role in determining the inflectional class of nouns and pronouns. We therefore distinguish between semantic (or natural) and grammatical (or formal or syntactic) person, number and gender.

All gender systems are based wholly or in part on semantic categories (Aksenov 1984; Corbett 1991): the main semantic categories that determine gender are sex, animacy,

humanness, and (ir)rationality. The grammatical genders of the German feminine noun *Frau* ‘woman’ and the masculine noun *Mann* ‘man’ correspond to their respective semantic gender, i.e. to the sex of their referents, but grammatical and semantic gender do not always accord: e.g. the grammatically neuter noun *Kind* ‘child’ can refer to a female or male individual, and the masculine noun *Tisch* ‘table’ has an inanimate referent. The distribution of semantic versus grammatical agreement follows the following hierarchy (Corbett 1991:237):

- (2)    attributive > predicate > relative pronoun > personal pronoun

In German, an attributive adjective agrees with its head in grammatical gender, but anaphoric reference to a grammatically neuter noun that refers to a female can be with the neuter pronoun *es* ‘it’ or with the feminine pronoun *sie* ‘she’.

- (3)    Ich sah        das        Mädchen.    Es/Sie lief    zur Schule.  
          I    see.PAST the.NEUT girl.NEUT    It/She went to    school  
          ‘I saw the girl. She went to school.’

Number can also be either grammatical or semantic. Pluralia tantum nouns like *scissors* and *pants* trigger plural agreement even if they refer to singular entities. Grammatically singular group designations such as *team* or names referred to teams can trigger plural agreement in British English.

- (4)    a.    The scissors are pretty. / My pants are on fire.  
          b.    India is/are leading by 316 runs.

Likewise, grammatical and semantic person do not always match. French *on* is grammatically third person but can refer to a first person group:

- (5)    On        a        été        loyaux  
          pron.3 have.3 be.PART loyal  
          ‘We have been loyal.’

## 2.2. Semantic features and markedness

### 2.2.1. Number and person

Traditional grammar treats number and person as orthogonal three-valued categories (singular/dual/plural number, first/second/third person), referring respectively to cardinality and speech act participation (Lyons 1968:276; Cysouw 2003; Cysouw 2005). The following (somewhat naive) formulations capture this plausible idea up to a point.

- (6)    a.    Singular number denotes atomic entities.  
          b.    Dual number denotes a pair of entities.  
          c.    Plural number denotes a groups of two or more entities (three or more if there is a dual).

- (7) a. First person refers to a group which includes the speaker.
- b. Second person refers to a group which includes the addressee but does not include the speaker.
- c. Third person refers to a group which does not include a speech act participant.

It has long been understood that dual and plural number in pronouns have an associative interpretation (Jespersen 1924:192; Benveniste 1966; Lyons 1968; Harley & Ritter 2002; Cysouw 2003; Cysouw 2005): First person dual and plural pronouns do not usually refer to a pair or chorus of speakers, but to a group that contains the speaker and some associates, i.e. one or more non-speakers. For example, *we* means 'I and the other people in some group' (which may be either implicit, or explicitly specified). Likewise, second person duals and plurals do not refer only to pairs or groups of addressees (regular plural) but also to groups containing at least one addressee plus other non-speaker individuals (associative plural). This much is captured by the formulations in (6) and (7), on the understanding that the cardinality of the group is determined by the number feature. Thus, first person singular *I* refers to the singleton group which includes the speaker, second person plural *you* refers to a group of more than one which includes at least one addressee but not the speaker; the associative reading is obtained when individuals other than addressees are included.

Two pieces of evidence show that this is not sufficient, that (6) and (7) are incorrect, and that a special semantics is required for the associative plural. The first piece of evidence is that the associative meaning is not restricted to pronouns. It also occurs in some languages in certain nominal duals and plurals, which denote not a set of two or more entities of the type denoted by the noun like the ordinary dual and plural, but a group containing one such referent and something else which forms a natural or conventional pair or group with it (Cysouw 2003; Moravcsik 2003): Spanish *los reyes*, for example, means either 'the kings' or 'the king and the queen'.

- (8) Hungarian associative plural *-ék* versus regular plural *-ok* (Moravcsik 2003)
  - a. *János-ék* 'János and associates'
  - b. *János-ok* 'the Jánoses' = 'people called János'
- (9) Dyirbal associative dual *-gara* (Dixon 1972: 23Of.)
  - a. burbula-gara      banijju  
burbula-AssocDu come.PREs  
'Burbula and another person are coming'
  - b. burbula-gara      badibadi-gara      banijju  
burbula-AssocDu badibadi-AssocDu come.PREs  
'Burbula, being one of a pair, and Badibadi, being the other of the pair, are coming'

Even when the associative is not marked by a special morpheme, it may be available as an interpretation, e.g. for the Japanese plural morpheme *tati*:

- (10) *sensei-tati* 'teacher-PL: (i) 'the teacher and his group', (ii) '(the) teachers'

The associative plural in nominals cannot be derived from the meaning of person in (7).

Still, associative duals/plurals occur only in nouns which are pronoun-like in that they without exception have a definite referent, and belong to a semantically restricted subclass, nearly always humans, and particularly often proper names, kin terms, or titles (Moravcsik 2003). The generalization is that the associative plural is available in a continuous segment from the top of the well-known “animacy” hierarchy (a better term would be INDIVIDUATION HIERARCHY) given in Fig. 78.1 down to some point which varies within narrow limits from language to language.

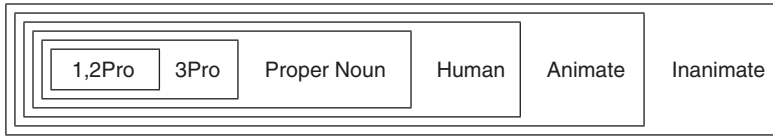


Fig. 78.1: Individuation hierarchy

A number of other pronominal phenomena are known to spill over into high-animacy nouns in just this way. Kiparsky (2011) argues that nouns behave this way in virtue of N-to-D raising (or its lexicalist equivalent), which syntactically assigns them to the category Pronoun and semantically converts them from property-denoting to individual-denoting. A corollary is that languages in which the plural is marked *only* in pronouns (Corbett 2000: 61–66) can be characterized simply as languages that allow only an associative plural. On this assumption, the associative plural and dual apply to an expression  $P$  to yield maximal individuals that include the individual denoted by  $P$  as a part:

- (11) a.  $\llbracket plural_{assoc}(P) \rrbracket$  presupposes that  $P$  denotes a (possibly complex) individual. If defined,  $\llbracket plural_{assoc}(P) \rrbracket = iy$  ( $y = \{\llbracket P \rrbracket\} \cup \{x \mid x \in \llbracket Q \rrbracket \wedge \llbracket Q \rrbracket \sqsupset \llbracket P \rrbracket\}$ ) for some contextually given super-property  $Q$  of  $P$
- b.  $\llbracket dual_{assoc}(P) \rrbracket$  presupposes that  $P$  denotes a (possibly complex) individual. If defined,  $\llbracket dual_{assoc}(P) \rrbracket = iy$  ( $y = \{\llbracket P \rrbracket + z \wedge \llbracket Q \rrbracket \sqsupset \llbracket P \rrbracket \wedge z \in Atom(\llbracket Q \rrbracket \setminus \llbracket P \rrbracket)\}$ ) for some contextually given super-property  $P$  of  $Q$

(11a), when applied to a noun like *teacher* (which functions as a title when used with the associative dual/plural) denotes a group consisting of the teacher and a contextually relevant group. An expression of the form ‘father-dual’ denotes, according to (lib), a complex individual consisting of the father and an individual that is a member of an (immediate, contextually given) super-property  $Q$ , e.g. ‘parent’, resulting in the denotation ‘the parents’.

Regular duals and plurals apply to *predicates* —in morphosyntactic terms to Ns rather than to DPs. One way of specifying the semantics of the plural and the dual is given in (12): the plural subtracts the atomic elements from the denotation of the (singular) predicate (which denotes a set consisting of atomic elements and all possible (non-empty) sets of atomic elements) and the dual denotes the set of sets of cardinality 2 in the denotation of  $P$ .

- (12) a.  $\llbracket plural \rrbracket(\llbracket P \rrbracket) = \llbracket P \rrbracket \setminus Atom(\llbracket P \rrbracket)$
- b.  $\llbracket dual \rrbracket(\llbracket P \rrbracket) = \{X \mid X \in \llbracket P \rrbracket \wedge |X| = 2\}$

The second piece of evidence for associative number comes from languages that distinguish inclusive and exclusive ‘we’, i.e. that have separate forms for ‘I and you (and

possibly others)’ and ‘I and a (possibly singleton) group that does not contain you’, respectively. In languages that additionally have a dual/plural number contrast, the form denoting ‘I and you’ does not behave as an “inclusive dual” as (6) would have it, rather the form denoting ‘I and you and one other’ does (despite the fact that its cardinality is 3). In Weri, which is such a language, basing number on cardinality, as in Tab. 78.3, would yield no unified semantics for the ending *-ip* and would require positing a Trial number instantiated only in the inclusive:

Tab. 78.3: Weri person/number paradigm (Daniel 2005: 15)

|                  | <i>Singular</i> | <i>Dual</i> | <i>Trial</i> | <i>Plural</i> |
|------------------|-----------------|-------------|--------------|---------------|
| <i>Inclusive</i> | —               | tepir       | tëar-ip      | tëar          |
| <i>Exclusive</i> | ne              | ten-ip      | —            | ten           |
| <i>Second</i>    | në              | ar-ip       | —            | ar            |
| <i>Third</i>     | pë              | pëar-ip     | —            | pëar          |

Clearly *tepir* ‘I and you’ morphologically patterns with the *singular* pronouns, and *tëarip* ‘I and you and one other’ patterns with the *dual* pronouns. Since this alignment cannot be reconciled with the cardinality-based semantics of the number categories in (6), it has been proposed that these languages have a different set of number categories: minimal, unit-augmented, and augmented, instead of singular, dual, trial, and plural. Minimal number denotes a set of minimum cardinality (two for the dual inclusive); unit-augmented number denotes a set minimally greater than that, and the augmented number denotes a set greater than unit-augmented (Greenberg 1988; Corbett 2000: 166; Daniel 2005). The resulting analysis of Weri is shown in Tab. 78.4. The ending *-ip* now has the homogeneous function of deriving unit-augmented number from augmented number.

Tab. 78.4: Revised Weri person/number paradigm

|                  | <i>Minimal</i> | <i>Unit-augmented</i> | <i>Augmented</i> |
|------------------|----------------|-----------------------|------------------|
| <i>Inclusive</i> | tepir          | tëar-ip               | tëar             |
| <i>Exclusive</i> | ne             | ten-ip                | ten              |
| <i>Second</i>    | në             | ar-ip                 | ar               |
| <i>Third</i>     | pë             | pëar-ip               | pëar             |

The new number categories are unnecessary since the definitions of associative dual and plural in (11) already give the right semantics: minimal is singular (a possibly complex individual), unit-augmented is associative dual, and augmented is associative plural. The suffix *-ip* restricts the “augmentation” to a single individual. This reduction does more than just simplify the set of number categories. It also explains why the applicability of unit-augmented and augmented number is restricted to pronouns. See Wechsler (2004) for a radical reanalysis of the customary person/number paradigm as a pure person paradigm with singular and augmented categories.

To fit the inclusive/exclusive distinction into the person inventory we assume that the inclusive is a fourth person category, defined as reference to both the speaker and to the addressee (Noyer 1992). Because it bears two feature specifications, it is the

most marked person. The exclusive is just first person, defined as reference to the speaker.

The revised features form a Horn scale (inclusive > first > second > third), which determines priority in pronominal reference and agreement, a desirable result because the hierarchy appears to be universal (Cysouw 2003; Cysouw 2005).

Tab. 78.5: Feature analysis of person

| <i>Person</i> | <i>feature specification</i> |
|---------------|------------------------------|
| Inclusive     | [+speaker, +addressee]       |
| First         | [+speaker]                   |
| Second        | [+participant]               |
| Third         | [ ]                          |

Being the most marked person, the inclusive blocks all other persons in the shared domain. First person blocks second person, and second person blocks third.

- (13) a. Inclusive person refers to a group which includes the speaker and the addressee.  
 b. First person refers to a group which includes the speaker (and, when there is an inclusive person, excludes the addressee).  
 c. Second person refers to a group which includes a speech participant (and, when there is a first person, excludes the speaker).  
 d. Third person refers to any group (and, when there is a second person, excludes a speech participant).

It also follows that the inclusive is the person that is missing in reduced (three-person) systems such as that of English. Further, we get the right semantics for first person pronouns in such systems, or in those subparadigms of four-person systems that neutralize the inclusive/exclusive distinction.

### 2.2.2. The meanings of plural predicates

Plural expressions participate in a variety of meanings besides those illustrated above. English bare plurals receive interpretations with seemingly different quantificational forces: generic (14a), 'most' (14b) and existential (14c); cf. e.g. Carlson (1977); Chierchia (1998b); Krifka (2003) and articles 44 (Dayal) *Bare noun phrases* and 47 (Carlson) *Genericity*.

- (14) a. Dogs are widespread.  
 b. Dogs are smart.  
 c. Dogs are barking.

According to Carlson, bare plurals uniformly denote names of kinds, e.g. *dogs* denotes the name of the dog-kind, and the verbal predicate that the bare plural combines with is responsible for its interpretation: Kind-level predicates such as *be widespread* apply directly to the kind denoted by the bare plural, resulting in a generic interpretation, whereas predicates such as *be smart* and *be barking* apply to (stages of) individuals that

instantiate the kind. The denotation of the bare plural is semantically singular, but stage-level interpretations involve semantic plurality.

Bare plurals in the scope of a plural noun phrase may receive a ‘dependent’ plural interpretation (Chomsky 1975; de Mey 1981; Roberts 1991). Such interpretations are characterized by two properties: (i) the bare plural argument contributes an narrow-scope existential quantifier, and (ii) the truth of the sentence requires at least two distinct entities in the denotation of the bare plural (Zweig 2008). Thus, (15) has a dependent plural reading since (i) each unicycle has a wheel, and (ii) the truth of (15) requires there to be at least two wheels (of unicycles).

(15) Unicycles have wheels.

Dependent plurals have been analyzed as a case of cumulative readings (e.g. de Mey 1981; Roberts 1991; Beck 2000), related to the cumulative reading of examples like *Three women gave birth to five babies*, according to which the group of three women together gave birth to five babies. Since bare plurals in downward-entailing contexts do not entail semantic plurality, other authors propose that singulars entail singular reference and that plurality arises from higher-order scalar implicatures (e.g. Spector 2003; Zweig 2008).

Plural nouns also participate in collective and distributive interpretations. In (16a), the individuals denoted by *the fathers* collectively participate in the gathering, while each individual in the denotation of *the fathers* in (16b) individually has the property denoted by the verb *laughed*. See e.g. Landman (1989) and Schwarzschild (1996) for other, e.g. group and bunch, readings.

- (16) a. The fathers gathered.  
b. The fathers laughed.

Such plural nouns are generally analyzed as semantically plural; the two interpretations are attributed to semantic differences between the verbs: for example, in contrast to *laugh*, *gather* requires the subject to denote a semantically plural entity.

- (17) a. The father laughed,  
b. #The father gathered.

The two main proposals for capturing the semantic plurality of noun phrases employ sets (e.g. Hoeksema 1983; Winter 2001) and sums (e.g. Link 1983). In e.g. Winter’s (2001) set-based analysis of plurals, a plural predicate denotes (the characteristic function of) the set of sets of atomic individuals in the denotation of the singular. In Link’s (1983) lattice-theoretic approach, the denotation of a plural predicate is the complete join-semilattice in the universe generated by the atomic individuals in the denotation of the singular. In both proposals, the denotation of the plural includes that of the singular, in contrast to the semantics given in (12); see section 2.2.3. for discussion.

- (18) In a universe consisting of two boys *a* and *b*, the denotation of *boys* is  
a.  $\llbracket \text{boys}' \rrbracket = \{\{a\}, \{b\}, \{a, b\}\}$  in Winter’s (2001) set-based approach, and  
b.  $\llbracket \text{boys}' \rrbracket = \llbracket * \text{boy}' \rrbracket = \{a, b, a \sqcup b\}$  in Link’s (1983) sum-based approach.

Link (1983) rejects the use of sets for representing the denotation of nouns since “inherent in the notion of a set is atomicity which is not present in the behavior of mass terms” (305). Other authors argue that a representation of plurals as sets can still capture the parallels between plurals and mass; see Lasersohn (1988): ch. 4; Landman (1989: 568–571); Schwarzschild (1996): ch. 2; Zweig (2008): ch. 4 and article 46 (Lasersohn) *Mass nouns and plurals*.

The semantics of the plural in (12a), together with standard Montague Grammar assumptions about interpretation, accounts for the collective interpretation of a sentence like (19), according to which a group of three students collectively carries a single piano (19a). The distributive interpretation in (19b) is derived with a distributive operator or a distinct meaning for the verbal predicate (e.g. Landman 1989; Lasersohn 1995; Winter 2001). Schwarzschild (1996) shows that context also plays a role.

(19) Three students carried a piano.

- a. Collective:  $\exists X \exists y (\text{piano}'(y) \wedge |X| = 3 \wedge X \subseteq \text{students}' \wedge \text{carry}'(X, y))$
- b. Distributive:  $\exists X (|X| = 3 \wedge X \subseteq \text{students}' \wedge \forall x (x \in X \rightarrow \exists y (\text{carry}'(x, y)))$

The traditional distinction between collective predicates (*meet, gather, be a good team*), distributive predicates (*laugh, enter, have a baby*) and mixed predicates that allow both interpretations (*carry a piano, build a house*) is based on whether a predicate distributes over individuals denoted by the subject (e.g. *Ali and Baba entered the gate* entails *Ali entered the gate and Baba entered the gate*) and whether a predicate can occur with a singular subject (cf. (17)). Refinements and alternative classifications have been suggested in e.g. Dowty (1987) and Winter (2001).

Cross-linguistic research points to variation in the semantics of number. Kwon & Zribi-Hertz (2004) show that Korean mass nouns can be pluralized (cf. also Spathas 2007 for Greek) and they argue that Korean plural nouns *X-deul* means ‘the various X’s’ (rather than ‘who/whatever is X’) and derive from this semantics their lack of certain readings: open kind readings, inalienable binding (e.g. body part plurals), quantificational binding, and narrow-scope readings. Similarly, Mizuguchi (2001: 532) proposes that “Japanese plurals are functions that individuate a set into atoms, while English plurals are functions that form a set from atoms”. Finally, in contrast to e.g. English where the default number assigned to a noun in the absence of number morphology is singular, the default number in other languages in such cases is unpredictable and must be lexically specified for the noun. In Kiowa (Athapaskan, USA), for example, default number and number agreement divides nouns into nine classes (Watkins 1984; Harbour 2007). Depending on the class, the number assigned to a noun that bears no number marking may be non-plural (all animates, most body parts, tools), dual (many plants and artifacts), or nonsingular. The INVERSE OR REVERSÄPVE number morpheme *-do* assigns nouns the complement of their default number, as illustrated in Tab. 78.6.

Tab. 78.6: Kiowa inverse number

| <i>class</i> | <i>default number</i>               | <i>inverse number</i>                                 |
|--------------|-------------------------------------|-------------------------------------------------------|
| nonplural    | <i>tógúl</i> ‘one or two young men’ | <i>tógúú-dó</i> ‘three or more young men’             |
| dual         | <i>k!ʒn</i> ‘two tomatoes’          | <i>k!ʒʒ-dó</i> ‘one tomato or three or more tomatoes’ |
| nonsingular  | <i>áá</i> ‘two or more sticks’      | <i>áá-dó</i> ‘one stick’                              |



Similarly, Arabic has a class of “collective” nouns from which count nouns are derived by the “singulative” or “unit” suffix *-a* (Cowell 1964: 215, 297; Erwin 1963: 165): e.g. *bá’ar* ‘cattle’, *bá’r-a* ‘a cow’, *laḥam* ‘meat’, *laḥm-a* ‘a piece of meat’, *daḥur* ‘kicking’, *daḥr-a* ‘a kick’.

### 2.2.3. Unmarked number

Theories of markedness maintain that semantic and formal markedness converge: the denotation of a formally more complex expression results in a more restricted (more marked) distribution than that of the formally less complex expression. The convergence of semantic and formal markedness is widely assumed in grammatical theories (cf. Koontz-Garboden 2007 for discussion) and has its roots in Roman Jakobson’s (1957) proposal that inflectional categories are decomposed into a set of semantically defined features, each of which is binary and privative, as discussed in section 1. Evidence for this position is provided e.g. by the Korean number system, where the plural marker *-tul* contributes the meaning “more than one”, while singular nouns lack such a specification, i.e. are semantically unmarked, and “may be either specifically singular, or on occasion be used when more than one object is involved” (Greenberg 1963: 73f.); see Ebert (1997) for psycholinguistic evidence for the markedness of the plural.

The claim that the singular is the semantically unmarked member of the singular/plural opposition has been challenged on the basis of data from English and a variety of other languages in e.g. McCawley (1968), Krifka (1987), Roberts (1991), Ojeda (1995), Sauerland, Anderssen & Yatsushiro (2005) and Farkas (2006). According to these proposals, the denotation of a singular (pro)noun conveys semantic singularity whereas the corresponding plural form is less specific, i.e. subsumes the denotation of the singular.

Both types of analysis need to account for the conditions under which the semantically less marked expression can be used: while proponents of the first position need to account for why a singular form is not typically used to express semantic plurality, proponents of the second position need to account for why plural forms are not typically used with singular meaning, e.g. why *I saw cows* is not used when the speaker saw a single cow. Blocking is appealed to in e.g. Krifka (1987) and Roberts (1991), while Sauerland (2003) and Sauerland, Anderssen & Yatsushiro (2005), who assume that the plural is unmarked since only the singular introduces a presupposition (that the denotation is an atom), appeal to Heim’s (1991) *Maximize Presuppositions*. Farkas (2006) assumes that the singular is the default interpretation; the plural is used to override the default and hence receives plural interpretation; cf. Spector (2007) for an account using higher-order implicatures.

If there was a perfect correlation between formal and semantic plurality, examples where a singular (pro)noun does not have singular semantic reference would be evidence for the first position, while examples with plural (pro)nouns that do not have plural semantic reference would be evidence for the second position. Since such a correlation does not, however, exist (cf. section 2.1.), formally plural (pro)nouns that can be used with singular reference, such as German *Sie* or French *vous*, can not be taken as evidence that the denotation of the plural is unmarked with respect to the singular (contrary to e.g. Sauerland, Anderssen & Yatsushiro 2005, henceforth SAY05) but rather only shows that these grammatically plural forms can be used with singular reference, similar to pluralia tantum nouns. Wechsler (2004) shows that assuming that plural forms like *vous* are lexically unspecified for semantic plurality makes correct predictions about of the French pronoun system and also fits with the cross-linguistic semantics of person/number

systems. Likewise, even if *their* in (20) can be used “even though it was just one umbrella owned by a single person that was left behind” (SAY05: 415), this only shows that the pronoun in question is only formally but not semantically plural, not that the denotation of semantically plural expressions includes singular entities.

(20) Someone left their umbrella. (SAY05)

Rullmann’s (2003) example in (21) shows that it is not tenable to assume that the plural form is used when “the gender marked singular pronouns *he/she/it* must be avoided” because “the gender of the referent is unknown” (SAY05: 416).

(21) Someone left their jockstrap in the locker room. (Rullmann 2003: 253)

Rather, *their* seems to have emerged as a gender- and number-neutral variant of the singular pronouns *he* and *she*.

Another type of evidence provided in favor of the second position involves plural noun forms that are semantically plural, and whose denotation has been argued to include atomic entities, such as (22):

(22) Every boy should invite his friends.

Since (22) can be used felicitously in a context where some of the contextually salient boys only have one or no friend, one could assume that the denotation of the plural noun phrase *his friends* includes atomic friends (cf. e.g. SAY05). An alternative analysis of (22) that allows one to maintain traditional assumptions about the relationship between formal and semantic markedness is that *his friends* in (22) is a dependent plural (cf. section 2.2.2.), i.e. does not distribute below the subject universal quantifier, but rather denotes the collective group of friends of all of the contextually salient boys; a plural noun phrase is used since the group of boys invite more than one friend.

Noun phrases with the quantifier *no* such as *no chairs* in (23) are another semantically plural noun phrase whose denotation has been argued to include singular entities. Winter’s (2001) contrast between *No teachers are similar* and *\*No teacher is similar* shows that the number distinction with *no* is not merely a grammatical reflex but semantically meaningful.

(23) No chairs are available. (SAY05: 409)

SAY05 argue that the plural form does not mean ‘two or more’ by pointing out that (23) is not equivalent to *Two or more chairs aren’t available*, which unlike (23) “implicates the availability of one chair” (410). While this shows that the two utterances have different sets of implications, it does not conclusively show that the denotation of *chairs* must include the atomic entities. Cf. also Schwarzschild’s (1996: 5) example in (24), which he argues should be felicitous if the denotation of *men* only includes plural entities.

(24) #No men lifted the piano but John did. (Chierchia 1998a: 10)

Contrary to Schwarzschild (1996) and SAY05, Chierchia (1998a: 75) argues that such examples do not warrant the conclusion that the plural is semantically less marked than the

singular: a modification of the meaning of *no* so that it adds the atomic elements to the denotation of the plural common noun ensures the infelicity of (24). A similar analysis can be given to other determiners that trigger plural agreement but result in noun phrases whose denotation is not (necessarily) plural, e.g. *1.0 cows*, *zero cows* (Krifka 1987) or *fewer than four cows*; in fact, Krifka (1987) cautions against using such examples as evidence for the position that the plural is semantically unmarked.

Negation also features in examples like (25), which is claimed to be infelicitous in a context where John saw a single bear and hence taken to provide evidence that the denotation of the plural includes singular entities (Krifka 2003; SAY05; Spector 2007).

(25) John didn't see bears.

There was, however, no consensus among the native speakers of English we consulted that (25) is infelicitous in this context. This fits with the observation that (25) can be felicitously followed with . . . *he only saw ONE bear*. That this reading of (25) is not a case of metalinguistic negation is shown by the acceptability of the negative polarity item *ever* in *John didn't ever see bears, but he often saw single ones*.

A final set of examples provided in favor of the position that the plural is semantically unmarked involves semantically plural forms in form headings (e.g. *schools attended*, *children*, cf. McCawley 1968), invitations (*You're welcome to bring your children*) and questions (*Do you have children?*) (e.g. Krifka 2003; SAY05; Spector 2007; Zweig 2008). Such plurals are felicitously used even if the person filling out the form or being asked the question only has one child (i.e. can answer with *Yes, one*), which is taken as evidence that the denotation of the plural includes that of the singular. But such examples are unproblematic for the other position, too, if one takes into consideration the role of context. Shared by these examples is the contextual requirement that the speaker (or writer) be maximally inclusive: form headings and invitations need to take into consideration that some people have more than one child, disregarding the fact that a particular person filling out the form or being addressed might only have one (or no) child. According to the position where the singular is semantically unmarked, use of the singular implicates the absence of a plural meaning, such that e.g. *You're welcome to bring your child* implicates that the addressee has (at most) one child, which is not acceptable in such contexts. Further evidence for this context-dependency is presented by examples like (26) and (27) which show that the plural is felicitous only in those contexts where it is plausible that the cardinality could be larger than one (cf. also Farkas 2006). If this condition is not met, as in (26a) and (27a), the singular form is used:

(26) Context: Addressing a single person.

- a. Will you bring your spouse/#spouses?
- b. Will you bring your child/children?

(27) a. (to a friend you are helping with a cleaning task) #Do you have brooms?

- b. (to a shop keeper) Do you have brooms? (Zweig 2008: 24)

In sum, the currently available evidence does not warrant abandoning the traditional correlation between formal and semantic markedness in the singular/plural paradigm.

### 2.2.4. Gender

The inflectional category ‘gender’ classifies (pro)nouns. The semantic notion most commonly associated with the semantic exponents of this inflectional category is sex, although there are many conceivable ways of classifying entities, especially humans, such as animacy, humanness, and (ir)rationality (Corbett 1991). While every gender system has some (pro)nouns whose gender assignment depends on semantic gender (Corbett 1991: 63; Dahl 2000: 101), languages differ in the location of the cut-off point for the assignment of semantic gender on the animacy hierarchy in Fig. 78.1.

In Tamil (Dravidian, India), there are separate genders for male humans and female humans, while everything else is assigned to a third gender (Corbett 1991: 9), i.e. the cut-off point is between HUMAN and ANIMAL. In many Indo-European languages, humans and some higher animals are assigned masculine and feminine gender on the basis of their sex (e.g. German *die Kuh* ‘the.FEM cow’), while inanimates and lower animals get their genders by lexeme-specific or formal criteria. Thus, the ANIMAL class does not always behave homogeneously (Dahl 2000). Gender in Ket (isolate, Russia) distinguishes between male animates, female animates, and a residue class that includes mainly inanimates (Corbett 1991: 19). Since neither of the two sex categories is more or less marked than the other, establishing semantic markedness for the inflectional category ‘gender’ is inconclusive.

### 2.3. Person, number and gender at the syntax-semantics interface

Person, number and gender are formal categories that are semantically interpreted, but also have consequences for syntax, in the form of agreement. A key question in the formal treatment of these categories is the extent to which agreement is to be treated semantically; cf. also article 82 (von Stechow) *Syntax and semantics*. Cooper (1983) proposes a semantic account according to which agreement markers trigger presuppositions. In *A neighbor<sub>i</sub> thinks that she<sub>i</sub> saw John*, for example, the pronoun *she<sub>i</sub>* triggers the presupposition that the neighbor is female; the value of *\*The man washes herself* is undefined since the denotation of the subject is not in the domain of the partial function denoted by the reflexive pronoun (cf. also Dowty & Jacobson 1988). For arguments that number agreement is a semantic phenomenon see e.g. Bartsch (1973), Scha (1981), Link (1983), Hoeksema (1983) and Lasnik (1988). While some semantic analyses are restricted to non-local agreement (e.g. agreement of subjects with predicative adjectives, of pronominal anaphora with their antecedents), other analyses (e.g. Hoeksema 1983; Winter 2001) also treat local agreement semantically (e.g. subject-verb agreement, noun-adjective agreement). Winter (2001: ch. 5), for example, develops an analysis of collective and distributive readings of plurals that assigns different semantic types to singular and plural predicates and thereby also accounts for local agreement. In a departure from more classical treatments of inflection (e.g. Bennett 1974; Chierchia 1998a; Schwarzschild 1996), which assume that only inflectional morphology on nouns is semantically interpreted while that on verbs simply functions as markers of agreement, Winter (2001) assumes that every overt exponent of (number) inflection is semantically interpreted (be it on nouns, verbs or adjectives). Sauerland (2003) takes a leap in the opposite direction and proposes that none of the overt exponents of inflectional morphology (in a DP) are semantically interpreted, and instead analyzes them as (uninterpreted) markers of agreement with the

(interpreted) number feature that is realized (covertly) in the head of the  $\phi$ -phrase ( $\phi P$ ), a syntactic head over D.

Examples like (28), attributed to Irene Heim, illustrate the need for distinguishing between the semantic and the grammatical reflexes of person, number and gender agreement. The two interpretations of (28), given as LF1 and LF2, differ in whether *my* receives a bound variable interpretation (LF1) or not (LF2). In the former case, (28) means that nobody but me is an  $x$  such that  $x$  did  $x$ 's homework.

(28) Only I did my homework.

LF1: [only I]  $\lambda x$   $x$  did  $x$ 's homework.

LF2: [only I]  $\lambda x$   $x$  did my homework.

Kratzer (1998) proposes that the first person features of the pronoun *my* are mere agreement reflexes, which need to be present at the level of phonological form (PF) but are absent at logical form (LF). Since pronouns can start out as zero pronouns, in which case they do not bear inflectional information, they do not contribute a presupposition at LF. Such pronouns receive features at PF under agreement with a suitable nominal antecedent (cf. also Rullmann 2004). An alternative proposal, von Stechow (2003), suggests that all pronouns start out with  $\phi$ -features but that features of bound pronouns are deleted at LF.

In contrast to the above proposals, which assume that agreement involves checking features on targets that are specified on a trigger, Pollard & Sag (1988, 1994) motivate treatments of agreement as constraint satisfaction: for example, even though a ship can be referred to both as *she* and *it*, utterances such as *The ship lurched and then she rightened itself* are ruled out by requiring that the reflexive pronoun and its antecedent share the same features. Wechsler (2004) shows that it is not sufficient to treat agreement as the systematic co-variation in form. For example, Pollard and Sag's (1994: 97) claim that predicative adjectives show semantic agreement while finite verbs show grammatical agreement is satisfied for e.g. the formal use of *vous* (grammatically plural, semantically singular) as in (29a,b) but fails for pluralia tantum nouns like *ciseaux* 'scissors' in (29c), which can be semantically singular but nevertheless trigger plural agreement with predicative adjectives.

(29) a. Vous êtes loyal.

you.PL/FORMAL be.2PL loyal.SG

'You (one formal addressee) are loyal.' (Wechsler 2004: 255)

b. Vous êtes loyaux.

you.PL/FORMAL be.2PL loyal.PL

'You (multiple addressees) are loyal.' (Wechsler 2004: 255)

c. Ces ciseaux sont idéaux / \*idéel pour couper le velour

this.PL scissors(PL) are.PL ideal.M.PL / ideal.M.SG for cut.INF the velour.

'These scissors are ideal for cutting hair.' (Wechsler 2004: 256)

Wechsler argues that assuming two plural features for French (one for grammatical number, the other for semantic number) is not empirically motivated since the language only has one plural inflection. His analysis instead holds that a plural agreement target is not

semantically potent when the noun phrase it agrees with is plural-marked; otherwise, it may introduce semantic plurality. Thus, (30a) with *are* is grammatical since the subject noun phrase *these books* is semantically and grammatically plural; *are* in (30b) introduces optionally introduces semantic plurality since the subject noun phrase is only grammatically plural. The version with *is* is ungrammatical in (30a,b) since *is* requires grammatical and semantic singularity. In (30c), both *is* and *are* are acceptable: with *is* the subject noun phrase denotes a single entity, with *are*, it is required to denote two separate entities.

- (30) a. These books are / \*is interesting.  
 b. These scissors are / \*is dull.  
 c. His lifelong friend and the editor of his autobiography is / are at his bedside.

The need for recognizing the semantic as well as the grammatical side of person, number and gender is also apparent in coordination resolution. In many languages, the inflectional properties of a coordinate noun phrase are determined on the basis of the semantic person, number or gender values of the individual noun phrase conjuncts (see Corbett 1991; Johannessen 1998 for other resolution strategies). The Fula (Niger-Congo) verb in (31a) is marked for first person inclusive since the coordinated noun phrase subject denotes a group that includes the speaker. The French verb in (31b) is marked for masculine gender since only semantically feminine noun phrases trigger feminine agreement and the grammatically feminine conjunct *la sentinelle* ‘the sentry’ denotes a man. Thus, number but not person is a non-distributive feature since none of the conjuncts in (31a) bears the value of the coordinate noun phrase (Dalrymple & Kaplan 2000).

- (31) a. Fula (adapted from Dalrymple & Kaplan 2000: 782)  
 an e Bill e min kö Afriki djodu-dèn.  
 you and Bill and I in Afrika live.INCL  
 ‘You and Bill and I, we live in Afrika.’  
 b. French (adapted from Wechsler 2009: 572)  
 La sentinelle et sa femme ont été pris / \*prises en otage.  
 the.FEM sentry.FEM and POSS wife were taken.MASC taken.FEM hostage  
 ‘The sentry and his wife were taken hostage.’

While Corbett’s (1991) resolution rules can account for the person, number and gender of coordination constructions, their limitation to coordination constructions is problematic since plural anaphoric pronouns follow the same constraints, as pointed out in Farkas & Zee (1995): for example, the French utterance *Ils/\*elles sont malheureux/\*malheureuse* (they.MASC/they.FEM are unhappy.MASC/unhappy.FEM) is a felicitous continuation of (31b). Formal analyses of resolution characterize the features of individual conjuncts as sets; the feature value of the coordinate noun phrase is the intersection or union of these sets (e.g. Hoeksema 1983; Sag et al. 1985; Dalrymple & Kaplan 2000; Sadler 2006; Wechsler 2009). In contrast to person and number resolution, which are purely semantic, both grammatical and semantic gender affect gender resolution (see Farkas & Zee 1995; Sadler 2006; Wechsler 2009 for discussion).

## 2.4. Inflectional meanings and lexical classes

Cross-linguistically, co-occurrence with particular inflectional morphemes determines lexical categoryhood. Expressions that occur with the same set of inflections are also assumed to form a natural class semantically, under the view that the meaning of a particular inflectional category is compatible with the inherent semantic type of the core members of a given word class (e.g. Bybee 1985: 13–19; Croft 1991: 79, 86). Tense, for instance, occurs with verbs since they denote temporally less stable entities (compared to nouns) that need to be temporally anchored, and definiteness is a category of nouns since these denote individualized, time-stable entities (Givón 1979; Givón 1984). These assumptions have been challenged on the basis of descriptions of languages where markers of plurality and markers of tense, aspect or modality are morphologically realized and interpreted on verbs and nouns, respectively. Verbal plural markers, also called ‘pluractional’ markers, indicate the plurality of events and are found in a wide variety of languages (Mithun 1988; Lasersohn 1995: ch. 13, and references therein). The plurality of events can manifest itself as multiple event participants, multiple occurrences of the event over time, or occurrences of the event in different locations (Lasersohn 1995:240). In some languages, e.g.  $\text{ǃHoan}$  (Khoisan, Botswana) as described in Collins (2001), the same plural marker is used for nouns and verbs. Formal analyses have related pluractionality to the semantics of collectivity and distributivity (e.g. Ojeda 1998 for Papago (Uto-Aztecan, USA)), verbal aspect (e.g. van Geenhoven 2005 for Greenlandic (Eskimo-Aleut, Greenland) and reciprocity (e.g. Faller 2007 for Cuzco Quechua (Quechua, Peru)). Nordlinger & Sadler (2004) present cross-linguistic evidence that tense, aspect and mood can be cross-linguistically marked and interpreted on nouns (see also Tonhauser 2006: ch. 9 for discussion), but their claim of the existence of nominal tenses has been challenged in Tonhauser (2006, 2007, 2008) on the basis of a detailed analysis of such markers in Paraguayan Guaraní (Tupí-Guaraní, Paraguay), which are instead analyzed as aspect/modal markers. While these findings suggest that inflectional categories cannot be assumed to universally pertain to either nouns or verbs, they also demonstrate the need for rigorous formal semantic definitions of the meaning of (inflectional) categories for cross-linguistic and cross-category comparison (see Nordlinger & Sadler 2004; Nordlinger & Sadler 2008; Tonhauser 2008 for discussion).

## 3. Case

### 3.1. Semantic case features

Grammatical analysis of richly inflected languages shows that morphological cases fall into intersecting natural classes, revealed by neutralization patterns (syncretism), shared syntactic properties, and other grammatical diagnostics. Traditional grammar holds that cases have meanings and fall into natural classes on the basis of shared meanings. Formal grammar provides three main ways to model such case groupings:

1. A linear ordering, such that any set of adjacent cases is a potential natural class (Plank 1991).
2. Cross-classifying privative semantically defined features (Jakobson 1936; Jakobson 1958; Neidle 1988).



3. An inheritance hierarchy (Przepiórkowski 1999: ch. 3) or a lattice (Grimm 2011) where cases in their syntactic function refer to coherent regions in this space.

The linear ordering method served Pāṇini well in his Sanskrit grammar, but does not generalize well to some other case systems. Jakobson's approach of decomposing cases into semantically defined features has been mainly applied to Slavic languages (but see Bierwisch 1967); it is undermined by the imprecise semantic definitions of his case features.

### 3.2. Structural and inherent case

Recent work distinguishes two types of case, GRAMMATICAL case and SEMANTIC case (Kuryłowicz 1964), or STRUCTURAL and INHERENT (or LEXICAL) case (Chomsky 1981), where the former have no meaning. Chomsky proposes that grammatical relations (ABSTRACT CASES) are determined by the syntactic configuration at S-structure, and SPELLOUT RULES assign morphological case to arguments that bear them. In minimalist terms, structural case is an UNINTERPRETABLE FEATURE. Inherent cases do have a meaning; they are assigned at deep (D-)structure, in some cases depending on the governing predicate's lexical semantic properties, or in some cases idiosyncratically (QUIRKY CASE). A semantic decomposition seems more promising for them.

The richer the case system, the more compelling the case for semantic decomposition; it is inevitable for the elaborate local case systems of many richly inflected languages. Although the local cases are not necessarily morphologically complex, their semantics is like that of compound pre/prepositions, as illustrated by the subsystem of local cases in Lezgian (Haspelmath 1993) in Tab. 78.7.

In Jackendoff's (1983, 1990, 1996) analysis, locative cases are built from Path functions and Place functions:

Tab. 78.7: Lezgian local cases

|                 | 'at'        | 'in'          | 'behind'      | 'under'      | 'on'           |
|-----------------|-------------|---------------|---------------|--------------|----------------|
| <i>location</i> | adessive    | inessive      | postessive    | subessive    | superessive    |
| <i>source</i>   | adelative   | inelative     | postelative   | subelative   | superelative   |
| <i>goal</i>     | addirective | (indirective) | postdirective | subdirective | superdirective |

- (32) a. Path functions: at, to, from, toward, away-from, via  
 b. Place functions: under, in, behind, on. . .

Path functions are applied to local relations, which are formed by applying a Place function to a Thing:

- (33) Lezgian Postelative  
*sew-re-q<sup>h</sup>-aj*  
 bear-ERG-POSSESSIVE-INELATIVE  
 'from behind the bear'  
 [Path FROM [Place BEHIND [Thing BEAR]]]



The same structure extends to non-local relations, though usually less transparently. Finnish treats States like Places, so cases denoting state and change-of-state pattern with the locative cases, as in Tab. 78.8.

Tab. 78.8: Finnish cases

|                       | <i>‘at’, accidental location</i> | <i>‘in’, inherent location</i> | <i>‘as’, state</i>      |
|-----------------------|----------------------------------|--------------------------------|-------------------------|
| <i>state/location</i> | adessive <i>-lla</i>             | inessive <i>-ssa</i>           | essive <i>-na</i>       |
| <i>source</i>         | ablative <i>-ltä</i>             |                                | elative <i>-sta</i>     |
| <i>goal</i>           | allative <i>-lle</i>             | illative <i>-seen, -hen</i>    | translative <i>-ksi</i> |

The relation between essive (predication of state) and translative (predication of change-of-state) is quite parallel to that between inessive ‘in’ and illative ‘into’.

- (34) Se tuli        iso-ksi        ongelma-ksi  
 It (be)came big-Transl problem-Transl  
 ‘It became a big problem’ (‘came to as a big problem’)

[Path TO [State AS [Thing BIG PROBLEM]]]

Important non-local semantic cases include the instrumental ‘with’, ‘by means of’ (Strigin 1995; McKercher 2002), and the comitative (sociative, associative) ‘with, accompanied by’ (which are often syncretic; Croft 1991; McGregor 1989; Stolz 2001a; Stolz 2001b; Stolz & Stroh 2001), and the abessive (caritive) ‘without’.

Localist theories of case (Hjelmslev 1935; Anderson 1971) and of Th-roles (Gruber 1965; Jackendoff 1987) hold that various abstract domains such as possession, emotion, desire, cognition etc. are organized in a way that is parallel to the domain of spatial relations.

An apparently hybrid intermediate class of cases pattern syntactically with the structural cases, but are semantically conditioned. These cases however depend on different semantic conditions than inherent cases do: instead of being sensitive to the thematic relation that the NP bears to the verbal predicate, they are sensitive to a subclass of functional categories, especially definiteness, animacy, quantificational properties, the aspectual or modal character of the VP, or some combination of these factors—pretheoretically characterized in the literature in terms of “affectedness” or “degree of transitivity”. Examples include the Finnish accusative, which is assigned to complements of bounded (non-gradable) verbal predicates, while other complements are assigned partitive case (Kiparsky 1998); and the Hindi accusative case, which is assigned to specific complements.

Minimalist analyses have tried to accommodate these cases to the normal type of structural case by positing case assignment or checking in various higher functional projections. For example, it has been suggested that Finnish accusative is checked in AspP, a functional projection which induces telicity, while partitive is checked in a lower projection (Borer 2005; Megerdooimian 2000; van Hout 2000; Ritter & Rosen 2000; Csirmaz 2005; Kratzer 2004; Svenonius 2002; Thomas 2003).

A further challenge for theories that separate structural and inherent case is the substantial overlap between them. All structural cases except nominative function also as

inherent case. In some Indo-European languages, accusative case marks not only objects, but direction and extent of time. Ergative case is commonly identical to instrumental case down to the last allomorphic detail, as in many Australian languages. The dative often doubles as a semantic case (typically syncretic with directional locative ‘to’ case) in quite systematic ways (e.g. Japanese *ni*, Romance *a*). While this does not invalidate the distinction between structural and inherent case, it does invite a search for a unification of them. One such approach is outlined in the next section.

3.3. The relational semantics of structural case

Grammatical relations reflect the semantic relations between predicates and their arguments. Nearly all linguistic theories are designed to capture this relationship, usually by some notion of Theta-roles. A weakness of all traditional case theories (including Jakobson’s and Chomsky’s) is that they provide no principled intrinsic relationship between grammatical relations and the morphosyntactic cases that mark them. Government & Binding Theory merely masks the stipulative character of the association by a terminological and typographical artifice. The lower-case morphosyntactic category “accusative”, for example, *sounds* like the capitalized abstract Case “Accusative”, but the relation between them is no less arbitrary within this theory.

Kiparsky (2001) has suggested that structural cases do have a semantic basis, but it is relational rather than material. Once this is recognized, morphosyntactic case and abstract case (grammatical relations) can be unified. He proposes two relational case features, [ $\pm$ H(ighest) R(ole)] and [ $\pm$ L(owest) R(ole)] (see also Wunderlich 2003). Their fully specified feature combinations define the four known grammatical relations A, S, O, D, and their underspecified negative feature values define the four morphosyntactic structural cases nominative, accusative, dative, ergative. These relations can be modeled equally well by a lattice. Either way, they yield the markedness scale nominative < accusative, ergative < dative. This correctly predicts that if a language has a dative it has either an accusative or an ergative, and that if it has case at all, it has nominative.

Tab. 78.9: Kiparsky’s analysis of case

| <i>Grammatical relations</i> |           |                          | <i>Structural cases</i> |            |
|------------------------------|-----------|--------------------------|-------------------------|------------|
| a.                           | [+HR,+LR] | S (intransitive subject) | [   ]                   | nominative |
| b.                           | [−HR,+LR] | O (direct object)        | [−HR]                   | accusative |
| c.                           | [+HR,−LR] | A (transitive subject)   | [−LR]                   | ergative   |
| d.                           | [−HR,−LR] | D (indirect object)      | [−HR,−LR]               | dative     |

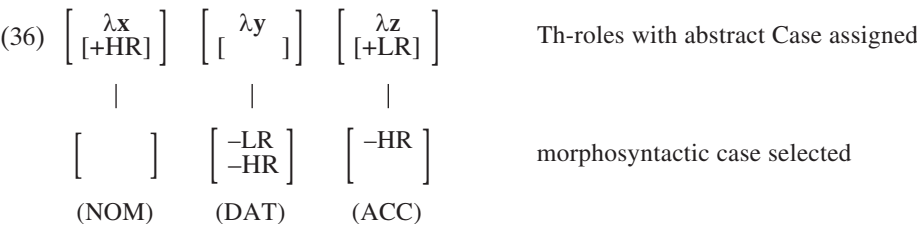
Structural case assignment is formal unification of feature matrices subject to the same principles that govern the distribution of all morphosyntactic elements. In particular, each Th-role is associated with argument bearing the most specific (most highly marked) morphosyntactic case that is compatible with (unifies with) the Th-role’s abstract Case. Arbitrary spellout rules (correspondence rules, mapping rules) have no place in this approach.

Following Bierwisch (1967, 1983, 1986, 1997) and Bierwisch & Schreuder (1992), Kiparsky assumes a level of Semantic Form, an interface between conceptual knowledge and syntactic structure (see article 31 (Lang & Maienborn) *Two-level Semantics*). A predicate is represented at Semantic Form by a function, and the predicate’s Th-roles correspond

to  $\lambda$ -abstractors over the function’s variables. The semantic role of the variable over which a  $\lambda$ -operator abstracts determines the semantic content of the resulting Th-role, and the variable’s depth of embedding in Semantic Form (the inverse of the order of  $\lambda$ -abstractors) determines the Th-role’s rank in the structural ordering known as the hierarchy of thematic roles. For example, *show* has three Th-roles, of which the highest, the Agent, is saturated last.

(35) *show*:  $\lambda z \lambda y \lambda x [x \text{ CAUSE } [CAN [y \text{ SEE } z]]]$

Abstract case and morphosyntactic case are assigned as follows:



The case features define classes of grammatical relations which play a role in syntactic constraints, such as binding, control, and parallelism in coordination. For example, the feature [+HR] picks out “A” and “S” in any language, irrespective of its case system, and thus universally defines the relation of grammatical subject. They also provide the appropriate representation on which valency-changing operations are defined (see also article 84 (Wunderlich) *Operations on argument structure*).

The compositional analysis brings out analogies between structural and semantic cases (Ostler 1979). The spatial domain corresponds to the four basic structural case categories.

Tab. 78.10: Structural and semantic case

|    |            | <i>Structural</i> | <i>Spatial</i>            | <i>Examples of locative cases</i> |
|----|------------|-------------------|---------------------------|-----------------------------------|
| a. | [     ]    | nominative        | location ('at', 'in')     | locative, inessive, adessive      |
| b. | [−HR]      | accusative        | end point ('to', 'into')  | illative, allative, terminative   |
| c. | [−LR]      | ergative          | source ('from', 'out of') | elative, ablative, exessive       |
| d. | [−HR, −LR] | dative            | goal ('towards')          | lative, directive                 |

These correspondences are borne out by synchronic syncretism patterns and historical change.

4. Evidentiality

Evidentiality is “the grammatical encoding of the speaker’s (type of) *grounds* for making a speech act [. . .]. For assertions, the speaker’s grounds can be identified with the speaker’s source for the information conveyed by the utterance” (Faller 2002: 2, emphasis in

original). Crosslinguistically, three main types of source of information are encoded by evidentials (Willett 1988): information obtained from visual, auditory or other sensory sources, information that is based on reports from others or tales, and information attained through reasoning on the basis of logic, intuition, mental constructs or previous experience. Cuzco Quechua has separate morphemes (*-mi*, *-si* and *-chá*) for these three evidential meanings: while the examples in (37) all convey a similar content (*p* = 'It is/might be/must be raining'), they differ in the speaker's source of evidence (EV).

(37) Cuzco Quechua evidentials (data adapted from Faller 2002: 3)

- a. Para-sha-n-mi.  
rain-PROG-3-mi  
*p* = 'It is raining.', EV = speaker sees that *p*
- b. Para-sha-n-si.  
rain-PROG-3-si  
*p* = 'It is raining.', EV = speaker was told that *p*
- c. Para-sha-n-chá.  
rain-PROG-3-chá  
*p* = 'It might/must be raining.', EV = speaker conjectures that *p*

Evidential systems of other languages code more evidential distinctions than Cuzco Quechua (cf. e.g. Morse & Maxwell 1999 on Cubeo (Tucanoan, Columbia)) or less; see Aikhenvald (2004) for a typology of evidential systems.

Faller (2002) formally analyzes the Cuzco Quechua evidentials as illocutionary operators (Austin 1962) which modify the sincerity conditions of the proposition that is their argument and express an evidential relation between the speaker and the proposition expressed. Evidentials of other languages, including Bulgarian (Izvorski 1997) and St'át'imcets (Salish, Canada; Matthewson, Rullmann & Davis 2008), have been analyzed as epistemic modals (see also Palmer 1986; Kiefer 1994), i.e. as quantifiers over possible worlds: an utterance containing an evidential denotes the proposition that, in every world in the modal base (which contains e.g. worlds in which the perceived or reported evidence holds), the proposition the evidential applies to is true. While evidentials are a type of epistemic modal on this view, Faller (2002) argues that the two are separate but overlapping categories; see Chafe (1986) for the position that evidentiality subsumes modality. A set of empirical criteria for distinguishing the two types of evidentials is presented in Matthewson, Rullmann & Davis (2008). Murray's (2010) dynamic semantic analysis of evidentials in Cheyenne (Algonquian, USA) as contributing both an evidential restriction and an illocutionary relation reconciles the two types of analysis.

While the St'át'imcets evidentials are part of the modal paradigm of the language, the Cuzco Quechua evidentials in (37) are traditionally analyzed as part of the focus enclitics (Faller 2002). The language also has a past tense marker that gives rise to a non-visual evidential meaning by locating the eventuality outside the speaker's perceptual field at topic time (Faller 2004). A different type of interaction between evidentials and tense is observed in Korean, where the evidentials are part of the mood system (as in Cheyenne): while distinct evidential meanings are often expressed in other languages by different

evidential markers, the two Korean evidentials give rise to different evidential meanings in interaction with the tenses (Lee 2010). An interaction between evidentiality and aspect has been found in Bulgarian and Turkish, which express evidentiality in the form of the present perfect (Izvorski 1997; Slobin & Akşu 1982).

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Paul Kiparsky, Stanford, CA (USA)  
Judith Tonhauser, Columbus, OH (USA)

## 79. Semantics of derivational morphology

1. The scope of data to be covered
2. Frequently found derivational types
3. Theoretical issues in the semantics of derivation
4. Conclusions
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### Abstract

*This article discusses issues concerning the semantic analysis of derivational morphology. We discuss difficulties in distinguishing the semantic scope of derivation from that of roots and bound bases on the one hand and from inflection on the other. After a review of the semantic consequences of so-called transposition and of various other semantic categories of derivation in the languages of the world, we address theoretical approaches to the semantics of derivation. We end with a discussion of such issues as the analysis of affixal polysemy, and of mismatches between form and content in derivation.*

### 1. The scope of data to be covered

#### 1.1. Formal types included under derivation

We will examine here the semantics of those aspects of morphology usually referred to as word formation, that is, those that are used for formation of new lexemes, including affixation, conversion, reduplication, ablaut, and templatic (root and pattern) morphology. In effect, a wide range of formal mechanisms can be used to create new lexemes, so although we will generally make reference to affixation in what follows, the reader should understand that the semantic categories we identify and the issues that we review pertain to these other formal mechanisms as well as to affixation. On the other hand, we will not consider here the semantics of compounding, of concatenation of bound roots, or of complex stem formation.

#### 1.2. Difficulties distinguishing affixation from compounding of bound roots

It is important to point out at the outset that it is sometimes not easy to decide whether a particular bound form is an affix or a bound root. We find this issue to some extent in familiar languages like English, where the distinction between affixes and elements of neo-classical compounds is problematic: are items like *bio-* and *eco-* to be considered bound stems or prefixes? (See Bauer 1998 for an insightful discussion of this problem.)

Similarly, in English even though the second element of items like *mailman* sometimes contains a reduced vowel, it is not yet quite bleached enough of its lexical content to qualify as a suffix. In other words, it is often implicit in the distinction between roots and affixes that the latter carry meanings that are general and abstract, whereas the former can have more robust semantics along the lines of simplex lexemes. But the dividing line is unclear.

The problem is especially vexed in languages that have so-called lexical affixes, that is, affixes with the sort of lexical content that in Indo-European languages at least tends to

be confined to roots. The discussion of this problem in Mithun (1999) is instructive. So-called lexical affixes occur in many Native American languages, across many language families. A simple example comes from the Native American language Koasati (Muskogean family). According to Kimball (1991), Koasati has verbal prefixes that have meanings like 'action on the ground or in fire' or 'action in water' (1991: 117–118). Even more prolific in affixes of this kind is Yup'ik (Eskimo-Aleut), which according to Mithun (1999: 49) has over 450 derivational suffixes that bear meanings such as 'catch game', 'gather', 'hit', and 'hurt', among many others. Spokane (Salishan) has upwards of 100 noun-like affixes that bear meanings like 'knob', 'stomach', and 'floor covering' (Mithun 1999: 48).

According to Kimball, the Koasati affixes are either bleached forms of historically independent nouns, or related to existing noun forms synchronically, and Mithun concurs that this is often the case (1999: 54–55). Nevertheless, she gives cogent arguments that they are indeed affixes and not bound roots. Real roots are potentially unlimited in number, but the so-called lexical affixes constitute closed, although sometimes surprisingly large classes. In Spokane and Yup'ik roots can stand alone (although they may need inflections), but these affixes cannot. In terms of their position in the word, the affixes differ from roots; roots in Yup'ik, for example, come first, followed by derivational suffixes. The so-called lexical affixes cannot occur in first position. And in spite of having substantial lexical content, they are less specific in content than roots, and more prone to metaphorical extension; for example, the affix *-cin* in Spokane can cover a range of meanings from 'mouth' and 'lips' through 'edge', 'speech', and 'food' (Mithun 1999: 50). Further, such lexical affixes are often lexicalized in specific forms. Finally, in discourse such affixes often serve to designate old information. On first mention, an independent noun root will be used, but in subsequent mentions the suffix can be used to background the already mentioned item. Mithun argues further that although lexical affixes might have developed historically from compounding forms, the above factors suggest that they are no longer compounding forms, but constitute bona fide affixes.

It should be noted that even Indo-European languages occasionally have affixes that seem to have robust lexical content. For example, French has an affix *-ier* that attaches to roots denoting types of fruit to derive the corresponding type of fruit tree: *poire* 'pear' ~ *poirier* 'pear tree'.

The conclusion we are forced to is that lexical affixes indeed present a challenge to the notion that derivation covers a rather abstract, fixed set of categories. We will see that this issue arises again in connection with the theoretical treatment of derivational semantics in section 3.

### 1.3. Difficulties in distinguishing derivation from inflection

Just as it is difficult in some cases to delimit the semantics of derivation with respect to compounding of bound roots, it is also sometimes difficult to circumscribe those semantic categories that belong to derivation from those that belong to inflection (cf. also article 78 (Kiparsky & Tonhauser) *Semantics of inflection*). The distinction between inflection and derivation is frequently made on the basis of formal criteria: inflection, according to Anderson (1982) is what is relevant to the syntax. In other words, markings that induce or participate in syntactic dependencies such as agreement are said to be inflectional.

Similarly, distinctions that are reflected paradigmatically are often said to be inflectional. The English comparative might be relevant here. It can certainly be presented

paradigmatically (*red ~ redder ~ reddest; pure ~ purer ~ purest*), but it does not trigger agreement, and is syntactically relevant only insofar as the comparative, for example, may license certain sorts of clauses. But it is not clear why comparative semantics should be considered inflectional rather than derivational.

Indeed some distinctions that can figure in syntax are nevertheless every bit as robust semantically as distinctions that are usually said to be derivational. For example, if one of the hallmarks of derivation is a substantial addition of meaning (even without category change), aspectual categories such as the imperfective or the inchoative could arguably be seen as derivational. Another borderline category might be affixation which changes the diathesis of a verb—for example, formation of causatives and applicatives. Certainly the addition of arguments has substantial effects in the syntax, but it also effects a significant semantic change on a verbal base. In what follows, I will discuss not only clear cases of derivation, but also some cases which might be considered inflectional. Such cases often fall into the category of what Booij (1996) has called ‘inherent inflection’, that is, inflectional markings that can induce dependencies in the syntax (for example, triggering agreement), but are not themselves the result of agreement with other elements in a sentence. These include number marking on nouns, and aspectual marking on verbs.

## 2. Frequently found derivational types

This section will survey a range of semantic categories that are frequently signaled by derivation in the languages of the world.

### 2.1. Transposition

Transposition is said to be word formation that changes the lexical category of an item without making any semantic changes other than those that are necessitated by the change of category. According to Beard (1995: 166), transposition involves “asemantic reclassification.” Adams (2001) implicitly disagrees with this definition, as she refers to any derivation that involves change of lexical category as a ‘transposition’ regardless of its semantic content; in contrast, Beard considers only those cases of derivation to be transposition that involve change of lexical class without concomitant change in ‘grammatical function’, for example, change from verb to nominalization (*accuse ~ accusation*) as opposed to change of verb to agent or patient noun (*accuse ~ accuser ~ accusee*). I will tentatively follow Beard’s narrower usage here.

Having accepted this definition, it must nevertheless be acknowledged that even the least contentful of category-changing derivation has semantic consequences. It is worth contemplating, then, whether transposition is in fact a distinct semantic category in derivation, or whether there is a cline from less contentful to more contentful category-changing morphology, without a clear division between transpositional and non-transpositional derivation.

#### 2.1.1. Transposition to noun

Perhaps the most straightforward and least contentful type of transposition is from adjective to noun, but even here, there are several semantic categories that seem to be

formed. Transpositions from adjective to noun create nouns denoting either ‘the abstract quality of x’ or ‘thing which has quality x’, in other words, either abstract or concrete nouns: *hard* ~ *hardness*; *pure* ~ *purity*; Slovak *stribrny* ‘silver’ ~ *stribrnak* ‘silver coin’ (Pavol Štekauer, p.c.). Abstract derivations seem to be more frequent in the languages of the world.

Transpositions of verbs to nouns are more complex, and arguably even less ‘asemantic’ than transpositions from adjectives. Nominalizations from verbs like *construction* or *refusal* are often ambiguous between two readings, what Grimshaw (1990: 45) calls the ‘complex event’ and ‘result’ readings (cf. also article 51 (Grimshaw) *Deverbal nominalization*). We get the former reading when the transposed verb maintains its complete argument structure; in a noun phrase such as *the doctor’s examination of the patient* the noun *examination* is perhaps as close in meaning to that of its base verb *examine* as is possible with a change of lexical category. The same nominalization, however, also admits of another reading which is less dynamic and more referential in nature; this is what Grimshaw calls the ‘result’ reading, although it is not clear that all such non-eventive nominalizations actually denote results. Referential nominalizations are decidedly less ‘verby’ in flavor than their eventive correlates; for example, *the examination* can refer to the end-product of examining in a sentence like *the examination was successful*, or even to a concrete object in a sentence like *the examination was four pages long*. Concrete interpretations are frequently the result of lexicalization of individual items. Especially prone to concrete interpretations are the nominalizations of verbs of creation, for example, items like *construction* or *invention*.

In addition to nominalizations of adjectives and nouns, which are typically considered transpositional, we might consider word formation that does not change syntactic category, but does change semantic category. For example, English has several ways of creating abstract nouns from concrete nouns (*child* ~ *childhood*, *king* ~ *kingship*), although the reverse does not seem to happen in English at least. New concrete nouns in English seem, rather, to be created most often by compounding, rather than derivation.

### 2.1.2. Adjectival

When verbs or nouns are transposed to adjectives, the result is an adjective conveying ‘the property or quality of X’ where X is a noun (*history* ~ *historic*) or ‘the property or quality of Xing’ where X is a verb (*describe* ~ *descriptive*). Such derivations can have two slightly different interpretations, however: the relational or the qualitative interpretation. Relational adjectives are not gradable and do not permit modification by an adverb: for example, \**more congressional*, \**very congressional*. Qualitative adjectives, in contrast, are gradable and can be modified: *impressive*, *more impressive*, *very impressive*. In English at least, particular adjective-forming affixes do not seem to be specialized for one meaning or the other: *-al*, as noted above, can form adjectives that are clearly relational (*congressional*, *janitorial*), but also adjectives that have a qualitative interpretation; *professorial*, for example, can describe a kind of behavior or demeanor that can be graded (*more professorial*) or modified (*not very professorial*). However, Chukchee is reported to have two distinct affixes that create relational and qualitative adjectives; qualitative affixes are derived by prefixing *nə-* and suffixing *-qIn*, and relational affixes are derived by suffixing *-kIn* (Beard 1995; Muravyova 1998).



### 2.1.3. Verbal

Of all so-called transpositions, the least ‘asemantic’ or most contentful is transposition to verbs. By its very nature transposition to the category of verb involves the addition of arguments or participants, and therefore necessarily the addition of some semantic content (this point is noted by Beard (1995: 179) as well). Depending upon the number of arguments added, verbs may have different nuances. In English, a suffix like *-ize* can induce a variety of argument structures on its base, and therefore a variety of interpretations. The verb *philosophize* has a single argument, and a performative interpretation: *to philosophize* is to act as a philosopher does. Verbs like *hospitalize* and *apologize* require two arguments, but have slightly different readings. The former is locative in interpretation: *to hospitalize* is to cause something to go into the hospital, whereas *apologize* has what Plag (1999) terms an ‘ornative’ meaning: *to apologize* is to cause an apology to go to someone. See Plag (1999) and Lieber (2004) for further discussion of the polysemy of verb-forming affixes. It is likely that the semantics of the base predisposes the affixed form in *-ize* to have one or the other interpretation. Bases like *hospital* that denote places or bases like *container* that denote receptacles are likelier to give rise to locative interpretations. Bases like *philosophy* or *theory* which denote abstract systems are likelier to deliver performative readings.

Languages other than English of course have affixes that are more specific in their semantic (or argument structural) contributions to their bases. Bantu languages, for example, are well-known for having affixation processes that add and delete arguments from verb stems. For example, in Chichewa, the causative suffix *-its/-ets* (1) and the applicative suffix *-ir/-er* (2) (the choice between the two allomorphs is a matter of vowel harmony) each add an argument to the diathesis of the verb, the former an agent argument and the latter a benefactive, locative, or instrumental argument (Mchombo 1998). The suffix *-ik/-ek* has the effect of deleting an agent argument, creating a stative (not passive) sentence (3):

- (1) Causative (Mchombo 1998: 505)  
 Kalúlú a-ku-sék-éts-a chigawênga  
*3-lion 1SM-pres.-laugh-caus.-fv 7-terrorist*  
 ‘The hare is making the terrorist laugh’
- (2) Applicative (Mchombo 1998: 506)  
 Kalúlú a-ku-phík-ír-a mkángó maûngu  
*1a-hare 1SM-pres.-cook-appl-fv 3-lion 6-pumpkins*  
 ‘The hare is cooking (for) the lion some pumpkins.’
- (3) Stative (Mchombo 1998: 509)  
 maûngu a-ku-phík-ík-a  
*6-pumpkins 6SM-pres.-cook-stat.-fv*  
 ‘The pumpkins are getting cooked.’

### 2.1.4. General remarks

As I have implied in the sections above, the notion that some derivations are asemantic, and therefore that there is a special category of ‘transpositional’ derivation is quite

problematic. Changing category necessitates some quite specific semantic effects: choice of argument structure in verbs, of gradability in adjectives, and of concrete or abstract, and eventive or noneventive semantics in nouns. The issue is that the interpretation of items derived by ‘transposition’ is underdetermined by syntactic category-change; a single syntactic category does not correspond neatly to a single semantic category. My conclusion is that derivations that have been called transpositional are in fact not fundamentally different from the non-transpositional derivations, to which we turn next.

## 2.2. Participant oriented

Languages frequently have derivational processes that create nouns corresponding to particular sorts of participants in an event: agent, patient, location, manner, and so on. In English, it is possible to derive nouns that refer to agents (*writer, accountant, attendee*), experiencers (*hearer, dependent*) instruments (*printer, irritant*), stimuli (*pleaser*), location (*diner, orphanage, cattery*), measure (*six-footer*), and patient (*employee, loaner*). We will return in section 3 to the question of why the same affixes that convey these participants can overlap in meaning in some languages.

A related group of affixes that might be called participant-oriented are those like *-ite* and *-ian* that derive names for people who originate in certain places (*New Hampshireite, Bostonian*), or are followers or disciples of particular people (*Darwinite*). Although they attach to nouns, rather than to verbs, they nevertheless imply an eventive meaning (x comes from or follows y).

Yet another common derivational category that might at least indirectly be considered participant-oriented is what Haspelmath (2002: 71) calls ‘facilitative’. Facilitatives do not directly denote participants in an event, but facilitative affixes modify the argument structure of their base verbs such that one participant, the theme, is eliminated. An example is the suffix *-able* in English, which requires a transitive verb as its base (*drinkable, \*arrivable, \*yawnable*); this suffix has the effect of binding the theme argument from the verbal diathesis, in effect preventing it from being satisfied syntactically. Interestingly, in English *-able* occasionally attaches to nouns as well as to verbs, in which case the affix ‘binds’ an argument of the event implied by the base noun (e.g., *marriageable*).

## 2.3. Negative

Languages also frequently have affixes expressing various nuances of meaning that can be roughly classed together as ‘negative’. Most straightforward are what logicians have termed ‘contradictory’ and ‘contrary’ negation. The former is a sort of negation that follows the Law of the Excluded Middle; that is, contradictory negations are those in which P (some property) and not P cannot both be true at the same time, but cannot both be false at the same time. Contrary negations do not adhere to the Law of Excluded Middle; while P and not P cannot both be true at the same time, they can both be false at the same time. Negative prefixation in English can give rise to either interpretation, depending on the base carrying the prefix. For example, *discourteous, ineffectual*, and *unreliable* all have contrary interpretations for me (someone can be neither *discourteous* nor *courteous* at the same time), whereas *disengaged, incalculable*, and *undeniable* all have contradictory readings.



Clearly, whether a given negative adjective has a contrary or a contradictory reading has something to do with whether or not we can conceive of the base adjective as being gradable in meaning: the more likely that a given base admits of gradation, the more likely the negation is to have a contrary rather than a contradictory reading. In fact, particular adjectives can be either gradable or nongradable, and therefore contrary or contradictory in reading when prefixally negated, depending on nuances of meanings. For example, in *nonAmerican*, the adjective *American* refers exclusively to nationality, a property which does not admit of gradation; one is either American or not, depending upon one's citizenship. The negated form *nonAmerican* therefore has the contradictory reading. On another reading, however, *American* can refer to all the various properties that make up 'American behavior', whatever those might be. With this reading, the negated form *unAmerican* does admit of gradation, and therefore has a contrary reading; someone can be neither American nor unAmerican in the sense of bearing those specific properties. Indeed, different speakers may have different judgments on the gradability of specific adjectives, and therefore on whether the negative prefixed forms of those affixes express either a contradictory or a contrary reading.

Also clearly related to the notion of negation is privation, a notion which is frequently signaled by a derivational affix. In English, the suffix *-less* is very productive, deriving privative adjectives from nouns (*shoeless*, *hopeless*). It is also possible to form privative verbs in English from both nouns and verbs. The prefix *de-* performs this function in English (*debug*, *demilitarize*, *dehumidify*).

A final relation that might be classed under negation is reversativity in verbs (*untie*, *unwind*). While it might at first seem that this relationship is somewhat different—to *untie* is to reverse the action of tying—it has nevertheless been argued in the literature (Maynor 1979; Andrews 1986; Horn 2002; Lieber 2004) that negativity is at the bottom of reversativity: assuming that a verb *tie* can be interpreted as something like 'cause to be tied', the reversative reading results when a negative takes scope over the predicate *tied* (so to *untie* is 'to cause to be not tied').

## 2.4. Prepositional/Relational

Affixes may also express a wide range of spatial or temporal relations that can in some languages be expressed by adpositions (prepositions or postpositions). Indeed, in many Romance and Germanic languages, the affixes and the adpositions are the same items. In English, for example, the prepositions *over-*, *after-*, *up-*, *down-*, *under-*, *out-*, *through-*, *back-*, and *by-* double as prefixes with varying degrees of productivity. In Dutch (Booij 2002: 116) prepositions like *aan-*, *achter-*, *door-*, *om-*, *onder-*, *over-* and *voor-* have prefixal counterparts.

The question might again arise whether these items are to be treated as true prefixes, or rather should be considered the first elements of compounds. In some cases, there are good arguments in favor of treating them as prefixes. For example, in English *out-* and *over-* may have an effect on the argument structure of verbal bases they attach to:

- (4) a. Letitia ran.  
      b. \*Letitia ran Prunella.  
      c. Letitia outran Prunella.

- (5) a. The plane flew over the field.  
 b. \*The plane flew the field.  
 c. The plane overflowed the field.

The case can therefore be made that at least these items behave differently from their corresponding prepositions, and therefore might be considered prefixes rather than compounding elements. In other cases it is perhaps less clear what to call these items.

Some of the Native American languages present an abundance of affixes that convey spatial concepts. Mohawk (Iroquoian), for example has prefixes that are glossed as Cislocative (denoting the direction towards the speaker) and Translocative (denoting the direction away from the speaker (Mithun 1999: 139):

- (6) a. Cislocative  
 ta-s-at-awei-a't  
 CISLOC-2AGT-MIDDLE-be.in-CAUS  
 'Come in'  
 b. Translocative  
 ia'-s-at-awei-a't  
 TRANSLOC-2AGT-MIDDLE-be.in-CAUS  
 'Go in'

Mithun also reports the language Chumash (Chumashan family) to have a variety of directional affixes expressing such relations as 'on', 'around', 'across', 'back', 'penetrating', among others (1999: 140). The language Karok (isolate) has a range of spatial affixes expressing such concepts as 'blocking', 'at rest', 'into a container', 'around in a circle', and 'downriver' (Mithun 1999: 142).

Temporal relations are also expressed affixally in some languages. English, for example, has the prefix *ex-*, meaning 'former'. Yup'ik not only has an affix with the meaning 'former', but also one which attaches to nouns to mean 'future x' (Mithun 1999: 154).

The prefix *ex-* in English has interesting scopal properties: although it takes a noun as its base, it may actually take scope over a specifier of the noun (*my ex-car* is still a car, but it's no longer mine), or an adjunct of the noun (*an ex-shortstop for the Red Sox* may still be a shortstop, only not for the Red Sox).

## 2.5. Quantitative/Aspectual

Quantitative derivation covers such concepts as number and collectivity in nouns, as well as aspectual distinctions such as duration, punctuality, iterativity, and distributiveness in verbs. Aspect is one of the categories that hovers on the edge between inflection and derivation. Still, there are clear cases of languages that express aspectual distinctions derivationally and in any case, whether derivational or inflectional the semantic distinctions are sufficiently robust that they merit discussion. I will, however explain in more detail below why quantity in nouns and aspect in verbs have come to be treated as the same semantic category.

Although number marking in English and other Indo-European languages is clearly inflectional, there are languages that do mark number derivationally: in these languages number marking is optional, and it does not trigger syntactic effects like agreement. One

such language is Koasati, which optionally marks plural or paucal number on nouns (paucal is used for 2–6 kinsmen or children): *athómma* ‘Indian’ ~ *athómma-ha* ‘Indians’; *tá:tasi* ‘paternal uncle’ ~ *tá:tasi-ki* ‘2–6 paternal uncles’) (Mithun 1999: 83–84). An interesting case of derivational number is represented by Jemez (Kiowa-Tanoan), which has what Mithun calls ‘Inverse’ number. A single affix *-sh* is used for singular or plural; its semantic effect is to deliver the reverse of what the expected number of an item is. For items that usually come in pairs or groups (e.g. *lips*, *weeds*), the affix delivers a singular meaning; on items that usually come in singles, like human beings, it delivers a plural reading (1999: 81). Blackfoot (Algonkian) also allows collective marking on nouns (e.g. *otáákii-ʔsin-ʔa* ‘womenfolk’, where *-ʔsin* is the collective suffix) (Mithun 1999: 91).

It has long been argued in the philosophical literature that concepts of quantity apply to verbs as well as to nouns (Carlson 1981; Bach 1986, among others). Various sorts of aspectual marking on verbs conceptualize actions or states as being bounded or unbounded, composed of one or more parts, or as being internally undifferentiated. Morphology designating repeated actions, for example, might be seen as analogous to morphology forming plurals of count nouns. Looked at in this way, the prefix *re-*, usually glossed as ‘again’, in English might be considered a quantitative affix, as it designates a distinct but identical event corresponding to its base. Semelfactive affixes, that is, affixes which denote a single, punctual action, are arguably the correlate of singular number on count nouns; they denote temporally bounded unitary events, just as singular count nouns denote spatially bounded, unitary entities. Distributives of various sorts might be correlated with collectives. For example, Mohawk has an affix *-nion*’ which distributes an action over space (Mithun 1999: 89):

- (7) *te-w-anine’kara’wa-nion’-s*  
 DUALIC-NEUTER.AGENT-lightning.strike-  
 DISTRIB-IMPRF  
 ‘Lightning was striking all over’

In a distributive of this sort, we think of a series of identical events which nevertheless together constitute a whole event, in the same way that a collective noun (e.g. *herd*) consists of multiple identical entities conceived of as a whole. Similarly, duratives might be considered analogous to mass nouns in that they designate unbounded actions that persist in the same way over a period of time without internal differentiation of parts.

Another aspectual distinction that might be mentioned here is telicity. A telic situation is, according to Comrie (1976: 4) “one that involves a process that leads up to a well-defined terminal point.” Lieber (2004) has argued that there is no specific morphology in English that makes a verb telic, telicity instead being built at the level of the proposition with contributions from the lexical meaning of the verb, and quantificational characteristics of its arguments and adjuncts. Other languages, however, may well have derivational morphology that makes verbs telic. Levin & Rappaport Hovav (1998: 260) report that the prefix *vy-* in Russian has the effect of turning an atelic verb (e.g., *pit* ‘drink’) into a telic one (*vypit* ‘drink up’). Other candidates might be affixes that are glossed ‘completive’ in the literature.

Some Native American languages have especially rich systems of aspectual markers, and no one, to my knowledge, has as yet tried to broaden the analogy between number in

nouns and aspect in verbs to all of these categories. Mithun (1999: 168) reports, for example, that Koyukon (Athapaskan) marks a broad range of aspectual distinctions. Given the verb root *-tlaatl* ‘chop’, one can derive the forms in Tab. 79.1:

Tab. 79.1: Aspectual categories in Koyukon

|                               |                 |                                           |
|-------------------------------|-----------------|-------------------------------------------|
| <i>Semelfactive</i>           | <i>yeetlet</i>  | <i>‘she chopped it once/ gave a chop’</i> |
| Consecutive<br>(= repetitive) | yegheetletl     | ‘she chopped it repeatedly’               |
| Dir-repetitive                | yootlaa         | ‘she chops at it repeatedly’              |
| Bisective                     | yenaaltlet      | ‘she chopped it in two’                   |
| Momentaneous                  | neeyeneetlaatl  | ‘she chopped it all up’                   |
| Conclusive                    | yeghedaaltlaatl | ‘she hewed it into a shape’               |
| Durative                      | yegheetlaatl    | ‘she was chopping it for a while’         |

Still, it doesn’t seem out of the question that all of these might correlate in some way with categories of quantity in nouns. Aside from the repetitive, durative, and semelfactive meanings we have mentioned above, what Mithun calls Momentaneous seems to convey a notion of boundedness or completion that is perhaps related to telicity, and the Bisective seems clearly quantitative as well.

## 2.6. Evaluative derivation

The most frequently discussed types of evaluative morphology are diminutives and augmentatives, but this is a semantic category that extends as well to derivation conveying intensive (‘very’) and approximative (‘sort of’) meanings; or creating feminine, ameliorative (‘nice, good X’), honorific, and pejorative (‘nasty, bad X’) forms; or morphology expressing childishness or childlikeness, familiarity (as in hypocoristics), or intimacy. A variety of examples is given in Tab. 79.2 (examples from Jurafsky (1996: 536); Haspelmath (2002: 68–69)(Russian); Bauer (1997: 545)):

Tab. 79.2: Types of evaluative morphology

| <i>Language</i> | <i>Type of evaluative derivation</i> | <i>example</i>              | <i>gloss</i>                       |
|-----------------|--------------------------------------|-----------------------------|------------------------------------|
| Yiddish         | diminutive                           | mil ~ milexl                | mill ~ little mill                 |
| Russian         | augmentative                         | borod-a ~ borod-išča        | beard ~ huge beard                 |
| Latin           | intensive                            | parvus ~ parvulus           | small ~ very small                 |
| Greek           | approximative                        | ksinos~ ksinutsikos         | sour ~ sourish                     |
| English         | female                               | steward ~stewardess         | male ~ female                      |
|                 | ameliorative                         |                             |                                    |
| Fula            | pejorative (diminutive)              | loo-nde ~ loo-ngum          | storage pot ~ worthless little pot |
| Tibetan         | child                                | dom ~ dom-bu                | bear ~ bear cub                    |
| Big Nambas      | honorific                            | dui ~ dui-et                | man ~ sacred man                   |
| English         | familiarity, intimacy                | sweetie, various nick-names |                                    |

Indeed, as Jurafsky (1996) and others have pointed out, these concepts are often expressed in languages by precisely the same set of affixes or other derivational devices, something we will return to in section 3.2.

Some theorists have argued that expressive morphology is formally akin to neither inflectional nor derivational morphology (e.g., Scalise 1984), but rather constitutes a special category of word formation in its own right. Bauer (1997), however, disputes this claim, arguing that in some languages evaluative morphology seems to be purely inflectional, for example, in the Bantu languages, where certain noun classes are specifically diminutive or augmentative, and in other languages more clearly like derivational morphology. Either way, from the point of view of their robust semantic contribution to words, evaluative derivation deserves to be treated here.

## 2.7. Summary

This survey of semantic types frequently expressed by derivation is inevitably incomplete. There are no doubt derivational affixes in some languages that convey semantic nuances not discussed here, or that don't fall into one of the above categories easily. Nevertheless, it seems safe to say that the vast majority of non-lexical derivational affixes in the languages of the world will fall into these major categories.

Before we go on to survey theoretical treatments of derivational semantics, a word might be said about reduplication. In the sections above, I have not distinguished reduplication from other forms of derivation (affixation, root and pattern or templatic derivation, etc.) Generally any of the semantic categories discussed above is compatible with any of the formal means of deriving new lexemes. It might be expected that reduplication would be used for some semantic categories more frequently than for others, for example, plurality, intensiveness, repetition, frequency, and iteration. In other words, we might expect reduplication to be semantically iconic: phonological full or partial doubling ought to lend itself to semantic categories that signal multiplicity in various forms. But as Inkelas & Zoll (2005: 12) point out, "Iconic semantics is not, however, the general rule. Reduplication, especially partial reduplication, is associated cross-linguistically with all sorts of meanings, both inflectional and derivational, whose degree of iconicity is often negligible."

## 3. Theoretical issues in the semantics of derivation

It seems safe to say that the most neglected area of morphological theory in the last three decades has been derivational semantics. Following a brief treatment in Dowty (1979) in the framework of model theoretic semantics, only a few theorists have offered extended treatments of this topic, among them Beard (1990, 1995) in the framework of Lexeme Morpheme Base Morphology, Jurafsky (1996) in the framework of Cognitive Linguistics, and Lieber (2004) in the framework of Conceptual Semantics. Several key issues are addressed in these works: whether there are limitations on the range of meaning that can be conveyed by derivation; why individual affixes tend to be polysemous; why there are often several affixes in a given language that convey the same meaning; and generally why there are mismatches between form and meaning in derivation. We will consider each of these issues in turn.

### 3.1. Limitations in the range of meaning conveyed by derivation

The catalogue in section 2 of semantic categories that are frequently manifested in derivation raises a question: is it purely accidental that such categories are repeated over and over in derivation in the languages of the world, or is there a reason for this circumscription? To the extent that this issue has been addressed in the literature, the consensus is that this cannot be an accident, but several different explanations for the semantic circumscription of derivation have been proposed.

Beard (1990, 1995) argues that derivation parallels inflection, and therefore that any semantic category that can be expressed in the inflection of some language can be used in derivation. In fact, his position seems to be even stronger. He proposes what he calls the Universal Grammatical Function Hypothesis (UGF) which “limits the number of categories available for this type of derivation [i.e., derivation of adjectives and nouns R.L.] to those of the inflectional paradigm” (1990: 125). Starting from the case-marking system in Indo-European languages, Beard (1995), following Szymanek (1988), proposes 44 grammatical categories into which derived nouns and adjectives can fall. Included are Agent and Patient, of course, but also Measure, Means, Manner, Location, Purpose, and a variety of others that are listed in Tab. 79.3.

Beard’s claim is that any of the inflectional categories into which nouns and adjectives can fall in Indo-European languages can also form the basis of a derivational category. For example, corresponding to the inflectional category of Subject (nominative), languages can have subjective derivations, that is, affixes that derive subject nouns (generally agentives). A given inflectional relation does not, of course, have to exist in a particular language for that language to express one of the 44 possible relationships derivationally. Languages like English and Dutch that lack overt case marking can nevertheless have derivational affixes that form ‘subjective nominals’.

One immediate difficulty with Beard’s hypothesis is that it pertains only to the derivation of nouns and adjectives. Beard is forced to categorize a fairly wide range of derivation as asemanic, that is, as transpositions. But as we have seen in section 2.1, transposition is rarely truly asemanic: the so-called transpositions still have specific readings that are underdetermined by simple change of syntactic category. Beard’s theory also has nothing to say about derivation of verbs, which again is relegated to the realm of transposition and deemed asemanic. But to relegate so many derivational categories to transposition is to beg the question of semantic limits.

A second difficulty that Beard’s proposal encounters concerns the so-called lexical affixes that are found in polysynthetic languages. As Mithun argues, these cannot be dismissed as bound roots. But their semantic robustness precludes treating them as variations on case relations that appear in Indo-European languages. In other words, although lexical affixes are probably atypical in the larger scheme of things, a semantic framework that is based on inflectional categories in effect predicts that they should not exist at all.

Lieber (2004) develops another framework that can be used to circumscribe the typical semantic range of derivation, without however, ruling out the existence of lexical affixes. Lieber claims that the circumscription in the semantic range of derivation follows not from the semantics of inflection, but rather from the semantic categories that distinguish classes and subclasses of simplex lexical items from one another. A brief discussion of her framework is necessary to make sense of this claim.

Tab. 79.3: Beard's derivational categories (1995: 391–395)

| <i>inflectional functions</i> | <i>Corresponding derivational categories</i> |
|-------------------------------|----------------------------------------------|
| *Agent                        |                                              |
| *Patient                      |                                              |
| Subject                       | Subjective nominal                           |
| Object                        | Objective nominal                            |
| Possessivity                  | Possessive adjective                         |
| Possession                    | Possessional adjective                       |
| Measure                       | Mensurative nominal                          |
| Material                      | Material nominal                             |
| Partitivity                   | Partitive nominal                            |
| Distinction                   |                                              |
| Absolute                      |                                              |
| Means                         | Modalic nominal                              |
| Route                         | Vialic adjective                             |
| Manner                        | Similitudinal adjective                      |
| Ession                        | Essive adjective                             |
| Duration                      | Durative adjective                           |
| Iteration                     | Iterative adjective                          |
| Accordance                    | Accordant nominal                            |
| Purpose                       | Purposive nominal                            |
| Exchange                      | Permutative                                  |
| Cause                         |                                              |
| Sociation                     | Sociative noun                               |
| Location                      | Locative noun                                |
| Goal                          | Goal nominal                                 |
| Origin                        | Originative nominal                          |
| Inession                      | Locative noun                                |
| Adession                      | Locative noun                                |
| Anteriority                   | Anterior nominal                             |
| Posteriority                  | Posterior nominal                            |
| Superession                   | Superessive nominal                          |
| Subession                     | Subessive nominal                            |
| Transession                   | Transessive nominal                          |
| Intermediacy                  | Intermediative nominal                       |
| Prolation                     | Prolative nominal                            |
| Proximity                     | Proximate nominal                            |
| Opposition                    | Oppositive adjective                         |
| Perlation                     | Perlative nominal                            |
| Circumession                  | Circumessive                                 |
| Termination                   | Terminative                                  |
| Concession                    | Concessive                                   |
| Distribution                  | Distributive                                 |
| Exception                     | Exceptive                                    |
| Privation                     | Privative adjective                          |
| Thematicity                   |                                              |

\*In ergative/absolutive languages

According to Lieber (2004), the lexical semantic representation of a simplex item has two parts. The skeleton is that part of the lexical semantic representation that is of significance to the syntax. Formal and tightly constrained, it consists of functions and arguments arranged hierarchically, similar to the LCSs of Jackendoff (1990) (cf. article 19 (Levin & Rappaport Hovav) *Lexical Conceptual Structure*, and article 30 (Jackendoff) *Conceptual Semantics*). The body is that part of the lexical semantic representation that is encyclopedic, consisting of those aspects of perceptual and cultural knowledge that form the bulk of lexical meaning, but are of no consequence with respect to syntax.

Skeletal functions in Lieber's system consist of features that can be used cross-categorially, and in either a binary or privative fashion. For example, simplex nouns are either [+material] (concrete: *dog, hand*) or [−material] (abstract: *truth, minute*), and may also bear the feature [dynamic] if they have an eventive or processual flavor (*author, sunset*). Basic verbal classes can be distinguished on the basis of two features. The feature [+/−dynamic] distinguishes events from states, where [+dynamic] items are eventive (*eat, yawn*) and [−dynamic] stative (*own, love*). Eventive ([+dynamic]) lexical items can also bear the feature [+/−IEPS] (“Inferable Eventual Position or State”), which essentially distinguishes those verbs for which a path is relevant (*fall, grow, walk*) from those for which no path is relevant (*eat, yawn*). [+IEPS] items have directed paths as part of their meaning (*fall*), whereas [−IEPS] items imply a non-directed or random path (*walk*). Lieber (2004) develops a number of other semantic features which apply cross-categorially and delimit various locational and quantitative classes.

Derivation, Lieber argues, can create new lexemes that fall into any of the classes to which simplex lexical items belong. Typical derivational affixes have skeletons that are added to the skeletons of their bases, but they have little or nothing in the way of semantic body: they are devoid of encyclopedic content. This does not preclude, however, that some affixes in some languages might have encyclopedic content; this leaves the way open for the lexical affixes that we find in polysynthetic languages.

Given that there are a limited number of lexical classes into which simplex items can fall, the range of affixes (or derivational processes of other sorts) is predicted to be equally limited. Tab. 79.4 gives an idea of basic lexical semantic categories in Lieber's system, and some of the affixes that can contribute those meanings in English.

Tab. 79.4: Lieber's lexical semantic classes

| <i>Class</i>         | <i>Simplex example</i> | <i>Derivational affix</i> |
|----------------------|------------------------|---------------------------|
| [+material]          | chair, leg             |                           |
| [−material]          | time, fact             | -ness, -ity, -hood, -ship |
| [+material, dynamic] | author, chef           | -er, -ee, -ant, -ist      |
| [−material, dynamic] | habit, war             | -ation, -al, -ment, -ure  |
| [+dynamic]           | eat, kiss              |                           |
| [−dynamic]           | know, fond             | -ic, -ive, -ary, -al,     |
| [+dynamic, +IEPS]    | fall, go, grow         |                           |
| [+dynamic, −IEPS]    | walk, run, vary        |                           |
| causative*           | kill                   | -ize, -ify                |

\* Following Dowty (1979) and Rappaport & Levin (1992), Lieber (2004) uses a bipartite skeleton to capture the semantics of causative verbs. See Lieber (2004) for details of this analysis.



Where there seem to be categories in which English lacks affixes, there are other (non-affixational) word formation devices that create new lexemes in those classes. For example, new material (concrete) nouns are frequently created by compounding, and new eventive verbs by conversion from nouns. Other languages, of course, can use derivational means to create items of those categories. Czech, for example, appears to have an affix *-ivo* which attaches to verbs to create mass nouns: *rezat* ' ~ *rezivo* 'cut' ~ 'timber'; *tkat* ' ~ *tkanivo* 'weave' ~ 'fiber' (Pavol Štekauer, p.c.).

The framework that Lieber develops avoids two of the pitfalls of Beard's proposal mentioned above. First, it is not confined to derivation of nouns and adjectives, but covers all sorts of derivation, including those that Beard is forced to call asemanitic. Second, it can account for lexical affixes: although typical derivational affixes bear skeletons but have little or nothing in the way of semantic body (that is, encyclopedic meaning), nothing prevents them from having semantic bodies. Lexical affixes are simply affixes that have the type of encyclopedic content that is more typical of simplex roots.

The two formal stances also give rise to different predictions that can be tested by looking at the various mappings of form to meaning that can be found in derivation cross-linguistically. We turn to these in the following sections.

### 3.2. Polysemy vs. homophony

One of the important questions that arises with respect to the semantics of derivation is why a single affix can often cover a range of meanings. For example a single affix is used in many languages to cover both agentive and instrumental meanings. This happens in English, of course, with the suffix *-er* (*writer*, *printer*), and in other Indo-European languages as well, (e.g., Dutch, Czech). But it happens as well in such genetically unrelated languages as Kannada (Dravidian) (Sridhar 1993) and Yoruba (Niger-Congo) (Pulleyblank 1987). Similarly, in many languages diminutive affixes also cover a whole range of meanings including 'small', 'child', 'affection', 'good', 'nasty'. They may double as intensive or attenuative affixes as well.

One conceivable answer to this question is that it is simply an accident that these meanings are frequently clustered together under a single affix. This answer claims in effect that there are several homophonous *-er* suffixes in English (and Dutch, etc.), and that there is no more relation between the agentive and instrumental *-er* suffixes than between the agentive and the comparative, which is also signaled by *-er* in English. After all, this clustering of meanings is not necessary; Bauer (1993: 514) reports that Maori has a prefix that derives agentives but not instrumentals. Nevertheless, the two meanings fall together frequently enough to call into question an analysis of accidental homophony and to make it worth asking the question why these particular meanings should cluster together so often.

Several theorists have addressed the issue of affixal polysemy. There is a substantial literature on the polysemy of the affixes *-er* and *-ee* in English and other Germanic languages. The former affix is treated by Booij (1988), Rappaport Hovav & Levin (1992), Beard (1990, 1995), and Lieber (2004), and the affix *-ee* by Barker (1998) and Lieber (2004), all treatments that fall roughly within the tradition of generative morphology. Jurafsky (1996) discusses the polysemy of diminutive morphology from the perspective of Cognitive Grammar. These approaches are quite different, as we will see.

Beard's treatment of polysemy follows from the principle of Uniform Grammatical Function (see section 3.1 above). He argues that since derivational affixes display

the semantic categories made available by the inflectional system, where two or more inflectional categories are marked by the same case, we might expect those categories to fall together under the same derivational affix (1990: 125). For example, in Russian both passive agent and instrument are marked with the Instrumental case. Beard therefore predicts (1990: 121) that agent and instrument should both be derived with the same derivational suffix, as indeed is the case in Russian.

The difficulty with Beard's proposal is in defining just what counts as the same "case" marking in a particular language. For example, Beard counts the passive agent in German as being marked Ablative because it requires the preposition *von*, which is also the directional preposition 'from'. Beard predicts from this that both agentives and nouns designating place of origin should use the same suffix in German: *Lehrer* 'teacher'; *Amerikaner* 'American'. However, the nominal object of *von* is in fact marked with the Dative case. If we take Dative as the relevant category that gives rise to derivational polysemy, we ought to expect the existence of derivational affixes which put together any combination of the relationships that are expressed by the Dative. But this does not happen in German. It is only when we count a particular preposition plus the case it governs as a "case" that Beard's prediction follows.

The notion of "case" is even more vexed in English: Beard considers the passive agent in English to be marked with the Instrumental case, because it is signaled by the preposition *by*. Because *by* also marks instruments (*by candlelight*), Beard argues that we would then expect some derivational morpheme to be polysemous between an agent and an instrument reading, which *-er* certainly is. English, of course, has virtually nothing left in the way of case marking, but as with German, Beard treats prepositional choice as the equivalent.

The problem with this idea is that a preposition like *by* can signal many relations in English, not only passive agent and instrument (*by candlelight*), but also locative (*by the river*), quantity (*by the minute*), and a variety of other relations. Instrument is in fact more often signaled in English by the preposition *with*. The fact that agent and instrument fall together in English is explained only if we accept Beard's characterization of the "case" function of one particular preposition.

Booij (1988) and Rappaport Hovav & Levin (1992) explain the polysemy of *-er* on the basis of argument structure. They show that any thematic relation that can be expressed by the external argument (the subject) can be expressed by nominalizations in *-er*, since this suffix essentially binds or saturates the external argument. Since the external argument can express such roles as agent, instrument, stimulant, experiencer, and even patient/theme (with unaccusatives and middles), all of these relations can occur in *-er* nominalizations:

- (8) agent: writer, driver
- instrument: opener, printer
- experiencer: hearer
- stimulus: pleaser, thriller
- patient/theme: fryer
- denominal noun: Londoner, freighter
- measure: fiver
- location: diner

This analysis covers a great deal of ground, but does not cover all cases of polysemy with *-er*. Specifically, it does not account for the interpretation of *-er* forms that have nouns, rather than verbs as bases, for example, *Londoner*, *freighter*. Since the base nouns do not have argument structure in the classic sense, the Booij/Rappaport Hovav & Levin analysis fails to explain why these are interpreted as personal nouns and instruments, just as the deverbal nouns are.

Barker (1998) argues that the polysemy of the suffix *-ee* in English cannot be explained on the basis of argument structure, but must take semantics into account. Like *-er*, suffix *-ee* can express a number of semantic relations:

- (9) patient/theme: employee, nominee
- agent/subject: escapee, standee
- ind. obj.: addressee, dedicatee
- prepositional: experimentee
- no argument: amputee
- denominal person noun: biographee

But it is impossible to say that *-ee* saturates or binds any particular syntactic argument of its base verb: the saturated argument is sometime the direct object, sometimes the indirect object, sometimes the object of a governed preposition, and sometimes even the subject. Rather, he argues that the suffix *-ee* must satisfy a number of semantic needs in choosing the semantic argument it binds: the argument must be a (direct or implied) participant in an event, it must be sentient, and it must be non-volitional. For a verb like *employ*, the direct object is the argument that fulfills these requirements; the object of *employ* is generally human, and therefore sentient, but not under direct control of getting the job. But for *address*, which has a non-sentient direct object (i.e., one addresses a letter), the indirect object is the argument that satisfies the semantic needs of the suffix. If none of the arguments of a verb (e.g., *amputate*) fulfills the requirements, it can even be an implied argument that the *-ee* form expresses: an *amputee* is the person whose limb has been removed. The reader is referred to Barker's (1998) article for the full details of the analysis.

Lieber (2004) provides an analysis of affixal polysemy that builds on the insights of Booij, Rappaport Hovav & Levin, and Barker. The formalism of her framework provides a tightly constrained set of features that can constitute the skeletons of various affixes. Noun-forming affixes must have some value of the feature [material] (that is, they must be concrete or abstract), and they may bear the feature [dynamic] (that is, they may be processual or eventive in some way). Given the two values of [material] and the presence or absence of [dynamic], four categories are defined:

- (10) [+material]
- [-material]
- [+material, dynamic]
- [-material, dynamic]

As affixes bear skeletal features, but typically have no encyclopedic information as part of their semantics, there are in effect only a few meanings that affixes can bear. Some noun-forming affixes form purely abstract nouns (*-hood*, *-ship*, *-ism*), some form abstract

processual nouns (*-ation*, *-ment*, *-al*) and others concrete processual nouns: this is the category into which *-er* and *-ee* in English fall. The polysemy of the affixes stems from the abstractness of their semantic content; since they only supply a concrete processual meaning, they are equally amenable to agent, patient, instrument, or locational meanings. The differences between the affixes stem from constraints on the way in which the affixal skeleton is integrated with the skeleton of its base. All other things being equal, affixes typically bind the highest argument of their base. This is the case with *-er*. But affixes may also place particular semantic requirements on the base argument which they bind. As Barker has argued, *-ee* requires that that argument be both sentient and non-volitional. It therefore typically skips over the agent argument (although it need not), and binds the patient/theme, the goal, or some other argument that is more in tune with its requirements. The sort of polysemy that Lieber attributes to *-er* and *-ee* has been termed 'logical polysemy' (Pustejovsky & Boguraev 1996).

Neither Beard (1995) nor Lieber (2004) treats the issue of polysemy in evaluative morphology, and it appears that neither theory is currently equipped to account for it. The range of meanings found in evaluative affixes (e.g., diminutive, childlike, pejorative, intensive, attenuative, etc.) clearly cannot be derived from inflectional categories, as in Beard's analysis. Nor does Lieber (2004) provide semantic features that cover this range of meanings (although nothing precludes her from adding such features). In contrast, Cognitive Grammar gives an interesting way of explaining this range of polysemy: Jurafsky (1996) considers 'diminutive' to be a radial category, with prototypical meanings such as 'child' and 'small' at its center, and links from these prototypical senses that "represent metaphorical extensions, image-schematic transfer, transfers to different domains, or inferences" (1996: 542). In other words, Jurafsky classes the polysemy of evaluative affixes as 'sense extension' rather than as logical polysemy (Pustejovsky & Boguraev 1996).

The use of diminutives for pets, for example, results from a metaphorical extension: pets are conceived of as children. The extension of diminutives to affection and intimacy results inferentially from the prototypical meaning of child: we usually feel affection for and intimacy with our children, so over time this inferred affection and intimacy becomes conventionalized in the meaning of the diminutive.

Jurafsky argues that the radial category not only represents the synchronic net of meaning relations borne by this category, but also its historical development; morphology dealing with affection, intimacy, and the like is predicted to have developed at one time or another from central senses of 'child' or 'small' even if it no longer conveys those central meanings in a particular language. Jurafsky's treatment of evaluative morphology is convincing, but it is not clear whether the cognitive approach can be extended to other polysemous derivational categories as well.

### 3.3. Multiple affixes with the same function

A second issue that arises in the treatment of the semantics of derivation in many languages is why there are frequently several different affixes that have the same function or semantic effect on their bases. In English, for example, there are several cohorts of affixes that seem to cover the same territory: *-ity* and *-ness* form abstract nouns from adjectives; *-ation*, *-ment*, and *-al* form nouns from verbs; and *-ize* and *-ify* form verbs from nouns and adjectives. It might be thought that the existence of these cohorts can be explained merely as historical accident; English, for example, has both native and borrowed affixes that do

the same work. But this cannot be the whole story. With respect to simplex lexemes, we know that a foreign term can be borrowed even where a native equivalent exists, but the usual course of events is for one of the two to die out eventually, or for the meanings of the two to diverge. Such is not the case with affixes, where native and borrowed can exist side by side with no semantic drift. Why should this be the case?

Beard (1995) argues that the existence of multiple affixes follows from the general architecture of Lexeme Morpheme Base Morphology. Part of this theory is what Beard calls the Separation Hypothesis. The Separation Hypothesis bifurcates the morphology into a morphosyntactic part in which morpho-syntactic features are added to lexemes, and a morpho-phonological part in which the affixes themselves (that is, their phonological content) are added. Several different phonological affixes (e.g., *-er*, *-ant*) can correspond to the same set of morphosyntactic features (e.g., [+agentive]). Given that there are limitations on the range of morpho-syntactic features, affixes are likely to overlap in meanings.

Note that the Separation Hypothesis is not unique to Lexeme Morpheme Base morphology. It is also embraced by Distributed Morphology (Halle & Marantz 1993; Harley & Noyer 1999; cf. also article 81 (Harley) *Semantics in Distributed Morphology*), within a rather different architecture of inflection and word formation.

Lieber (2004) also explains the multiple affix issue on the basis of the limited number of lexical semantic classes into which affixes can fall. If featural representations are highly circumscribed (see above), and if derivational affixes normally consist of skeletal features without body (that is, encyclopedic material), there is limited semantic space that affixes can cover. If a language—like English—has many derivational affixes, some of them are bound to fall into the same categories, thus giving rise to the multiple affix phenomenon.

### 3.4. Other mismatches between form and meaning

Affixal polysemy and the existence of multiple affixes are two instances of a mismatch between form and meaning: polysemy pairs several meanings with one form, and multiple affixes represent different forms corresponding to a single meaning. There are other potential mismatches between form and meaning as well, which we will consider here.

The first case concerns so-called conversion or zero derivation, in which new lexemes are derived with no overt formal morphology. In such cases a change in meaning corresponds to no change in form. Both Beard (1995) and Lieber (2004) argue that this form/meaning mismatch is theoretically unproblematic.

Beard's reason for dismissing this form/meaning mismatch derives from his Separation Hypothesis. Since the Separation Hypothesis bifurcates the morpho-syntactic part of derivation from the phonological part, with morpho-syntactic features being paired with various phonological forms, on the one hand, and various phonological forms being paired with different sets of morpho-syntactic features, on the other, nothing precludes his theory from pairing some set of morpho-syntactic features with no phonological form at all. In other words, in such cases derivation consists only of addition of morpho-syntactic features.

Lieber's solution to this form/meaning mismatch is to say that conversion is in fact not a form of derivation at all, but rather is a form of lexical relisting of items. While derivation is expected to be constrained to one of the major lexical semantic categories (with of course room for logical polysemy, and in some cases additional encyclopedic content),

conversion should be unconstrained in meaning, with converted forms having the ability to be relisted in any of the semantic categories into which new lexemes might be coined. With respect to conversion of nouns to verbs, Lieber (2004) shows that this is indeed the case. As shown in (11)-(12), noun-to-verb conversions in English fall into a far broader range of semantic categories than verbs derived with such affixes as *-ize* and *-ify* that take nouns as their bases:

- (11) Range of meanings exhibited by *-ize*, *-ify*  
 make x: standardize, acidify  
 make x go to/in/on sthg.: apologize, glorify  
 make sthg. go to/in/on x: hospitalize, codify  
 do x: theorize, speechify  
 do in the manner of x: despotize  
 become x: oxidize, calcify
- (12) Range of meanings exhibited by noun-to-verb conversion in English  
 make x: yellow, bundle  
 make x go to/in/on sthg.: jail  
 make sthg. go to/in/on x: leaflet  
 do x: hostess  
 do in the manner of x: buffalo  
 become x: cool  
 use x: hammer  
 remove x: peel  
 be x: landmark  
 move using x: jet  
 move on x: quarterdeck  
 move in x manner: cartwheel

The wider range of semantic categories exhibited by noun-to-verb conversion in English suggests that it is correct to distinguish the semantic effects of conversion from those of affixational derivation. It remains to be seen if this conclusion holds for languages other than English.

The final semantic mismatch we will consider here is the case in which derivational form corresponds to no meaning at all. What we have in mind here is so-called 'empty affixation', that is, phonological material that appears to be meaningless. For Beard, again, this sort of derivation poses no problem: the Separation Hypothesis allows him to say that just as there can be meaning without form (as in the case of conversion), there can be form without meaning.

But Lieber's theory is more constrained: derivation requires both form and meaning. She argues that apparently meaningless derivation is actually a by-product of allomorphy. For example, in the English examples in (13), it might be thought that *-at*, *-et*, *-ut*, *-in*, *-t*, and *-n* are empty morphs:

- (13) orient-at-ion  
 retard-at-ive  
 them-at-ic

observ-at-ory  
 theor-et-ic  
 revol-ut-ion  
 absol-ut-ory  
 longitude-in-al  
 schema-t-ic  
 Messia-n-ic

Lieber points out (2004: 173) that the choice of empty morph is arbitrary; there is no phonological motivation for the choice of one empty morph over another with a particular stem. For example, *schema* and *Messiah*, the bases of *schematic* and *Messianic*, both end in schwa, and yet take different empty morphs. She also points out that the choice of empty morph seems to take place once per stem: given the stem *invite*, the empty morph is always *-at* (*invitation*, *invitatory*). She therefore argues that what appear to be empty morphemes are actually stem allomorphs that occur with Latinate morphology. In other words, there is no semantically empty morpheme *-at* or *-it*, only stem allomorphs like *themat-alongside* of *theme*. The former is selected by derivational affixes, the latter occurs as a free form.

#### 4. Conclusions

It has been remarked several times that the semantics of word formation is one of the most understudied areas of morphology (Carstairs-McCarthy 1992; Levin & Rappaport Hovav 1998). This brief survey gives further proof that the semantics of derivation is a rich area that deserves far wider attention than it has previously enjoyed. From a cross-linguistic perspective, it would be worth looking more closely at the so-called lexical affixes to explore further the range of meaning that is exhibited from one language to another. The question of polysemy also deserves more work: besides agent/instrument nouns and evaluative morphology what other areas of derivation are prone to polysemy? It should also be considered whether all cases of so-called empty morphs can be explained as cases of stem allomorphy. Especially important will be to test current theoretical proposals against data from a wide range of languages.

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Rochelle Lieber, Durham, NH (USA)



## 80. Semantics of compounds

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### Abstract

*Compounds, at least on the surface, seem to exemplify a baffling array of different types and patterns. This contribution concentrates on the characterization of the regular, productive, determinative pattern of noun-noun combinations in its search for a theoretical analysis able to unite the different constructions in a coherent way into a single pattern of interpretation that is to be expected of such a simple juxtaposition of lexemes. It proceeds chronologically through several different analytical perspectives to arrive at a simple analysis in terms of a template that conjoins two predicates mediated by an open conceptual inference. The success of the compound template provides the basis for the consideration of such further questions as the different function of compounds vis-à-vis seemingly equivalent syntactic phrases (computer screen—screen of a computer, table top—top of a table). It then broaches the questions of how less regular patterns can be subsumed under the general analysis and what restrictions apply to the inference process of a conceptual relation underlying compound meaning.*

### 1. Introduction

Compounding is a process of word formation in which two lexemes are combined to form a complex lexeme, cf. *trumpet blast*. It is a highly productive process in many languages which results in a binary grouping of constituents in which one of the constituents functions as the head. For example, *smart phone* is a noun because *phone*, the head, is a noun. A certain amount of recursion is permitted, cf. *[[bumper-sticker] slogan]*, *[[Sunday morning][news program]]*, *[home [[health care] worker]]*, but basically compounds represent simple structures that are made up exclusively of lexical categories that combine freely with one another. The combination is not restricted by the categorial or selectional properties of the head as is generally the case in derivational and syntactic configurations. Because of their lack of functional categories, compounds do not overtly express the logical or grammatical relations that exist between their constituents. Therefore, they are inherently ambiguous. Within the class of compounds, different types of formal and semantic structures can be identified. The traditional classes of determinative, possessive, and copulative compounds stemming from the early study of Sanskrit grammar can be broken down into further subtypes and cross-classified with respect to their endocentric (headed) and exocentric (non-headed) nature. However, by considering the conjunction

of predicates as one possible strategy open to determinative compounds and by recognizing the possessive interpretation as an instantiation of a more general metonymic strategy of interpretation, modern theories of word formation are able to reduce the classes of copulative (*architect-sculptor* 'both an architect and sculptor') and possessive (*airhead* 'someone with a head of air') compounds to the determinative pattern and, hence, speak more generally of a single class of modifier-head structures that have become known as root or primary compounds, cf. *adrenaline junkie* 'junkie dependent on (thrill induced) adrenaline'. In addition, synchronic approaches recognize further types of compound structures, the most important of these being synthetic or verbal compounds in which the first constituent satisfies a (basic or inherited) argument position of the head, cf. *town mayor* and *window installer*.

In contrast to the relatively simple structural properties of compounds, their interpretative possibilities give rise to a surprising number of complex, far-reaching and intriguing problems which are the focus of this article. In order to provide a systematic discussion of the substance and development of these issues, concentration will be placed first and foremost on the class of regular determinative compounds consisting of two nouns which represents the most productive pattern of compounding in most languages. After gaining insight into this area, the results of the discussion will be applied in conclusion to a number of less frequent and more peripheral compound types.

Since compounding is a productive process of word formation, novel compounds enter the language continuously. In order for communication to be successful, these new complex expressions must be understood in the sense in which they are intended. A central question to be asked in this context, therefore, concerns their meaning constitution: what semantic components enter the interpretation besides those explicitly given in the component parts? Compounds, as morphological units, strongly tend to take on a categorizing and naming function in contrast to the descriptive function of syntactic expressions. Furthermore, as names of categories, compounds tend to take over a permanent need in the vocabulary and are therefore prone to idiosyncratic and other specializations of meaning. Such drifts of meaning, including non-transparent (e.g., *lord* from OE *hlaf* 'loaf' + *weard* 'warden') and lexicalized compounds (*cupboard* 'cabinet'), will be left out of consideration here because their idiosyncratic features are not predictable and, hence, must be explicitly recorded in the lexicon.

## 2. Early treatments of compound meaning

### 2.1. Descriptive approaches

Within the framework of traditional descriptive linguistics, there has been a strong tendency to study compounding via the general semantic patterns instantiated by established compounds and to use this fixed set of patterns as a prediction for the types of meanings that are possible in compounding. Jespersen (1909), for example, discerns eight categories, partly syntactic but mostly semantic in nature. He acknowledges, however, that such an analysis can never be "exhaustive" (Jespersen 1909: 138). His categories are: 'apposition' (*woman doctor*), 'subject or object of an action' (*sunrise*, *sun-worship*), 'location' (*garden-party*), time (*evening-star*), 'purpose' (*wineglass*), 'instrument' (*gunshot*), 'contained-in' (*feather-bed*), and 'material content' (*gold ring*). Criticizing Jespersen's method of classification as employing "a random group of criteria" (Hatcher 1960: 359),

Hatcher (1960) attempts an “exhaustive” account of compound meaning by setting up a classification scheme based on what she considers to be “logically consistent criteria” (Hatcher 1960: 356) consisting of four abstract symmetrical categories that are, in her view, general enough to accommodate all compound types. These are ‘A is contained in B’ (*sand paper*), ‘B is contained in A’ (*broomstick*), ‘A is source of B’ (*cane sugar*), ‘A is goal of B’ (*sugar cane*). She claims that ‘location’, ‘time’ and Jespersen’s two verbal types are subsumed by this scheme as well. Admitting that these four categories are extremely “vague and elastic” (Hatcher 1960: 366), Hatcher goes on to predict more specific relations within each general category by taking into consideration the semantic features of the constituent nouns in each group. This idea, however, is only briefly illustrated by means of a table of classified examples, cf. Hatcher (1960: 368).

Marchand’s (1969) analysis focuses on the idea that nominal compounds are based on the same relations that underlie sentences and consequently he uses syntactic terms to structure his categorization: “Morphologic composites (= compounds, suffixal derivatives, prefixal derivatives) are ‘reduced’ sentences in substantival, adjectival, or verbal form and as such explainable from ‘full’ sentences:” (Marchand 1969: 31). His subgroups, however, include reference to semantic notions yielding the following classes: ‘subject type’ including attributive (*girl friend*), resemblance (*eggplant*) and possession (*picture book*), matter (*bread crumb*), production (*disease germ*); ‘predication type’ including affected object (*air-brake*), effected object (*candlelight*), production (*corn whisky*); and ‘adverbial complement’ including place (*corn belt*), time (*tea time*), and instrument (*writing pen*), cf. (Marchand 1969: 39–53). The influence of syntactic relations on the study of compounding found in Marchand may have had two different sources: the earlier Bloomfieldian (1933) and Brugmannian (1900) tradition as well as the generative tradition of the 1960’s to be discussed in the next section. Bloomfield’s view of compounding was that it depended on the syntactic features of the language. ‘Syntactic’ compounds are made up of constituents that stand in the same grammatical relation as in a syntactic phrase (*black-bird*), while ‘asyntactic’ compounds do not reflect syntactic constructions of the language (*door-knob*). An intermediate type of ‘semi-syntactic’ compounds reflects syntactic relations but in a deviant form (cf. *housekeep* vs. *to keep house*). Bloomfield’s analysis is complemented by a second classification into endocentric and exocentric compounds (Bloomfield 1933: 233–235).

Influenced by Jespersen’s and Marchand’s analyses, Adams (1973) uses eleven categories (i.e., subject-verb, verb-object, appositional, associative, instrumental, locative, resemblance, composition, adjective-noun, names) to arrive at an extensive typology of compound meaning. Her approach subdivides each general category according to a mixture of syntactic, morphological and more specific semantic notions.

The general criticism leveled against these analyses has focused on the problem that the categories are so broad that it is often not clear to which class a compound belongs; indeed, it is often possible to place a compound in more than one class. Hence, a great deal of artificial ambiguity results. Furthermore, the extremely general categories used are unnecessarily vague in that they disguise the more specific meanings that compounds actually have. *Gold ring*, for instance, belongs in the class of ‘material content’ for Jespersen but instantiates the category ‘A contained in B’ for Hatcher. So whereas *gold ring* and *sandpaper* are distinguishable via the contrast between ‘material content’ and ‘contained-in’ for Jespersen, these two compounds exemplify the same relation for Hatcher. From a more sophisticated semantic vantage point, it is easy to recognize that

the progress-inhibiting mistake of these early taxonomic approaches is one of elevating frequently occurring relations to the level of linguistic primitives rather than having the meaning of compounds follow from an interaction among the semantic properties of the participating constituents.

Warren's (1978) treatment of noun-noun compounding rises to a certain extent above this criticism in that, although basically taxonomic in its approach, it nevertheless is based on a large corpus of data which are first grouped under a set of general relations (constitute and resemblance, belonging to, location and purpose) and then each relation is analyzed into reversible semantic roles. The purpose relation represents, for example, the semantic classes of place-object (*tablecloth*), object-place (*water bucket*), time-object (*nightdress*), object time (*dinnertime*), object-causer (*ball bat*) and causer-object (*foot-ball*). The systematicity of the discussion substantiates on the one hand the more sketchy analyses of previous works, while transcending them on the other in its principled attempt to ground the productivity and restrictiveness of the individual patterns in a detailed discussion of the finer semantic properties of each subclass.

## 2.2. Early generative approaches to compound formation

In the early stages of transformational generative grammar, the lexicon was limited to monomorphemic forms. All complex expressions were a product of the phrase structure rules generating an underlying deep structure and a set of generalized transformations operating on the deep structure. In the first study of nominalizations within this framework, Lees (1963) derived nominal compounds from underlying sentence structures in which the relationship between the two nouns was given by an explicit predicate. Lees' 'NPN-transformation' deleted the overt predicate (often prepositional, therefore 'P') and reversed the two flanking 'N' categories in their order (Lees 1963: 174). The semantic ambiguity found in compounds, e.g., German *Holzschuppen* from 'shed for storing wood' or 'shed made out of wood', could be explained according to Motsch (1970: 208) by tracing the compound structure back to different underlying phrasal representations for the compound.

This proposal immediately triggered a discussion of the problem of ambiguity resulting from the irrecoverability of the deleted material. In the standard theory of generative grammar, deep structure was the sole basis for semantic interpretation. Therefore, transformations operating on deep structures had to preserve meaning; i.e., they were not permitted to delete material whose content could not be recovered from the surface structure. A solution for the irrecoverability of deletion that his earlier analysis had engendered was sought by Lees himself in Lees (1970). In this paper, Lees attempted to establish a small number of compound types in which the participating nouns were assigned a Fillmore-type case role and associated via grammatical rule with a small number of generalized verbs. For instance, the representation of *steam boat* would be formalized as 'Verb-Object-Instrument', where the generalized 'Verb' for this class contained the minimal set of semantic features that are shared by the variants: *impel*, *propel*, *energize*, *activate*, *power*, *drive*, *actuate*, etc. By assigning each compound to a specific semantic pattern by a grammatical rule "the compounds in question need not be described by the grammar in such a way as to imply that they are indefinitely ambiguous." (Lees 1970: 182). In a similar vein, Brekle (1970) postulated underlying semantic representations in symbolic logic (so-called 'Satzbegriffe') that contained only a limited set of predicates that

were deleted after the topicalization operation applied to yield a surface compound structure. Kürschner (1974), as well, adopted an analysis very similar to Lees (1970) for German compounds based on underlying case roles, abstract verbs and permutation transformations.

Most notably however, it was Levi (1978) who pressed the idea of a 'recoverably deletable predicate' the furthest. Her approach assumed that the predicate in the underlying form of a noun-noun compound was limited to one of nine recoverably deletable predicates that were later removed by a predicate deletion rule. These predicates were: *cause, have, make, be, use, for, in, about, from*, whereby the first three allowed subject and object reversal. Thus, her system predicted a twelve-way ambiguity for each noun-noun combination. However, in line with the criticism at the end of section 2.1., the notion of a recoverably deletable predicate yielding such extremely abstract classes makes little headway into an understanding of compound meaning.

### 2.3. The naming function of words and the notion 'appropriately classificatory predicate'

Zimmer (1971, 1972) suggested abandoning the attempt at an exhaustive positive characterization of compound types undertaken by his predecessors. He argued that, in producing a new compound, speakers do not "check its underlying structure against a list of possible compounding rules to see if it matches the input to one of them." (Zimmer 1971: C10). Instead, he proposed that any relation that is 'appropriately classificatory' can underlie compound formation. A noun has an appropriately classificatory relationship to a noun B "if this relationship is regarded by a speaker as significant for his classification—rather than description—of B." (Zimmer 1972: 4). It is mistaken in his view to define nominal compounds in terms of sentence structures without consideration of the basic function of words vis à-vis sentences, namely that of categorizing experience and naming the resulting categories rather than describing facts or events. Zimmer's view was influenced by a similar line of thought expressed much earlier in Bradley (1906). In discussing the semantic openness of nominal compounds like *house-boat* which, in addition to its conventionalized meaning 'both a house and boat', can also mean 'boat kept in a house', 'boat belonging to a house' or 'boat supplying the needs of a house', Bradley (1906: 81) states: "The general meaning of this class of compounds might be expressed by saying that the noun which is formed of the two nouns A and B means 'a B which has some sort of relation to an A or to A's in general'."

Other linguists have since independently converged upon this insight. Describing the meaning of compounds, Selkirk (1982: 23) states "it would seem that virtually any relation between head and nonhead is possible—within pragmatic limits . . ." And Bauer (1978: 122) suggests adopting a covert PRO-verb that would underlie all compound structures and carry the meaning "stands in such a relationship as one might expect, given all contextual factors, to."

Zimmer's idea of an appropriately classificatory relationship is given further weight in Downing (1977) who stresses that the compounding relationship differs noticeably with the various classes of head nouns. In her view, different types of relationships have different classificatory value, depending on the nature of the entity being referred to. Humans are most often characterized in terms of occupation or sexual or racial identity (*police woman*), animals and plants according to their appearance or habitat (*giraffe bird, prairie*

*dog*), natural objects in terms of their composition or location (*salt flats*, *mountain stream*) and synthetic objects in terms of their purpose (*banana fork*), cf. Downing (1977: 35) Drawing on Zimmer's and Downing's insights, Dowty (1979: 316) formalized the idea of an open, yet classificatory relation between the constituents of a compound by relating the external arguments of the predicates involved in the compound to one another via an unspecified relation variable 'R' that was qualified by the higher-order predicate 'appropriately classificatory'. Allen (1978: 93) attempted to characterize the range of possible meanings of a compound in terms of a Variable R Condition that ensured a matching of semantic feature content between the two constituents.

The major insight achieved by this line of argumentation is that the semantics of compounding is seen as being anchored in both the psychological act of categorizing experience with the real world as well as in the linguistic need for the efficient naming of the resulting categories.

### 3. Semantic approaches to compound meaning

#### 3.1. Inferred stereotypic and basic relations

In the early 1980s, the content and orientation of the linguistic debate reviewed in the previous section began to shift as linguists started to reconsider the theoretical relevance of the implicit relation that completes the meaning of a noun-noun compound. The question coming into focus was not whether the missing relation could be seen as a covert instantiation of one of a fixed set of general semantic relations such as 'purpose', 'location', etc., or even as the deletion of a generalized verb, the realization of a PRO-predicate or a silent, appropriately classificatory relation inferable from the linguistic or situative context. Rather, the true linguistic task was to discover what meaningful units enter into the interpretation of a compound in addition to those that are actually represented by its overt constituents and what parameters restrict the process of inferring this implicit information. It had become clear that the answer to this question could not be anchored in the formal structure of the compound; hence, it must be sought in a theory of linguistic meaning. One of the first attempts to do so was Fanselow (1981a). Working within the framework of Montague Grammar, Fanselow (1981a) formalized approximately 23 different rules that combine two nouns A and B into a compound AB and assign the newly formed compound a semantic interpretation. The application of a particular rule is triggered by the subcategorizational properties of the nouns involved (i.e., whether they denote a relation or an individual, group, mass, proper name, etc.). The compound *street corner* 'corner of a street', for example, would be interpreted by the rule given in (1)

- (1) Let B be a relational noun and A a non-relational noun. Then AB is a non-relational noun. If  $a'$  is the meaning of A and  $b'$  is the meaning of B, then the meaning of AB is:  
 $\{x \mid \text{There is a } y, y \text{ from } a', \text{ so that } (x, y) \text{ from } b'\}$

and the compound *Time-Warner* by the rule in (2):

- (2) Let A, B be proper names. Then AB is a proper name. If the meaning of A is  $a'$  and that of B is  $b'$ , then the meaning of AB is: the smallest thing that has  $a'$  and  $b'$  as parts.



These rules are taken from Fanselow (1981b: 49–50) in order to avoid the complex formal detail of the Montague account in Fanselow (1981a).

The need for an extensive set of 23 rules arose from the basic assumption of Montague Grammar that each semantic interpretation is tied to a distinct formal rule. But precisely this inflation of rules engendered quite a bit of criticism. Handwerker (1985) and Meyer (1993: 24), for example, both note that it is highly implausible that a battery of 23 different rules is necessary to account for a phenomenon that entails one very simple binary branching structure. Consequently, Fanselow's analysis merely describes a number of compound types without offering an explanation for why these particular types occur and whether other types are possible. In answer to this criticism, Fanselow (1981b) simplified his (1981a) position by working in a less technical framework that enabled him to formulate the idea that all nouns are relational in an extended sense in that they invoke extra-linguistic associations from which a stereotypic relation can be inferred and applied to the semantics of the second constituent to complete the meaning of the compound. So, for instance, a *car motor* is a motor that drives a car because speakers know that that 'driving' is what motors are stereotypically built for. In the same vein, a *knife wound* is a wound inflicted by a knife because speakers associate 'cutting' stereotypically with knives. In addition to inferring a relation in this manner, it is also possible to extract a salient property from the non-head constituent and use it to modify the head, cf. *snail mail*, where a prominent property of 'snail' is its slow motion, or *snake dance*, where the form of a snake gives a characteristic property of the dance. Furthermore, there are a set of basic relations including 'and', 'part-of', and 'location' that also may underlie the interpretation of compounds, cf., e.g., *astronomer-geologist*, *piano keys*, and *country road*.

### 3.2. Knowledge structures and discourse

Meyer (1993) criticizes Fanselow's (1981a) analysis of compound interpretation for being based on underlying relations that do not result directly from the meaning of the constituent nouns but have to be induced by special processes of finding stereotypes and identifying basic relations. Meyer attempts to show that compound interpretation results directly from the lexical and conceptual knowledge associated with the constituent nouns. He bases his theory on a framework that incorporates the two-level semantic approach to meaning (Bierwisch 1983; Bierwisch & Lang 1989; cf. also article 31 (Lang & Maienborn) *Two-level Semantics*) into discourse representation theory (Kamp 1981; Kamp & Reyle 1993; cf. also article 37 (Kamp & Reyle) *Discourse Representation Theory*) and also makes use of knowledge structures and scripts such as those developed in the field of artificial intelligence. The formalities of his approach will not be delved into here, since the insightful ideas he develops that are relevant in this context can be illustrated without them. The two-level theory of semantics distinguishes the context invariant aspects of lexical meaning from the variable aspects of conceptual structure that arise in the context of use. A noun like *museum*, for example, denotes in its invariant lexical-semantic sense a family of related concepts (= (3)) that may be fixed in a particular discourse to a specific concept: 'institution' (= (4a)), 'building' (= (4b)), or 'staff' (= (4c)). This type of disambiguation is termed conceptual shift (cf. Bierwisch 1983):

- (3) The museum is interesting.

- (4) a. The museum plays an important role in the cultural life of the city.  
 b. The museum is being repainted.  
 c. The museum is on strike.

On the basis of this insight, Meyer (1993) identifies four levels of knowledge that play a role in the interpretation of isolated compounds: first, the grammatical level of argument satisfaction; second, the level of lexical-semantic knowledge consisting of the context-independent information contained in the lexical entries of the individual nouns; and third, the level of conceptual knowledge including context-dependent information and information about prototypical properties associated with a concept. An additional level, the level of discourse, takes background knowledge in the form of scripts into account and allows the hearer to identify antecedents for the compound's constituents as well as relations that exist between them in an actual discourse. This fourth level, therefore, is concerned not with the potential meanings a compound can have in isolation, but with the actual utterance meaning assigned to a compound on the basis of its position in a discourse. These four levels of knowledge form a network that is ordered with respect to the salience of the relation they produce.

When considering the potential meanings of isolated compounds, the most salient interpretations result from the grammatical process of argument satisfaction. *Opera fan* has such a strong tendency to be interpreted on the basis of the 'fan' relation (i.e., 'fan of opera') that no other meaning seems even remotely plausible. And German speakers will reject the compound *Patientenbesitzer* 'patient owner' as incoherent until they are made aware of a context that allows a legitimate argument-head relation to hold between the constituents (e.g., words on a sign in the parking lot of a veterinarian's office). If the head noun is not relational but sortal, the first level of grammatical knowledge cannot apply and an attempt will be made to find an appropriate lexical relation at the second level of lexical knowledge. Artifacts have as a prominent relation in their lexical structure the purpose for which they are created, hence *wine glass* has the reading 'glass for holding wine' and *cement factory* 'factory producing cement'. If no plausible relation can be found at the lexical level, or if for other reasons an alternative interpretation is necessary, the search moves on to the conceptual level where a larger number of interpretative possibilities suggest themselves due to the richness of conceptual knowledge: things can be related to one another in a variety of ways, e.g., via location (*sand crab*), the material of which they are made (*cement factory*), whether they are composed substances (*flour dough*), and so on. Even more complex chains of relations are possible as in *commuter city* 'city consisting of a suburban area where people live and an urban area where they work' (Meyer 1993: 102–141).

Interestingly, the level at which the relation arises influences the compound's ability to undergo conceptual shifts. At the level of argument satisfaction, the selectional restrictions of the head noun fix the concept-specific meaning of the non-head. Therefore, *Museumseite* is interpreted as the side of a museum building (and not a museum as an institution) and *book cover* is the cover of the physical object 'book' (and not its informational content). Once the head noun assigns its internal role to the non-head, no further contextual variation is found (Meyer 1993: 109–110). At the level of lexical knowledge however, the lexical relation chosen is part of the context-independent meaning of the head noun and, hence, need not invoke access to a specific concept for either itself or the non-head noun. For example, the lexical entry for 'museum' will specify its purpose as one of 'exhibiting things'. This relation will not fix the conceptual domain of its internal



argument. Consequently, the meaning of ‘book’ in *book museum* is not fixed to a specific concept. Even after satisfying the internal role of the relation ‘exhibit’, the ‘book’ concept is still open in both the examples (5a) and (5b) below. And as the different readings of the sentences in (5a) and (5b) also show, the head concept ‘museum’—which is open initially—shifts to a more specific concept when the further sentential context is taken into account to be understood an institution in (5a) but as a building in (5b), cf. Meyer (1993: 114, 150–151):

- (5) The *book museum* is closing
- a) for lack of funds.
  - a. museum (institution) exhibiting books (complete concept or physical object)
  - b) at 7 p.m.
  - b. museum (building) where books (complete concept or physical object) are exhibited

Some purpose relations, on the other hand, require their internal argument to belong to a specific ontological domain and when such a relation is invoked the non-head will be fixed to the requisite domain. By way of example, the lexical entry for ‘cup’ has the purpose relation ‘containing a liquid’. Therefore, the concept ‘coffee’ in *coffee cup* is limited to ‘beverage’, thus eliminating the ‘bean’, ‘powder’ and ‘plant’ variants of ‘coffee’ (Meyer 1993: 112, 150–151).

When a conceptual relation is involved, it relates specific concepts to one another, so no further conceptual shifts, for either the head or the non-head, are possible. The readings of *museum book* based—not on the lexical relation ‘exhibit’, but—on the conceptual relations ‘written-by’, ‘sold-by’, ‘published-by’ or ‘located-in’ can only make reference to a specific concept in both the denotation of ‘museum’ and in the denotation of ‘book’. This yields the disambiguated readings shown in (6), cf. Meyer (1993: 153–154).

- (6) museum book
- a. book (information mediator) written by a museum (institution)
  - b. book (physical object) sold by a museum (institution)
  - c. book (physical object) sold in a museum (building)
  - d. book (physical object) located in a museum (building)
  - e. book (complete concept) published by a museum (institution)

Thus, conceptual shifts and relation selection are independent processes. Conceptual shifts are general processes of meaning constitution and, as such, are also free to occur in compounds, but they do not occur in the non-head of a compound when the subcategorization restrictions of (the grammatically or lexically recruited) relation limit its denotation to a specific conceptual domain. At the conceptual level, where a conceptual relation holds between two specific concepts, they do not occur at all because the conceptual relation arises on the basis of specific concepts. In interpreting isolated compounds, the saliency of a relation is predicted by the hierarchy of knowledge structures; grammatical relations take precedence over lexical relations and lexical relations take precedence over conceptual relations. If one level is not applicable, the search for a plausible relation moves on to the next. Within the complex domain of conceptual knowledge, object-specific properties will take precedence over more general relations

like ‘part-of’, ‘made-of’ and ‘has-part’, which in turn take precedence over completely general relations like ‘location’ which can apply to almost any object (Meyer 1993: 148).

Discourse knowledge differs from the other knowledge types in yielding a specific utterance meaning rather than a potential meaning or meanings assigned to a compound in isolation of context. The information presented in a discourse may allow one to find an anaphoric referent for one or both of the compound’s constituents, especially if the compound occurs in a definite noun phrase, and may also supply a specific relation between the two antecedents (Meyer 1993: 189), cf. also Boase-Beier & Toman (1984):

- (7) In der Sahara gibt es eine Schlange, die sich von Skorpionen ernährt. Die Skorpionsschlange ist sehr giftig.  
 ‘In the Sahara there exists a snake that feeds on scorpions. The scorpion snake is very poisonous.’

Discourse relations, being explicit, are the most salient relations of all and can even override a relation based on argument satisfaction. Independent of context, the compound *Dichterfreund* would be interpreted via argument satisfaction as, friend of a poet’. However, in the discourse in (8), its meaning is clearly ‘friend and poet’.

- (8) Der Dichter Heiner Müller hatte Geburtstag. Der Regisseur Hans Neuenfels schenkte dem Dichterfreund einen Blumenstrauß.  
 ‘It is the poet Heiner Müller’s birthday. The director Hans Neuenfels gave his poet-friend a bouquet of flowers.’

The discourse has absorbed the internal argument of ‘friend’ (it is assigned to Hans Neuenfels). Consequently, the compound contains two nouns from the same ontological domain with compatible functions whose external arguments can be linked to a common discourse referent, Heiner Müller, yielding a conjunctive interpretation (Meyer 1993: 171).

Scripts activated by a discourse also supply the source of an utterance meaning. The mentioning of *Bahnhofscafe* in a discourse will open up a script about coffee houses enabling the interpretation of *Bahnhofskafee* as ‘coffee (beverage) purchased at the train station’ (Meyer 1993: 183). It is even possible for a discourse to provide a highly unusual interpretation, one that would never occur in isolation, such as ‘museum that gives away books’ for *book museum*:

- (9) In Hamburg gibt es ein Museum, das Bücher an seine Besucher verschenkt. Das Büchermuseum ...  
 ‘In Hamburg there is a museum that gives books to its visitors. The book museum ...’

This process, however, is not without limitations; a discourse relation cannot successfully contradict the lexical meaning of the constituents, (Meyer 1993: 190):

- (10) In Hamburg gibt es ein Museum, das alte Bücher vernichtet. ?Das Büchermuseum ... ‘In Hamburg there is a museum that destroys books. The book museum ...’

Meyer (1994) takes up the topic of compounds in context again and shows how dynamic processes of abduction play a role in the interpretation process.

## 4. Cognitive psychological approaches to compound meaning

### 4.1. Analogy and linguistic templates

Although Ryder (1994) does not achieve the same degree of coverage and insight into the complex semantic properties of compounds as the approaches reviewed in section 3, her approach nevertheless brings to light an important aspect of compound interpretation that has not yet been touched upon, namely the role played by analogy. Working within the theory of cognitive grammar developed by Langacker (1987), Ryder assumes that conventionalized expressions determine the interpretation of novel forms by functioning as patterns or 'linguistic templates'. A single conventionalized compound can function in this sense as an analogical base for a new formation (e.g., *blackmail* > *whitemail* 'obtaining results via promises rather than threats'), as can more general patterns centered around a common first or second constituent, or 'core word', cf. *cigar box*, *shoe box*, *matchbox*, *gift box* >  $X + box$  'box intended to hold X' (Ryder 1994: 80). The latter phenomenon is known in psycholinguistic studies as the 'positional family size' of a constituent, cf., e.g., Baayen (2010) and Plag & Kunter (2010). At an even more abstract level, a cluster of semantically similar cases such as *suitcase*, *ice bag*, *wastebasket*, *wine glass*, *dustbin*, etc., will give rise to the abstract pattern:  $Y + Container = 'X \text{ that holds } Y'$  (Ryder 1994: 99). By generalizing from groups of semantically similar established expressions to patterns of different degrees of abstraction, a speaker builds up a repertoire of linguistic templates in his grammar that function as models for the creation and interpretation of new words. When the listener is confronted with a novel compound, a salient template is identified and a search begins in the semantic information schemas associated with the compound's constituents to find a common schema that can be used to justify the template. The hearer then uses a plausible relation in the schema to fill in the meaning of the compound. Upon hearing *giraffe cage*, for example, the template  $Y + Container$  will be called up and can be justified, licensing the meaning 'cage that holds a giraffe'. In integrating the meanings of the nouns into a common semantic information schema, it will sometimes be necessary to accommodate one or both of the meanings. The meaning of 'dog' in *doghouse* is not altered, but the meaning of 'house' has been accommodated to fit the combination since this is not a prototypical use of 'house'. If no interpretation can be constructed on the basis of a common semantic information schema, a similarity relation may be used, i.e., a compound  $XY$  will be interpreted as a 'Y that is like X in shape, size, color, activity, etc.' (Ryder 1994: 91). Ryder considers the similarity relation a strong default interpretation, but her data show that it is often possible to obtain this reading along with a reading based on a linguistic template. So, on the one hand, the novel compound *fire-spider* elicited a response by her informants on the basis of the low-level template *fire-ant* yielding 'spider whose bite stings', but interpretations based on similarity were actually in the majority, i.e., 'spider that is red/that glows like fire', cf. (Ryder 1994: 161).

### 4.2. Concept combination

In recent years psycholinguists, psychologists and cognitive scientists have joined theoretical linguists in their interest in the interpretation of compounds. This increasing interest can be attributed to the fact that compounds represent combinations of concepts in the purest sense. Concept combination is the process whereby two independent concepts

are integrated into an innovative combination. By nature, combinations of concepts are not restricted to compounds but underlie all types of phrases. However, in a compound, in contrast to a phrase, the concepts are often conjoined with the intention of creating at least a temporary name for a new complex concept and without additional information as to how they are interrelated. The primary reason for the interest in the nature of concept combination on the part of psychologists and cognitive scientists is the light this process sheds on both the structure of simple concepts and the flexibility of the categorization process, cf. also article 106 (Kelter & Kaup) *Conceptual knowledge, categorization, and meaning*. When two concepts are combined, the combination often invokes more information than is present in the union of the simple concepts (this phenomenon is referred to as 'emergent attributes', cf. Hampton 1987; Murphy 1988, 1990). For example, a 'wooden spoon' is typically understood as a larger object than a 'metal spoon' and an 'empty store' as one that is not only empty, but also losing money. Consequently, the area of concept combination is a good testing ground for theories that attempt to answer the question of how concepts are structured and represented in the human mind. Often the empirical data considered are adjective-noun combinations as, for instance, in Smith & Osherson's (1984) feature weighting model. Here adjectives, construed as denoting a single feature, pick out a slot in the schema of the head noun and add weight to it: a 'red table' is a 'table' with additional weight added to the feature COLOR via the property 'red'. Murphy (1988) is concerned with the inadequacy of this model in accounting for noun-noun combinations. Nouns represent more complex concepts than adjectives. In *apartment dog*, for example, the concept 'apartment' picks out the HABITAT slot in the head concept 'dog' and replaces all other possible fillers for this slot. The process of specifying the concept of the head via the modifier (known as 'concept specialization') is highly dependent on world knowledge in at least two senses: world knowledge is needed to pick out the correct slot (speakers know that it is more likely that a dog *lives* in an apartment than *bites* one or *looks like* one), and once the appropriate slot is filled, the combination undergoes a second process of elaboration to "clean up" the complex concept, making it more complete and coherent. An apartment dog is likely to be smaller, quieter and friendlier than, e.g., a farm dog (Murphy 1988: 532–533).

For Wisniewski (1996), as well, the study of concept combination is important because it offers insight into how concepts are represented in the mind. When the individual concepts are accessed, a fit between them must be determined. Wisniewski distinguishes three basic strategies for achieving this fit: linking the concepts via a relation, mapping properties from one concept onto the other, and combining the concepts into a hybrid. Relation linking yields two whole concepts connected by means of a relevant relation, cf. *car squirrel* with the meaning 'squirrel that *chases* cars' or *snake robin*, meaning 'robin that *eats* snakes'. Property mapping yields a single concept modified by a feature from the modifier concept as in 'thin rake' for *pencil rake* or 'pony with stripes' for *zebra pony*. The strategy of property mapping clearly shows that concepts are not represented in the mind as impermeable wholes but must be structured in terms of relevant properties that can be accessed individually when the concept is activated. Hybridization, finally, yields a combination in which both objects are represented, cf. *moose elephant* 'creature with properties of both a moose and an elephant'. In addition to property mapping, Wisniewski (1996) found that the informants in his experiments were using another type of 'noun construal' where a concept is not accessed in its entirety. When employing the strategy of relation linking, often a representation of one of the objects was chosen instead of the object itself

to complete the relation, cf. *stone squirrel* 'figure of a squirrel made of stone' and *clay elephant* 'figure of an elephant made of clay', or a part of the object was selected instead of the whole object as in *tiger chair* 'chair covered with tiger skin'. Again, the phenomenon of noun construal shows that world knowledge plays a role in interpretation of complex concepts. When it is recognized that a constituent does not plausibly fit a relation, the concept will be construed to obtain a sensible combination. Wisniewski (1996), as well as Murphy (1988, 1990), recognizes the need for a second stage of processing beyond slot filling, i.e., 'concept elaboration'. Once a slot is filled, world knowledge is used to refine the resulting combination. For example, upon hearing the compound *elephant box*, it could be postulated that the box has air holes in it. What Wisniewski's notion of construal suggests is that the process of elaboration sometimes goes beyond mere refinement and involves altering the typical referent of a constituent by picking out a depiction of it or a particularly salient feature or a relevant part of it.

Concept combinations often display an ambiguity in interpretation with readings resulting from more than one of the strategies. For instance, *snake vase* can be interpreted via relation linking as 'vase in which snakes are kept' or via property mapping yielding 'vase in the form of a snake'. Likewise, *cow horse* can be understood as a 'horse that herds cows' via relation linking or an 'animal that is both a cow and a horse' via hybridization. Relation linking and property mapping are conceptually different processes for Wisniewski. His experiments show that concepts that are highly similar to one another lend themselves to an interpretation via property mapping or even hybridization rather than relation linking, cf. *zebra horse* 'horse with stripes' and *newspaper magazine* 'newspaper and magazine in one'. In these cases, a property (or several properties) of the modifier concept are relevant to the head concept. Relation linking, however, doesn't depend on shared properties but holds when a concept expressed by the modifier fits the preconditions for filling a slot in the head concept (Wisniewski 1996: 448–449).

Gagné & Shoben (1997), Gagné (2000) and Gagné & Spalding (2006) take issue with the previously mentioned studies and suggest an alternative approach which they term the CARIN ('competition among relations in nominals') theory. Murphy (1988), Wisniewski (1996) and others view concept combination as a process whereby the head provides a schema in which the modifier selects a particular slot and fills it with its own concept. The more prominent the slot is in the concept, the easier it is to interpret the combination (e.g., *cold beer*). Deviant complex concepts arise when the dimension expressed by the modifier is not relevant to or incongruent with the head concept as in *cold garbage* and *sliced typewriter* respectively, cf. (Murphy 1990). The CARIN theory, however, views the interpretative process the other way around: The interpretation of a complex concept is determined primarily by the modifying constituent of the combination and not the head. A relation previously used with a modifier becomes associated with the lexical representation of that modifier and strongly influences the interpretation of a novel combination when the same modifier is used again. In cases where several relations are associated with a modifier, the different relations compete with one another in the interpretation process. For example, the 'made-of' relation is more strongly associated with the constituent *chocolate* than the 'derived-from' relation, hence *chocolate bee* will be interpreted as a 'bee made of chocolate'. And since 80% of combinations with *mountain* as a first constituent are interpreted via the 'location' relation (cf. *mountain stream*, *mountain path*, *mountain cabin*), *mountain bird* will be more easily interpreted than *mountain magazine*, where the latter requires the infrequent 'about' relation. In order to

justify the idea that the relation comes from the modifier and not the head constituent, the authors appeal to the functional difference between the two: The head provides the category name for the new concept, while the modifier names the 'contrast set' belonging to the category. Hence, 'mountain' in *mountain bird* sets up a contrast with other types of birds and, in so doing, actually alters the concept of the head. Thus, in opposition to the assumptions of the concept specialization approach to compound interpretation, the authors of the CARIN theory propose that the interpretative relation stems from the modifier and is evaluated for its goodness of fit by the head, thus altering the concept expressed by the head alone.

New experimental evidence has lead the authors of the earlier CARIN theory to revise their initial assumptions in a modified approach now termed the RICE ('relational interpretation competitive evaluation') theory, cf. Spalding et al. (2010). Experiments based on a different experimental task indicate that when the meaning of the head is active in a context, it is also able to suggest possible relations for the interpretation of the compound. Hence, the relational meaning used in interpreting a compound is not limited to the modifier but can also be associated with the head. The earlier claims of the CARIN theory were derived from sense/nonsense tasks in which the participants saw a prime in which one of the constituents was identical to its counterpart in the target and the prime had either the same or a different relation from the target. After viewing the prime, participants were asked to judge whether the target compound made sense. A priming effect for the relation was found only when the modifier was the same in prime and target; the head constituent did not exert a similar influence. Furthermore, it took more time to judge the target when the modifier was associated with a number of relations than when it had only one strong relation. This was the source of the claim that the different relations associated with the modifier compete with one another as they are being evaluated as to their compatibility with the meaning of the head. The stronger the competition is between the relations, the harder it is to make a sense judgment, which is reflected in elevated reaction times by the participants. The so-called relational strength of the modifier was a better predictor of reaction time than the frequency of the relation chosen. However, the use of a relation verification task in which the relation is already provided and hence available to the participant who must simply affirm its plausibility, has shown that relations associated with the head constituent are also available during the interpretation of a compound. In the verification tasks, the largest amount of relational priming occurred when the head was the repeated constituent. Modified to accommodate these new findings, the RICE theory now assumes that both constituents, modifier and head, store and activate relational information. Multiple relations compete and are evaluated in a parallel process that rules out implausible fits. This step is followed by a process of elaboration in which the relational interpretation is enriched with further conceptual information that is not literally part of either the constituent concepts or the relation connecting them, but is necessary for understanding the complex concept. Importantly, however, the RICE theory, as the CARIN theory before it, holds to its criticism of theories of concept combination in terms of 'concept specialization' in which new complex concepts are derived from the schema of the head via modification of one of its inherent features by the modifier constituent. Spalding et al. (2010) argue that such theories cannot account for the modifier-based effects they find in their experiments. The idea of competition among relations plays a key role as well in Štekauer's (2005) theory of compound interpretation, cf. Štekauer's notion of 'objectified predictability rate'.



## 5. Origin of compounds in a protolanguage?

How exactly do the simple structures of compounds with their semantic openness, their pragmatic flexibility, and their conceptual motivation fit into the architecture of grammar? Fanselow (1985) considers this question and proposes a novel viewpoint concerning the theoretical status of compounding. Differentiating compounding from other types of morphology, he argues that compounding is not part of formal grammar and, thus, differs in status from both derivation (cf. article 79 (Lieber) *Semantics of derivational morphology*) and inflection which do obey grammatical principles. Compounds are composed exclusively of lexical categories; functional categories that form the foundation of syntax are absent from their structures. Moreover, compounds actually violate central principles of grammar like X-bar theory, theta theory, case theory, binding theory, etc. Since central semantic categories like tense, modality, definiteness and quantification are also absent from compound structures, compounds cannot be explained by the principles of semantics either. Fanselow adduces further grammatical, neurocognitive and evolutionary evidence to strengthen his argument that compounds originate from a rudimentary language code that was a precursor to grammar. The rudimentary code is a symbolic system in the right hemisphere that contains an inventory of meaningful symbols denoting objects and events. It allows a certain amount of manipulation and inference on the content of these symbols which results in the production and comprehension of simple messages that lack the characteristic elements of formal syntax. Actually this symbolic ability is common to both cerebral hemispheres, but is consistently overridden in the left hemisphere by the superiority of the task-specific language centers. Products of the primitive code may be found in certain other peripheral areas of modern grammar besides compounds such as in the nonconfigurational structures of syntax, ellipitical discourse structures, telegraphic speech, headlines, etc. It surfaces furthermore as a means of primitive communication when linguistic ability is absent or impaired as in the earliest stages of child grammar, the language of apes taught to sign, the language of linguistically deprived children like Genie, as well as in aphasic speech.

Normal language learners begin the acquisition process with the null hypothesis that compounds and other products of the primitive code are not part of grammar. This initial assumption is modified according to the strength of the presence of these structures in the input. To the extent that a child is exposed to compounds in the primary linguistic data, he will accommodate the relevant patterns into his grammar. Their formal structure is simple enough to be learned without the help of Universal Grammar. Nevertheless, their accommodation into grammar enforces certain restrictions on their structure. In order for a complex lexical expression to be introduced into a phrase structural position, one of its parts must correspond to a lexical category that can function as the head of the word. As a head, it will express the morphosyntactic features which are overtly encoded in the grammar of the language.

Fanselow draws a parallel between the structural properties of compounds and the combinations of the earliest stage of language acquisition before the development of grammar takes effect. The earliest two-word stage of child language acquisition is universally characterized by an overabundance of nominal elements whose combinations instantiate conceptual patterns like agent + action, action + patient, object + location, etc., and whose interpretations are dependent on inferential processes rooted in general knowledge about how different types of objects relate to one another. In the first stage of



language acquisition before the child has an awareness of grammar, nominal combinations stand on their own and can have sentence character, cf. *Mommy sock* ‘I see Mommy’s sock’, ‘Mommy is wearing a sock’, ‘Mommy should put my sock on me’, etc. After the grammar begins to develop, such a combination must fit into a nominal position in phrase structure and hence will be limited in its denotation to a nominal meaning. Thus, a compound structure like *Merkel biographer* must denote a one-place predicate, i.e., ‘x = biographer of Merkel’ and can no longer express a proposition, i.e., ‘Merkel is a biographer’. Where such expressions are not bound to grammar, this constraint on meaning type does not hold even in the adult grammar. And, indeed, non-nominal, sentential meaning can be found for such combinations in certain situations as, for instance, in the telegraphic style of headlines, cf. *MERKEL CHANCELLOR!* (cf. Fanselow 1985: 117).

Recently, Jackendoff (1999, 2002, 2009) in his deliberations on language evolution has also expressed doubts as to whether compounding involves grammatical competence. Bickerton (1990) proposed that human language evolved in two stages: our modern language ability developed as a refinement of an earlier ‘protolanguage’ that was structured into a vocabulary and pragmatics. Jackendoff scrutinizes our modern language for remnants of the earlier protolanguage postulated by Bickerton and concludes, like Fanselow, that elements of the protolanguage can still be observed in situations where modern language is incapacitated. Such cases include for Bickerton the two-word stage of language acquisition, pidgins, late language learning as in the case of Genie, the language of apes and agrammatical aphasia. Jackendoff adds to Bickerton’s cases four further examples: the language of the right hemisphere, the so-called ‘home sign’ of deaf children of non-signing parents, the steady state of second language by immigrant learners (termed ‘The Basic Variety’ by Klein & Perdue 1997) and compounding. These, too, are all cases where derivational and inflectional morphology, function words and the complex configurations of syntax are absent. In Jackendoff’s terms, phonology in these simple structures interfaces directly with conceptual semantics and meaning results from the inferences hearers make as to what the words can take on.

## 6. Compounds in the lexical system of grammar

### 6.1. Compounds as lexical items in grammar

Fanselow’s and Jackendoff’s insights into the origin of compounds vis-à-vis grammar shed light on the nature of the compounding process and help us to make sense of the properties of compounds as entities in the lexical systems of modern-day languages. Fanselow’s analysis of compounds was reviewed in section 3.1. Jackendoff’s current work assumes that the interpretation of a compound is the realization of one of two general configurations. First, a non-head constituent can fill an argument position of the head as exemplified in (11) for *helicopter attack* yielding the interpretation ‘attack on something by a helicopter’ (Jackendoff 2009: 123):

- (11)  $\text{helicopter}_1 \text{ attack}_2 = (\text{ATTACK}_2 (\text{HELICOPTER}_1, \text{INDEF}))$

Otherwise the non-head constituent serves as a modifier to the head and, hence, is bound by an inferred function that also binds the head (Jackendoff 2009: 124). The function can have one of two origins. First, it may belong to a set of basic functions (SAME, LOC,

CAUSE, PART, etc.) that form part of a generative system yielding an unlimited number of possibilities. This is illustrated in (12) for *window seat* that requires the basic function LOC yielding the meaning ‘seat located at a window’ (Jackendoff 2009: 124):

$$(12) \text{ window}_1 \text{ seat}_2 = \text{SEAT}_2^a; [\text{LOC} [\alpha, \text{AT WINDOW}_1]]$$

Secondly, the function relating the head and non-head can be coerced in Pustejovsky’s (1995) sense from the semantic structure of the head. Coercion will, in most cases, supply a proper function (= PF) anchored in the qualia structure of the head, cf. (13) where the proper function of ‘cup’ is that of ‘holding’ a liquid. The PF is then cocomposed in Pustejovsky’s sense with the meaning of the head yielding the interpretation ‘cup for holding coffee’ (Jackendoff 2009: 125):

$$(13) \text{ coffee}_1 \text{ cup}_2 = \text{CUP}_2^a; [\text{PF} [\text{HOLD} (\text{COFFEE}_1, \text{IN } \alpha)]]$$

Jackendoff (2009: 125ff.) goes on to provide the formal interpretation of more complex cases requiring a concatenation of functions. Examples are *coattail* ‘something similar to a tail that is part of a coat’ and *piano bench* ‘a bench for **sitting on while playing** a piano’ (where I have underlined the basic functions and placed the coerced functions in boldface type, S.O.).

So it would appear that, even if compounds can be traced back to a protolanguage in an attempt to explain their simple, non-formal, open and ambiguous character, basic compound patterns have been adopted into the lexical system of many modern languages.

## 6.2. Complex words vs. syntactic phrases

The insights gained from section 5, however, justify a closer consideration of precisely this question. Have compounds become fully integrated into the lexical system and grammar of the individual languages that allow them or does a principled divide perhaps still remain between the simple, concatenative structure of compounds and the complex formal configurations of modern syntax?

Bücking (2009, 2010) argues that compounds and phrases typically fulfill complementary functions: Compounds name concepts and are closely associated with the denotation of ‘kinds’; they specify a link between a linguistic expression and a complex concept. Phrases, on the other hand, describe objects and are compositional in a way that compounds are not. Furthermore, they are less closely related to kind terms. Working within the two-level theory of semantics (cf. article 31 (Lang & Maienborn) *Two-level Semantics*), Bücking assumes that compounds exemplify an abstract version of the general modification template that holds for modifier-head structures in general, as discussed by Higginbotham (1985), Zimmermann (1992) and Maienborn (2003) (cf. also article 34 (Maienborn) *Event semantics* and article 54 (Maienborn & Schäfer) *Adverbs and adverbials*). Intersective modification has generally been analyzed as the conjunction of predicates provided by a modifier and head. This process was termed “theta identification” by Higginbotham (1985: 564). The somewhat extended version of the modification template adopted by Bücking is shown in (14). This template conjoins two predicates in such a way that their external variables are related via an unspecified relation R. The use of the unspecified relation variable R allows Bücking to capture both what the modification

structures of phrasal grammar and of compounds have in common as well as how they differ. When the modification template applies to phrases, the relation  $R$  is instantiated as the identity function. When applying at the lexical level,  $R$  will be instantiated as a relation that is associated in an integral way with one of the predicates of the construction. The specific relation that is chosen to complete the variable  $R$  is inferred from extra-linguistic knowledge and is instantiated during the mapping of the semantic form of the complex expression onto its conceptual structure, cf. Bücking (2010: 256).

(14) Modification template:  $\lambda Q \lambda P \lambda x [P(x) \wedge R(x, v) \wedge Q(v)]$

The result is that, for instance, the German noun phrase *blauer Tee* ‘blue tea’ receives the interpretation in (15) as ‘the set of  $x$  which are tea and blue’

(15) [blauer Tee]  
 $= \lambda x. \text{TEA}(x) \wedge \text{IDENTITY}(x, v) \wedge \text{BLUE}(v)$   
 $= \lambda x. \text{TEA}(x) \wedge \text{BLUE}(x)$

while the corresponding compound *Blautee* carries the interpretation via the open integral relation as ‘the set of  $x$  which are tea which stand in an integral relation to  $v$  which is blue’, cf. Bücking (2010: 257)

(16) [Blautee]  
 $= \lambda x. \text{TEA}(x) \wedge R_{\text{integral}}(x, v) \wedge \text{BLUE}(v)$

The compositional meaning of the noun phrase thus contrasts with the more flexible meaning of the compound. Bücking shows how a compound based on this template will allow incompatible attribution (cf. (17a)) that is strictly prohibited in a phrase (= (17b)).

(17) a. Dies ist ein roter Blautee.                    ‘This is a red [blue tea]’  
       b. \*Dies ist ein roter blauer Tee.            ‘This is a red blue tea’

The compound [blue tea] with the attribute ‘red’ will have the interpretation in (18), in which the incompatible predicates ‘red’ and ‘blue’ are predicated of different variables by virtue of the relation  $R$ :

(18) [roter Blautee]  
 $= \lambda x. \text{RED}(x) \wedge \text{TEA}(x) \wedge R_{\text{integral}}(x, v) \wedge \text{BLUE}(v)$

In the case of an incompatible attribution with a phrasal adjective-noun combination, however, a contradiction arises by virtue of the fact that the two incompatible predicates are predicated of the same entity:

(19) [roter blauer Tee]  
 $= \lambda x. \text{RED}(x) \wedge \text{TEA}(x) \wedge \text{BLUE}(x)$

The assumption that compound meaning arises by means of an abstract version of the modification template thus predicts the more flexible meanings of compounds vs. their phrasal counterparts. The most plausible candidate for the relation  $R$  in the interpretation

of compounds is found by means of abductive reasoning which searches for the simplest explanation for the semantic form of a linguistic expression that is compatible with the given knowledge.

### 6.3. The compound template

Bücking's studies concentrate on the contrast between adjective-noun combinations at the lexical and the phrasal level. Olsen's (2004) and (2010) investigations of noun-noun compounds make use of a similar template and come to the conclusion that, if compound interpretation is based on the modification template, there is no need for a principled division between the so-called primary and verbal interpretations of compounds. All interpretations can be traced back to the conjunction of predicates mediated by the relational variable *R* in the compound template in (14), repeated here as (20). This includes the copulative reading of noun-noun compounds as well. So, *pasta chef* would receive the "primary" interpretation 'chef that cooks pasta' if the 'cook' relation is inferred on the basis of knowledge related to the predicate 'chef' and is used to instantiate the variable *R* of the template, cf. (21). I assume that at this stage of the interpretation a free variable such as *y* will be existentially bound if not otherwise specified. *Ophthalmologist-politician* would receive the copulative reading 'ophthalmologist and politician' in (22) if the identity relation (*IDENT*) is chosen to specify the variable *R* on the basis of the recognition that the two predicates can both characterize a single individual in accordance with the Principle of Ontological Coherence that applies to the conjunction of predicates at the lexical level as discussed in Olsen (2004).

(20) Compound template

$$\lambda Q \lambda P \lambda x [P(x) \wedge R(x,y) \wedge Q(y)]$$

(21) *pasta chef*:

$$\lambda x \exists y [CHEF(x) \wedge COOK(x,y) \wedge PASTA(y)]$$

(22) *ophthalmologist-politician*:

$$\begin{aligned} &\lambda x [POLITICIAN(x) \wedge IDENT(x,y) \wedge OPHTHALMOGIST(y)] \\ &\equiv \lambda x [POLITICIAN(x) \wedge OPHTHALMOGIST(x)] \end{aligned}$$

Furthermore, the interpretation of the compound *street corner* with a relational head arises via the same assumption that the modifier predicate *street* stands in a relevant relation to another predicate *P*, the head of the construction, mediated by the relational variable *R*. The modifier and head constituent are introduced into the template and the free variable *R* is replaced by the most salient information available, i.e. the relation denoted by the lexical head *corner* and the free variable *y* is identified with *u*, the internal argument of the *CORNER* relation. The meaning of *street corner* becomes 'the set of *x* such that *x* is a corner of a street'.

(23) a.  $\lambda Q \lambda P \lambda x [P(x) \wedge R(x,y) \wedge Q(y)] (\lambda z [STREET(z)])$

$$\equiv \lambda P \lambda x [P(x) \wedge R(x,y) \wedge STREET(y)]$$

b.  $\lambda P \lambda x [P(x) \wedge R(x,y) \wedge STREET(y)] (\lambda u \lambda o [CORNER(o, u)])$

$$\equiv \lambda x [\lambda u CORNER(x, u) \wedge R(x,y) \wedge STREET(y)]$$

c.  $\lambda x \exists y [CORNER(x, y) \wedge STREET(y)]$

Consequently, compounds in all their potential interpretations make use of the same combinatorial mechanism as modification. The difference is that modification in the unmarked case instantiates the variable *R* as the identity relation and any deviant cases are structurally marked (Maienborn 2003). In the case of compounds, the opposite holds. The unmarked case is the abduction of a salient relation via conceptual knowledge (or lexical knowledge if the head is a relational item), while the choice of the identity relation results in the special case of the copulative reading.

The same strategy seen in (23) applies to *horse rescuer* and other ‘synthetic’ compounds in which the agentive head noun has inherited the arguments of its verbal base (skipping over the event argument). In contrast to the relational interpretation of the compound *street corner* and *horse rescuer*, the interpretation of the syntactic phrases *corner of the street* and *rescues the horse* results when *corner* and *rescue* head a noun phrase and verb phrase, respectively, in which they can assign their internal theta role to their complement directly. This process is referred to in Higginbotham (1985) as theta-marking which has as its semantic counterpart the functional application of the head to its complement. In order for functional application to apply, the referential argument of the complement must be bound (Higginbotham’s theta binding) so that the complement represents an individual. One choice of binder is the iota operator yielding a definite determiner phrase of (24). But in principle the referential argument of the complement is open to other operators such as the existential operator (*corner of a street*) or a quantifier (*rescued two/ many horses*).

- (24) a. *corner*  $\lambda y \lambda x. \text{CORNER}(x, y)$   
 b. *corner of the street*  $\lambda x. \text{CORNER}(x, [\iota y. \text{STREET}(y)])$

Thus, the difference between the phrases on the one hand and the nominal compounds on the other is one of direct theta assignment from the head position in a phrase as opposed to the mediation in the compound of an inferred relation between two conjoined predicates that function as a head and modifier. The relation chosen in the two cases is similar—both interpretations are based on the relation inherent to the relational lexeme functioning as head of the construction. Nevertheless, the relationality of the compound template is indirect, arising via abductive reasoning to instantiate the open parameter *R* in the general modification template. First, it is merely one of several other possible options, cf. *street corner*—*shop corner*; *news reporter*—*newspaper reporter*; *taxi driver*—*Sunday driver*, etc. Secondly, similar relations can be inferred from non-relational heads as in *car thief* ‘steal’ *snow gun* ‘shoot’, *speech synthesis* ‘produce’. The relationality of the syntactic head on the other hand results from the grammatically specified argument structure associated with the head in its lexical entry that triggers obligatory theta assignment. Thus, *to drive a Sunday* and *to report a newspaper* are not well-formed VPs.

It would seem, therefore, that the original (in Jackendoff’s terms:) ‘pragmatic’ aspect of compound interpretation stemming from the origin of compounds in a pre-modern ‘protolanguage’ has apparently been retained as a characteristic feature of compound interpretation in modern language even after such simple and free combinations have been reanalyzed as complex words. Compound structures have been accommodated into the lexical system insofar as the predicates that are involved are actual lexemes of the grammar. Their role in a compound structure, however, does not derive from the grammatical information encoded in their lexical entry but rather stems from a contextual or

conceptual inference based on general reasoning strategies that is captured in the compound template.

## 7. Left-headed compounds

The analysis just sketched holds for languages that allow genuine compound structures in their lexical systems. In their discussion of compounds in the Romance languages, Rainer & Varela (1992) and Kornfeld (2009) for Spanish, Bauer (1978), Zwanenburg (1992) and Fradin (2009) for French as well as Scalise (1992) for Italian draw attention to the fact that the determinative pattern of noun-noun compounds, so prevalent in Germanic, is highly restricted in the Romance languages. The formations that do appear have the atypical property for words that they are left headed:

- (25) a. Sp.: *tren mercancías* ‘train goods’ = “freight train”  
 b. Fr.: *timbre-poste* ‘stamp postage’ = “postage stamp”  
 c. It.: *capostazione* ‘master station’ = “station master”

The plural forms of these examples are *trenes mercancías*, *timbres-poste*, and *capistazione* where the underlined plural morpheme attaches to the left constituent in defiance of the definition of a word as an indivisible morphological unit. As the head of the word, the left constituent determines the gender of these complex words as well, as the masculine nouns Sp. *año luz* ‘year light’, Fr. *timbre-poste* and It. *capostazione* attest in which the second constituent is feminine and the first masculine. The left-headedness of the noun-noun combinations in Romance renders them highly marked word structures.

Two further features characteristic of Germanic compounds are absent from their Romance counterparts, namely their productivity and their openness in interpretation. The productive noun-noun formations that occur in Romance are restricted to a few fixed semantic patterns such as the ‘resemble’ formations of (26), cf. Rainer & Varela (1992: 126), Fradin (2009: 430) and Scalise (1992: 177),

- (26) a. Sp.: *ciudad dormitorio* ‘town dormitory’ = “bedroom community”, *empresa fantasma* ‘company ghost’ = “ghost company”  
 b. Fr.: *poisson-chat* ‘fish cat’ = “catfish”, *requin-marteau* ‘shark hammer’ = “hammerhead shark”  
 c. It.: *pescecane* ‘fish dog’ = “shark”

and the coordinative constructions in (27), cf. Kornfeld (2009: 441), Fradin (2009: 430) and Scalise (1992: 183):

- (27) a. Sp.: *poeta-pintor* ‘poet-painter’, *casaquinta* ‘house-villa’, *panadería-pastelería* ‘bakery pastry’, *pollera pantalón* ‘skirt-trousers’, *cantante autor* ‘singer author’  
 b. Fr.: *chanteur-compositeur* ‘singer-composer’, *enseignant-chercheur* ‘teacher-researcher’, *boulangier-pâtissier* ‘baker-confectioner’ *physique-chimie* ‘physics-chemistry’, *guide-interprète* ‘guide interpreter’  
 c. It.: *caffelatte* ‘coffee milk’, *cassapanca* ‘box seat’

Noun-noun constructions that show an open relation similar to the compounds of Germanic are either borrowings from the other languages, mostly Germanic, (Bauer 1978: 84; Rainer 1993) or are reduced versions of the more typical native N+P+N structures, cf. Sp. *tren de mercancías* > *tren mercancías* (Rainer & Varela 1992: 120) and Fr. *stylo à bille* > *stylo-bille* ‘ballpoint pen’ (Fradin 2009: 433).

The N+P+N construction of Romance (cf. Fr. *pomme de terre* ‘apple of ground’ = ‘potato’), on the other hand, is not as restricted semantically as the N+N construction. Despite first appearances, these structures are not merely lexicalized noun phrases consisting of a head noun on the left followed by a prepositional phrase modifier. Several facts speak against such an analysis. First, in a syntactic construction, the governed N inside the adjunct PP must have an article if it is a count noun while such functional categories are absent in the lexical N+P+N pattern, cf. *estrella de mar* ‘starfish’ with the corresponding NP *una estrella del mar* ‘a star of the sea’ (Kornfeld 2009: 445). Secondly, the combinations in (28) do not describe objects but denote fixed conceptual units and hence function as names of categories. Finally, the prepositions involved are the most neutral prepositions of the languages (e.g., *de*, and *a*) and are syntactically opaque in the N+P+N constructions (Bauer 1978: 191 and Kornfeld 2009: 442):

- (28) a. Sp.: *agente de seguridad* ‘security officer’, *bicicleta de montaña* ‘mountain bike’, *botas de lluvia* ‘rain boots’, *casa de campo* ‘country house’, *diente de leche* ‘milk tooth’, *patas de rana* ‘legs of frog’ = ‘fins’  
 b. Fr.: *carte de visite* ‘calling card’, *sortie de secours* ‘emergency exit’, *chemin de fer* ‘railroad’, *chambre d’hôtes* ‘guest room’, *avion à réaction* ‘jet plane’, *serpent à sonnettes* ‘rattlesnake’, *poêle à frire* ‘frying pan’  
 c. It.: *mulino a vento* ‘windmill’, *film a colori* ‘color movie’

It appears, then, that the productive nominal patterns in Romance are the coordinative N+N combinations and the N+P+N pattern whose status as a proper compound is unclear. Rainer & Varela (1992: 120) and Kornfeld (2009: 441) report that the latter formations are termed ‘improper compounds’ in traditional treatments of Spanish word-formation and Fradin (2009: 415–420) surveys their controversial status in the handbooks of French.

Interestingly, a highly productive pattern found in Romance is the so-called exocentric V+N pattern which derives agentive and instrumental nouns by combining a verb form of the third person singular with a noun that is understood as its direct object. Thus, Fr. *coupe-légumes* ‘cut vegetables’ and Sp. *cuentachistes* ‘tell jokes’ are interpreted similarly to their endocentric Germanic counterparts, which display an overt agentive suffix on their deverbal head, as *vegetable cutter* and *joke teller*. Again, these combination cannot simply be seen as a VP that has been reanalyzed as an N, as Di Sciullo & Williams (1987: 81) claim, because the formations systematically lack the article that must accompany count nouns in phrasal structure, cf. Sp. *girasol* ‘turn sun’ ‘sunflower’ and Fr. *essuie-mains* ‘wipe hands’ = ‘hand towel’ which cannot be used as well-formed VPs. The phrasal equivalent of the latter would be *Ce tissu essuie les mains* ‘This cloth wipes the hands’, not \**Ce tissu essuie mains*, (Fradin 2009: 423). This makes it clear that the V+N structures—just as the N+P+N constructions in (28)—are correctly situated in the lexical system although, due to their left-headedness, neither can be considered genuine ‘morphological objects’



in Di Sciullo & William's (1987) sense. If the noun is a count noun it occurs with plural inflection (Sp. *espantapájaros* 'scare birds' = "scare crow", It. *spazzacamini* 'sweep chimneys' = "chimney sweep"). If it is a mass noun, it appears in the singular (Sp. *quitaesmalte* 'remove polish' = "polish remover", It. *portacenere* 'hold ash' = "ashtray"), cf. Kornfeld (2009: 445) and Scalise (1992: 189–190).

- (29) a. Sp.: *cuidacoches* 'care cars' = "car watcher", *tocadiscos* 'toss records' = "record player", *friegaplatos* 'wash dishes' = "dish washer", *sacacorcós* 'pull corks' = "cork screw", *abrepuertas* 'open doors' = "door opener"  
 b. Fr.: *essui-glace* 'wipe windshield', *tire-bouchon* 'pull cork', *abat-joir* 'weaken light' = "lampshade", *brise-glace* 'break ice' = "ice breaker"  
 c. It.: *stuzzica-denti* 'pick teeth' = "tooth pick", *portalettere* 'carry letters' = "postman", *lavapiatti* 'wash dishes', *scolapasta* 'drain pasta' = "colander"

Although there are analyses that consider the constructions of (29) left-headed endocentric structures by postulating the conversion of the verbal element to a noun, this question is under debate in the literature and most linguists consider them formally exocentric constructions in which neither the V nor the N is the head. Such exocentric formations are a frequent feature of Romance, one further example being the nominal P+N combinations in (30), which—again—cannot simply be considered as reanalyzed PPs because the article that must accompany the N in a phrasal structure is lacking in the complex word, cf. Sp. *sintecho* 'without roof' = "homeless person".

- (30) a. Sp.: *sinvergüenza* '(person) without shame', *sin papeles* '(person) without documents'  
 b. Fr.: *sans-cœur* '(person) without heart', *sans papier* '(person) without papers'  
 c. It.: *senzatetto* '(person) without roof'

This peculiar arrangement of data found in Romance begins to make sense when considered on the basis of the semantic analysis of compounds presented in the previous section.

In section 6.3 it was proposed that the simple juxtaposition of two nouns is interpretable by means of a general reasoning strategy. The compound template is a formalization of this strategy. When two nouns are juxtaposed, it is normal to assume that their cooccurrence has some relevance and the mind begins to search for an appropriate connection between them. This covert interpretative step, captured by the relational variable R in the compound template, is not triggered by an overt signal in Germanic, hence the hypothesis that the interpretation of compounds has its origin in general reasoning strategies that are independent of grammatical processes (although such reasoning may also be employed in the interpretation of grammatical constructions, cf. article 54 (Maienborn & Schäfer) *Adverbs and adverbials*).

Whatever the origin of the Romance compounds may be, synchronically it is evident that they carry certain features of the grammatical systems of the individual languages. The influence of the grammar on these complex words reveals itself in several ways. First of all, they are consistently left-headed in accordance with the position of the syntactic head in the phrasal structures of Modern Romance, rendering the resulting structures

highly atypical words and at variance with the other morphologically complex constructions of the lexical system, in particular the well-behaved right-headed derived words. Secondly, Romance compounds do not generally allow a simple juxtaposition of lexemes, but display a functional element as an overt signal of the subordinative relation between the head and modifier that is necessary in syntax when a nominal adjunct follows a head. The functional elements that mediate between a head and modifier in syntax are case morphemes (e.g., genitive markings) or equivalent functional prepositions. As seen in the examples in (28) above, the compounds of Romance make use of the latter, i.e., the prepositional elements *de* and *a*. (Case and agreement morphemes are not interpretable by the lexical system.) These relational elements signal the subordination of the N they govern and trigger an interpretative inference that relates the subordinate N to its head.

In Germanic, there is no overt signal present in the compound itself of the relation needed to complete the compound meaning; the relation is implicit and inferred via general reasoning strategies. The small caps in the column under the variable R in (31a) are intended to indicate its covert status. The situation is different in Romance. Here, the subordinative (or determinative) relation is explicitly encoded in the structure via a functional preposition, (31b). This type of functional marking which would break up the unity of a genuine word is possible because the head noun precedes the modifier.

|                    |                                           |                                                            |                 |
|--------------------|-------------------------------------------|------------------------------------------------------------|-----------------|
| (31)               | $\lambda Q \lambda R \lambda P \lambda x$ | $[P(x) \quad \wedge \quad R(x,y) \quad \wedge \quad Q(y)]$ |                 |
| a. righthand head: | chef                                      | COOK                                                       | pasta chef      |
|                    | novelist                                  | =                                                          | lawyer          |
|                    | corner                                    | CORNER                                                     | street          |
|                    |                                           |                                                            | street corner   |
| b. lefthand head:  | botas                                     | de                                                         | lluvia          |
|                    | poeta                                     | =                                                          | pintor          |
|                    |                                           |                                                            | botas de lluvia |
|                    |                                           |                                                            | poeta-pintor    |

The need in Romance to overtly signal a subordinate relation also explains the nature of the data in (29) and (30). The relational meanings of the V+N and P+N nouns are triggered by the use of the specific relational lexeme that instantiates the variable R of the compound template while leaving the head constituent implicit. This yields formations such as Sp. *rompecabezas* ‘break heads’ = ‘puzzle’ and *sintecho* ‘without roof’ = ‘homeless’ in which the head noun is not expressed, but the relation between the head and modifier is. The absence of the head is the source of the exocentric reading; the predicate variable P functions as an open parameter to be instantiated via a conceptual inference. It is understood as the entity that carries out the action expressed by V+N or that is characterized by P+N. The exocentric compounds of Germanic are of a different nature (although English does display a few remnants of the V+N pattern, cf. *pickpocket*, *telltale*, *scofflaw*, *scarecrow*). Typically the exocentric Germanic compounds are A+N or N+N combinations that conform to the compound template, as for instance *flatfoot*, *loudmouth*, *fathead*, *low life*, *heavy weight*, *longhorn*. Their exocentricity lies in the metonymic shift from a literal A+N (*redhead*) to an individual (person, animal or thing) characterized by the relevant property, i.e., ‘a person with red hair’.

|      |                                           |                                                            |             |              |
|------|-------------------------------------------|------------------------------------------------------------|-------------|--------------|
| (32) | $\lambda Q \lambda R \lambda P \lambda x$ | $[P(x) \quad \wedge \quad R(x,y) \quad \wedge \quad Q(y)]$ |             |              |
|      | c. lefthand head:                         | —                                                          | rompe       | cabezas      |
|      |                                           | —                                                          | sin         | rompecabezas |
|      |                                           |                                                            | techo       | sintecho     |
|      | d. righthand head:                        | head                                                       | HAS(x,HAIR) | red          |
|      |                                           |                                                            |             | redhead      |

Finally, the logic of this analysis provides an explanation for the regularity and productivity of the coordinative N+N pattern. Simple coordinative N+N combinations (Engl. *lawyer-novelist* and Sp. *poeta-pintor*) are to be expected since they instantiate a pure co-ordination of predicates as the default case of modification that carries no requirement for an overt relational element, even at the syntactic level, cf. Engl. *small dog* or Sp. *perro pequeño*.

So, whereas the Germanic compounds appear to have retained the original pre-grammatical “pragmatic” strategy that lacks an overt signal of the subordinative relation needed to complete the meaning of a combination of two predicates, the Romance languages have not adopted this strategy into their lexical systems. Predicates are combined in the lexical system but the subordinative relation that holds between them is signaled by an overt element—either a functional category (i.e., a semantically reduced preposition) or a relational lexeme.

## 8. Constraints on the productive compounding process

### 8.1. Conceptual restrictions

The discussion up to now has made it clear that the meaning of a regular, productively formed compound is a function of the meaning of its constituents together with implicit information about how they relate to one another. The implicit relation is variable, and hence open in one sense, but it is restricted in another sense, in that it is anchored in the lexical and conceptual meaning of the compound’s constituents. The question to be taken up in this section is whether there are further constraints on the meanings that compounds can express—constraints that restrict the type of conceptual or contextual inference made to instantiate the variable R of the template. The answer to this question is affirmative; there are constraints of a general nature on the compounding process and, in addition to these, language-specific constraints can be found as well that serve to limit the productivity of certain compound patterns in a particular language.

The most general restriction of all guarantees that the interpretation given to a compound must be inferable from the information present. Consequently, relations based on negation (Zimmer 1971: C11; Downing 1977: 825; Dowty 1979: 316) including dissimilarity and privation (Warren 1978: 247), do not occur. An *earthquake school* cannot be construed as a ‘school that is not located near a region prone to earthquakes’ just as a *cousin-chair* cannot be a ‘chair reserved for non-cousins’ or *snake dish* a ‘dish not similar to a snake’. The notions ‘non-location’, ‘not for’, ‘non-similar’, etc., leave open such a vast number of possibilities that such a designation provides no basis for a classification.

It has been pointed out by Zimmer (1971: C16), Downing (1977: 823), Warren (1978: 257) and Bücking (2009, 2010), among others, that compounds serve as names for relevant categories of a speaker’s experience. First and foremost, then, a compound must denote a category that conforms in a relevant manner to human experience. These categories will

pick out an individual from one of the domains of individuals in human ontology. *Fisherman-logician* is a possible compound picking out an individual that is both a fisherman and a logician, but the combination *\*diplomat-boat* can never induce the ‘and’ relation because human ontology does not entertain the assumption that an individual can be both animate and inanimate (cf. Olsen 2004: 23).

A further general restriction derives from the asymmetrical nature of compound structure: the modifier restricts the denotation of the head. Hence, all regular compounds denote hyponyms of the head concept. A compound violating this endocentric structure because the modifier denotes a superset—rather than a subset—of the head is therefore deviant, cf. *\*book novel*, *\*building house* (Meyer 1993: 102) and *\*animal horse* (Bauer 1978: 86). Further, in order to pick out a subcategory that is relevant to the speakers’ cognitive organization in a coherent manner, the modifier must make reference to a property that is not necessarily shared by the class as a whole. The choice of a default property as in *whisker-cat* (Ryder 1994: 90) or German *Seitenbuch* ‘page book’ (Meyer 1993: 103) does not result in hyponymy because all cats have whiskers and all books have pages. *\*Water fish* (Warren 1978: 72), *\*wind-flag* (Downing 1977: 824) and *\*waist-belt* (Ryder 1994: 101) fail in the same manner to denote a relevant subset of the head, since they do not name anything more specific than what is already in the denotation of the head and, hence, are—again—simply redundant.

Meyer (1993: 123) points to other violations of the condition that the compound must denote a specialization of the head. Since ‘flour’ is a powder, it can be formed into heaps. But since there are no other options for the formation of uncontained powder, *\*Haufenmehl* ‘heap flour’ is odd. Furthermore, the conceptual relation ‘part-of’ has several variants. The patterns ‘area–place’ (*Campuswiese* ‘campus lawn’) is possible as are the patterns ‘activity–phase’ (*Einkaufsbezahlung* ‘purchase payment’) and ‘mass–portion’ (*Zuckerkörnchen* ‘sugar grain’, *Wassertropfen* ‘water drop’, *Kuchenstück* ‘cake piece’, *Wurstscheibe* ‘sausage slice’). ‘Collective–element’ concatenations, however, are ruled out because their heads denote necessary parts of the modifier and hence the compounds do not express a specialization of the head, cf. *\*Waldbaum* ‘forest tree’, *\*Herdenantilope* ‘herd antelope’, *\*Geflügelfasan* ‘poultry pheasant’. If the constituents are interchanged to the order ‘element–collective’ however, the construction no longer violates the specialization constraint: *Antilopenherde* ‘antelope herd’ denotes one of many possible types of ‘herd’. Similarly, the ‘has-part’ relation is restricted in certain general ways. When the modifier represents a necessary part of the head, it does not specify the head concept. For instance, *\*Blütenblume* ‘blossom flower’, *\*Dachhaus* ‘roof house’, and *\*Gestellbrille* ‘frame glasses’ are odd, but *Schnurtelefon* ‘cord telephone’ on the other hand is fine because there are now other options, i.e., cordless telephones and cell phones. Again, this is an example of a violation of specialization: the ‘has-part’ relation can be used for compounding only if the modifier expresses a “disjunction of elements standing in that relation to the head”, cf. Meyer (1993: 136–138).

It is difficult to know where exactly to draw the line between general and language-specific constraints. Warren (1978: 85–87) notes that the ‘mass–portion’ pattern that Meyer just illustrated as possible for German (cf. *Wurstscheibe*, *Kuchenstück*) must be differentiated in English. English allows *raindrop*, *teardrop* but not *\*winedrop*, *\*sweat drop*. It allows *raincloud*, *dustcloud* but not *\*powdercloud*, *\*flourcloud*; furthermore *air-wave* is possible but not *\*people wave*, and *rainstorm* but not *\*applause storm*. Warren suggests that when ‘shape’ actually indicates ‘quantity’, English must employ a phrasal

construction, cf. *\*sausage slice* vs. *slice of sausage*; *\*cake piece* vs. *piece of cake* as well as *drop of wine*, *cloud of flour*, *wave of people*, *storm of applause* etc. This restriction is not active in German where *Wassertropfen*, *Mehlwolke*, *Butterberg*, *Applaussturm* are all possible; hence, it appears to be language-specific.

What about the restrictions applying to the use of human nouns? Are they general (i.e., founded in human cognition) or language-specific? Warren notes that human nouns cannot denote the 'part' in a 'part-whole' relation, cf. *\*girl crowd*, *\*women group*, *\*people queue*, *\*child gang*; the equivalent phrasal constructions show that the concept itself is not deviant: *crowd of girls*, *group of women*, *queue of people*, *gang of children*. Since inanimate nouns are possible in this position (cf., *tree clump*, *apartment block*, *car line*), she debates whether this has to do with the randomness with which humans enter a group relation and, thus, the inability of these combinations to form a stabile class (Warren 1978: 89–90). German, however, allows this pattern. cf. *Menschenmenge*, *Frauengruppe*, *Menschenschlange*, *Kinderschar*. Furthermore, human nouns are disallowed in English as the modifier to a kinship relation, but permitted in German: *\*doctor widow*, *\*professor son*, *\*artist aunt* vs. *Arztwitwe*, *Professorensohn*, *Künstlertante*. So perhaps the restrictions on the use of human nouns in compounds are particular to English.

Ryder (1994: 148) notes that English does not use a compound to refer to a part of an animal's body in relation to the body as a whole: *chicken-wing* refers to a part of the animal that has been removed; an intact part is referred to phrasally as *a chicken's wing*. *Calf skin*, *chicken fat*, *turkey leg*, and *horsehair* substantiate this assessment and show that this type of compound implies that the part has not only been removed, but has also been processed. Here, the German data seem to coincide, *Rindernase* 'steer nose', *Kuhhaut* 'cow skin', *Hühnerbrust* 'chickenbreast', *Froschschenkel* 'frog leg', *Schweineohr* 'pig ear'. Furthermore, when parts of living bodies (human or animal) occur in the head position, the compound does not denote the part itself, but shifts its meaning out of the realm of regular, endocentric compounds into an exocentric interpretation in the meaning 'someone/something having the part' (Ryder 1994: 149), cf. animals: *longhorn*, *cotton tail*, *diamondback*; person: *tenderfoot*, *airhead*, *butterfingers*, *loudmouth*, *paleface*. Since German data fit this pattern as well, it seems to be a general restriction on the pattern, cf. animal: *Plattnase* 'flat nose', plant: *Rotdorn* 'red thorn', person: *Krauskopf* 'curl head', *Dickbauch* 'fat belly', *Langbein* 'longleg'. If, in addition, the modifier denotes an animal of which the head is a part, the compound takes on a metaphoric interpretation (what Ryder 1994: 149 terms a 'whole-compound metaphor'): *dogleg* 'bend in fairway', *rabbit ears* 'dipole antenna', *ponytail* 'hairdo'. German *Löwenzahn* 'dandelion', *Fuchsschwanz* 'pad saw', etc. confirm this. So, in this case, the shift in meaning seems to be principled. Human nouns acts differently in head position from animal nouns with the modifier *house*; an animal will live in the house and be domesticated (*house cat*), while a person will work there (*houseboy*). The 'living' relation is redundant for people and therefore avoided, cf. *\*house-woman*, where other location modifiers are possible with head nouns denoting humans: *caveman*, *country girl*, *seaman* (Ryder 1994: 156). So again, we are back to a violation of the general constraint requiring a specification of the head.

It is also most likely a general cognitive constraint that dictates when and to what extent accommodations and metaphors are used. Ryder notices that the head noun in *sea* + N constructions is almost always metaphorical when referring to a plant or animal, cf. *sea horse*, *sea lion*, *sea cucumber*, *sea fan*, *sea weed*. Its metaphorical nature is attributed to the original need to find a name for the large amount of unfamiliar flora and fauna found at

sea and the ability of humans to find similarities with objects already known from land (Ryder 1994: 165). The reason *sea* almost never occurs in head position is that it does not lend itself to specialization; the normal person has no need to differentiate the individual seas (Ryder 1994: 165). Tacit knowledge of established patterns may have an influence on compound interpretation leading to the extension of a group of compounds that share a common component, cf. *newspaper mogul*, *cinema mogul*, *media mogul*, *oil mogul*, etc., ‘powerful person with respect to X’ or *smart key*, *smart card*, *smart phone* ‘X with electronic access’. Ryder (1994) claims such patterns arise via analogy, while Olsen (2012) assigns the relevant constituents a derived relational entry of their own in the mental lexicon.

## 8.2. Categorical restrictions

Compounds can be realized by constituents from the other lexical categories besides nouns. Verbs and prepositions, however, are not found as heads of compounds for principled reasons: The category preposition is not an open category and, hence, not extendable by word formation processes, cf. Fanselow (1988). But most importantly, verbs and prepositions have internal arguments that must be expressed syntactically in non-polysynthetic languages, cf. Wunderlich (1986). All lexical categories are found in the non-head position, however, and exemplify there the basic interpretation strategy outlined above. In adjective-noun and verb-noun combinations the property expressed by the non-head modifies the head (*sweet corn*; *search party* ‘party that searches’, *drawbridge* ‘bridge that is drawn’, *wash cloth* ‘cloth for washing’, *payday* ‘day on which one is paid’). Prepositional-noun combinations construe the prepositional relation as a region modifying the head (*overcoat* ‘coat worn over sth.’). In noun-adjective combinations the nominal first constituent often expresses a norm of comparison (*paper thin*, *sky blue*), or it satisfies the relational meaning inferred from the head (*fat free* ‘free of fat’, *power hungry* ‘hungry for power’). The adjective-adjective combinations the modifier may modify the head (*greenish blue*) or yield a coordinative interpretation (*sweet-sour*). A verbal as first constituent can satisfy the relation gleaned from the relational head as in *fail safe* ‘safe from failure’ or *trust-worthy* ‘worthy of trust’. Adjectival participles occur in constructions with nominal first constituents that express local, instrumental and temporal adjunct relations such as *farm-grown*, *hand-picked*, *home-made*.

Neoclassical compounds made up of combining forms stemming from the classical languages also display both a relational and non-relational meaning depending of the semantic structure of the head constituent, cf. *suicide* ‘killing one’s self’, *xenophobia* ‘fear of foreigners’, *biology* ‘study of life forms’ in relational readings and *telescope* ‘instrument for viewing at a distance’, *xenobiotic* ‘foreign compound’, *homophone* ‘same sound’ in non-relational interpretations. Adjectival combining forms can also be coordinated, cf. *Sp. hispano-franco*, but interestingly equivalent nominal constructions don’t seem to occur. And finally, even the recent tendency to use a phrase as the non-head (so-called ‘phrasal compounds’) conforms to the expected array of interpretations found in regular determinative compounds. A non-relational head encourages the inference of an open relation: *present-is-the-key-to-the-past approach*, *please-smoke-all-you-like policy* while a relational head yields a relational interpretation: *cost-of-living increase*, *right-to-life campaigner*, *thousand-words-a-day contributor*. Coordinative combinations are not possible due to the absence of categorial equivalence between the components.



## 9. Conclusion

The aim of this contribution has been to characterize the meaning of regular, productively formed, compounds. It has been proposed that their interpretation centers around the question of what relation(s) speakers can conceptualize to relate the component parts. The relevant interpretation strategy was formalized as a compound template in example (20) of section 6.3, which is an abstract version of the general modification template developed to model the interpretative process of predicate conjunction in the intersective modifier-head configurations in syntax. The compound template obviates the need for distinguishing different types of compound meaning such as the primary (root or non-verbal-nexus), verbal (relational, synthetic, verbal-nexus) and copulative (coordinative, appositive) readings. All interpretations go back to the simple conjunction of predicates mediated by an unspecified relation between them. Compounds differ from the modification structures of syntax in that they later instantiate the default identity relation. Furthermore, the verbal interpretation of compounds also differs from theta assignment in syntax. It is merely a special case of conceptual inference, i.e., one in which the relation inherent to a relational head is chosen to instantiate the variable R of the template. The nature of the inferred relation in the meaning of a compound predisposes compounds as names rather than descriptions, cf. Bücking (2009, 2010). Finally it was shown how untypical word structures such as the left-headed compounds of Romance comply with this analysis as well.

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Susan Olsen, Berlin (Germany)

# 81. Semantics in Distributed Morphology

1. Introduction
2. Distributed Morphology: The framework
3. Differences with lexicalist approaches
4. Morphosemantics in Distributed Morphology
5. Conclusion
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## Abstract

*This article introduces the grammatical framework of Distributed Morphology, with special attention to the implications of the framework for semantic interpretation. The derivation of a sample sentence is given, illustrating the dissociation between the semantically contentful abstract units which are the input to syntactic and semantic composition, and the phonologically contentful Vocabulary Items which compete to realize them. The central assumptions of the framework are contrasted with those of more established Lexicalist approaches, particularly with respect to the predictions for bracketing paradoxes, the Mirror Principle and the status of lexical roots. Areas in which Distributed Morphology has produced developed semantic proposals are described, including argument structure operations, idiomatic interpretation, the interpretation of nominal features, and the nature of on-line speech errors.*

## 1. Introduction

Distributed Morphology (DM) is a morphosyntactic framework which employs the same combinatoric and interpretive mechanisms for both word-formation and phrase-formation. Viewed in this way, morphology just *is* syntax, and vice versa. The locus classicus for the framework is Halle & Marantz (1993).

Given the assumption that morphology is syntax, and given that in modern Minimalist syntactic theory, syntactic representations are deterministically mapped to semantic representations, many DM analyses make significant semantic predication, and semantic evidence is often brought to bear in the DM literature. Many practitioners have employed the term ‘morphosemantics’ to describe their research.

This article attempts first to give the reader a feel for the structure of the framework, providing an introductory overview and a toy example of a derivation within the theory. Then certain differences between DM and more traditional Lexicalist approaches are remarked upon, touching on issues such as bracketing paradoxes and the question of whether word-formation has any special semantic effects or status. Then the paper provides a brief tour of some particularly significant issues within the theory, including argument structure, lexical decomposition, idiomatic interpretation, underspecification, zero morphology, nominal (‘phi’) feature interpretation and semantically-motivated speech errors.

## 2. Distributed Morphology: The framework

As noted above, DM is a framework for morphological, syntactic and semantic analysis in which word-formation is primarily a syntactic operation, in the usual sense of

'syntactic'. That is, the same mechanism that generates complex phrasal structure also generates complex morphological structure. There is only one 'generative engine' in the theory. In that sense, the theory does without a conventional generative lexicon. There are no lexicon-internal operations which create or operate on complex word-forms prior to their being fed into the syntactic computation. One consequence is the prediction that there can be no morphological operations that implement non-monotonic semantic changes. This is because semantic content can be added to a complex structure but not deleted from it by the introduction of a new terminal node with new semantic content. Hence morphology, like syntax, is predicted to obey the Monotonicity Hypothesis (Koontz-Garboden 2007).

In DM, the primitive elements which the combinatoric system operates on are abstract bundles of syntacticosemantic features, for example [PL] ('plural') or [√CAT] ('cat'). These feature bundles have denotations which are the input to semantic composition and interpretation after syntactic computation is complete, at the level of Logical Form (LF). There are two broad categories of items in this first list. Roots, or l-morphemes, like [√CAT], whose final interpretation includes Encyclopedic information, will determine the idiosyncratic aspects of the final semantic representation. Abstract Morphemes, or f-morphemes, like [PL], provide the functional structure and make deterministic semantic contributions. (In Chomsky's famous *Colorless green ideas* sentence, the 'semantic ill-formedness' which the sentence was intended to illustrate results from incompatibilities in the Encyclopedic content of the Root morphemes in the sentence. The functional elements are both syntactically and semantically coherent—in other words, the sentence has a well-formed LF.)

The mental storehouse of these feature bundles is termed List 1 (see the diagram in Fig. 81.1), and provides the raw material from which the syntactic computation begins. The contents of List 1 vary from language to language, both the particular Roots on the list and the particular content of the abstract grammatical feature bundles being determined during acquisition, subject to constraints imposed by Universal Grammar and the acquisition mechanism.

The operations which combine these bundles of features into larger hierarchical structures are essentially those of Minimalist syntactic theory. A subset of feature bundles is selected as input for combination (the Numeration). These feature bundles undergo the Merge, Agree, and Move operations, subject to relevant syntactic requirements, such as the Minimal Link Condition (Chomsky 1995), which constrains the potential targets of the Agree and Move operations.

As in garden-variety Minimalism, the derivation reaches a point at which it must be interpreted by the phonological and semantic interfaces, called Spell-Out. Here, the derivation branches. On the way to the interface with phonology, the syntactic representation is subject to some purely morphological operations, then morphophonological ones, before the final PF form is reached. Similarly, on the way to the semantic interface, it could be the case that some specialized operations apply to the syntactic representation to achieve an interpretable Logical Form. Most crucially, the phonological realization of the terminal nodes of the syntactic structure is determined on the way to PF, by an operation called 'Late Insertion'. The elements of List 1 have no phonological content. Purely phonological information about the realization of lexical items is therefore not present at the LF interface. For example, the LF representation does not 'see' the morphological difference between the realization of the [PL] feature as *-en* in *children* and as *-s* in *cats*; the LF

representations of both words contain just the same [PL] feature, and are interpreted accordingly.

The Late Insertion operation, on the PF branch, accesses a second list of information, specifying phonological realizations associated with particular feature bundles. The elements of this List 2 are termed “Vocabulary Items” (VIs). Importantly, VIs may be underspecified—the VI which is inserted to realize a particular feature bundle may be listed with only a subset of the features contained in the bundle. Insertion of Vocabulary Items proceeds according to a ‘best fit’ principle: the VI which wins insertion is the VI whose feature specification comes the closest to matching the features of the terminal node without containing any clashing features. Consider a pronominal terminal node specified for [+1, +SG, +NOM] (a first person singular subject), and three hypothetical VIs with different feature specifications, as illustrated below:

| <i>Terminal node</i>  | <i>Vocabulary items</i>                |
|-----------------------|----------------------------------------|
| $D_{[+1, +sg, +Nom]}$ | ‘ba’ $\Leftrightarrow [+1]$            |
|                       | ‘da’ $\Leftrightarrow [+1, +Nom]$      |
|                       | ‘ga’ $\Leftrightarrow [+2, +sg, +Nom]$ |

The *ga* VI is not eligible to realize the terminal node, because it refers to the clashing feature [+2]. Both *ba* and *da* are eligible for insertion, as their features are a subset of the terminal node’s, but *da* wins out over *ba* because *da* refers to more compatible features than *ba* does. This best-fit competition for insertion thus obeys Kiparsky (1973)’s *Elsewhere Principle*. (VIs may also be conditioned by features on other terminal nodes in the surrounding syntactic context; the same Elsewhere Principle applies.)

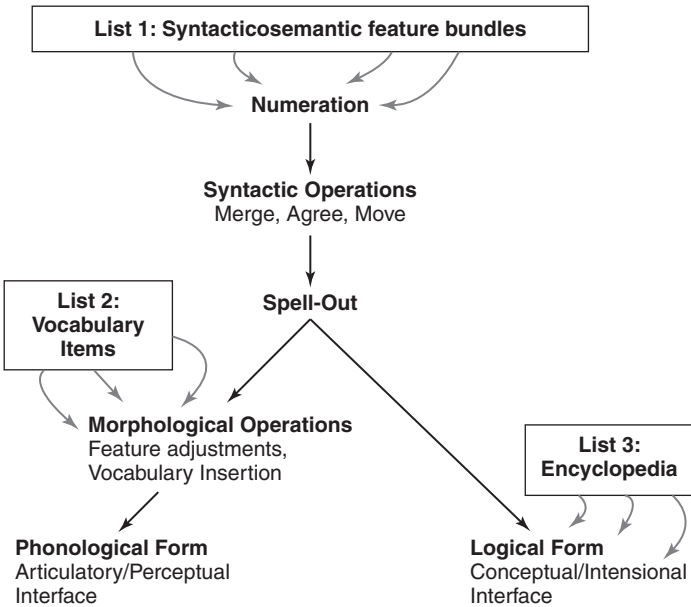


Fig. 81.1: The Distributed Morphology Model

Over at the LF interface, besides the normal semantic composition which computes the denotation of the syntactic representation, special information is accessed concerning the interpretation of particular Root items in the syntacticosemantic context in which they now appear. Both idiomatic and conventional interpretations of Roots are represented in this third list of idiosyncratic information, called the Encyclopedia or List 3. This special information composes with the denotations of the f-morphemes to produce the final interpretation of the structure. Standard model-theoretic semantic mechanisms of composition, those adopted by semanticists working in a broadly Minimalist context (e.g. like those in Heim & Kratzer 1998), are employed.

A schematic of the overall model is presented in Fig. 81.1.

### 2.1. Sample derivation

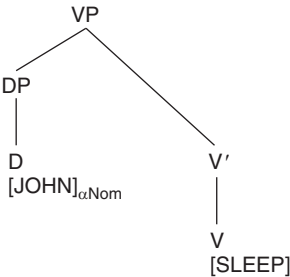
As an illustration of the kind of mechanisms at play, a toy derivation of the sentence *John slept*, with very basic assumptions concerning the denotations of the feature bundles involved, is illustrated below. Overall, the type of syntax-semantics interface outlined in article 82 (von Stechow) *Syntax and semantics* is assumed to apply.

Step 1: Selection of syntacticosemantic features from List 1. (I follow Demirdache & Uribe-Etxebarria (2007) in using ‘i’ to represent a variable over time intervals.)

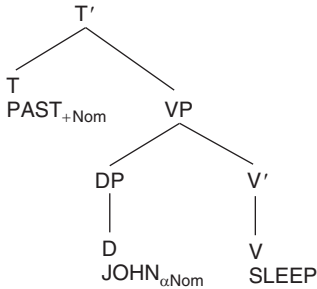
| <u>Feature(s)</u>         | <u>Denotation</u>                                     |
|---------------------------|-------------------------------------------------------|
| [JOHN] <sub>D, αNom</sub> | The relevant individual named ‘John’                  |
| [PAST] <sub>T, +Nom</sub> | $\lambda i.[\text{BEFORE}(\text{utterance-time}, i)]$ |
| [SLEEP] <sub>V</sub>      | $\lambda x.\lambda e.[\text{SLEEP}(e, x)]$            |

Step 2: Syntactic derivation. (I am assuming the VP-Internal Subject Hypothesis. I also silently include projection of the determiner [JOHN]<sub>D</sub> to a DP as well as projection of the verb [SLEEP]<sub>V</sub> to a V'. In fact, under Bare Phrase Structure assumptions (Chomsky 1995), [JOHN]<sub>D</sub> in this configuration is simultaneously a head and a phrase, and non-branching projection does not occur.)

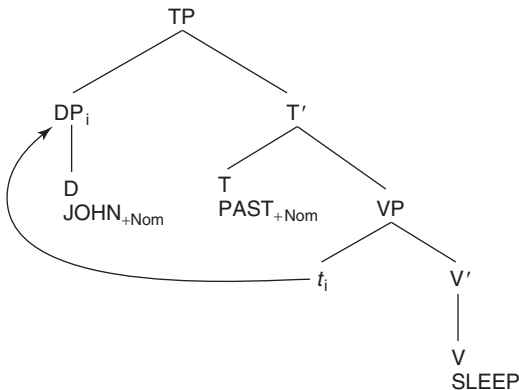
(i) [JOHN]<sub>D, αNom</sub> undergoes Merge with [SLEEP]<sub>V</sub>, producing a VP:



(ii) [PAST]<sub>T, +Nom</sub> undergoes Merge with the VP, producing a T' constituent:



(iii) The active [+Nom] Case feature within the [PAST]<sub>T</sub> feature bundle Probes its c-command domain for a Case feature with which it can Agree, finding [JOHN]<sub>D, αNom</sub>. The DP headed by [JOHN]<sub>D, αNom</sub> undergoes Move to Spec-TP, where it enters into Spec-Head Agreement with [PAST]<sub>T, +Nom</sub>. This results in a fully convergent syntactic structure with no unchecked features:



### Step 3: Spell-Out

The representation in (iii) above is sent for interpretation to the LF and PF interfaces. I first present a sketch of the derivation of the LF interpretation, then that of the PF interpretation.

#### Step 3.1: LF Interpretation

(i) The denotation of VP is computed by composing the denotation of the V with the denotation of the chain {DP<sub>i</sub>, t<sub>i</sub>}, which (especially under the ‘Copy’ theory of movement) is identical to the denotation of the DP.

$$[[VP]] = \lambda e[SLEEP(e, 'John')]$$

Standardly, the VP [JOHN SLEEP] denotes a function from events to truth values such that  $f(e) = 1$  iff  $e$  is an event of John sleeping. The identity criteria with which the speaker identifies sleeping events as such are contained in the List 3 entry for the



l-morpheme [SLEEP]—they are part of the content of the Encyclopedia, accessed once the final LF is determined.

(ii) Existential closure at the VP binds the event variable, asserting the existence of a John-sleeping event.

$$[[VP]] = \exists e[SLEEP(e, 'John')]$$

(iii) Type mismatch resolution: The  $[PAST]_T$  feature is a function from time intervals to truth values, but at this point the VP's denotation is not a time interval. For the purposes of this illustration, I assume that before the VP is composed with  $T^\circ$ , some operation applies that maps the event denoted by the VP to the time interval during which it takes place—something like the Temporal Trace Function  $\tau$  proposed in Krifka (1998) (see article 57 (Ogihara) *Tense* for discussion). This function could conceivably enter the derivation as the denotation of some feature bundle occupying an intermediate head position between VP and TP (e.g. an  $Asp^\circ$  head), but I will treat it here as an LF-specific compositional operation which applies just when this type mismatch is detected. This would be an example of a kind of special semantic operation which the PF computation could never be sensitive to, as it applies after the split at Spell-Out—a semantic analogue of the special morphological operations that can apply to adjust the representation on the way to PF. Following the application of this operation, very roughly speaking, the VP denotes the unique time interval during which the sleeping event took place:

$$[[VP]] = (i)\lambda i[\exists e[SLEEP(e, 'John')]] \& DURING(e, i)]$$

(iv) The denotation of  $T'$  is computed by composing the denotation of  $T$  with that of the VP:

$$[[T']] = BEFORE(utterance-time, (i)\lambda i[\exists e[SLEEP(e, 'John')]] \& DURING(e, i)])$$

i.e. The unique time during which there was an event of John sleeping was before utterance time.

(v) For present purposes, let us assume the denotation of TP is the same as that of  $T'$ , since the DP-chain has already been interpreted within the VP—i.e., reconstruction has applied.

### Step 3.2: PF Interpretation

Each terminal node in the syntactic structure is associated with a morphophonological Position-of-Exponence which must be filled by a phonological exponent—a Vocabulary Item—in order for the structure to be pronounced. Terminal nodes filled by traces or other empty categories explicitly marked as lacking a PF representation are excluded.

(i) Linearization: The hierarchical structure of the syntactic tree is linearized according to the Head Parameter setting for the language. In the case of English, specifiers are on the left and complements on the right of their heads, as in the tree diagrams above. By hypothesis, however, the linear order among terminal nodes is not relevant until PF; the hierarchical structure is all that matters for the computation of syntactic relations and for LF.

(ii) At this point, some operation is necessary to ensure that the PAST suffix is realized attached to the V within the VP, rather than above it in the T position. Following Bobaljik (1994), I'll assume that Morphological Merger applies to the  $[PAST]_T$  terminal node and the  $[SLEEP]_V$  terminal node, essentially lowering the  $T^o$  head to form a complex segment with the  $V^o$  head. This English-specific example of Morphological Merger is essentially a technical implementation of affix-hopping within the DM framework. It is also an example of the kind of PF-specific operation whose effects are never seen in the LF representation.

(iii) Now Late Insertion begins, by hypothesis from the Root morpheme upwards (though nothing in the framework would preclude top-down insertion of VIs; see section 4.6 below for discussion). The Vocabulary Items which compete for the l-morpheme SLEEP are accessed from List 2. I will assume that two such items are present in English, since SLEEP is an irregular verb (alternatively there could be just one,  $[slijp]$ , which is subject to a special vowel-shortening morphophonological readjustment rule later in the derivation, as Halle & Marantz (1993) originally proposed). The first of our two VIs for SLEEP is specified for insertion in the environment of a +PAST Tense node, and the second is available for all other contexts—i.e. it's the 'elsewhere' item.

SLEEP  $\Leftrightarrow /slɛp/$  /  $[[PAST]_T \text{ \_\_\_\_}]$   
 SLEEP  $\Leftrightarrow /slijp/$  elsewhere

The first VI wins insertion at the terminal node for SLEEP since it is a better fit in the current context than the second.

(iv) The Vocabulary Items specified for the f-morpheme  $[PAST]_T$  are accessed. Again, there are several such VIs in English. Each of the irregular PAST VIs is specified for input in the context of particular l-morphemes:

PAST  $\Leftrightarrow \emptyset$  /  $\left[ \begin{array}{c} \text{\_\_\_\_} \\ \left\{ \begin{array}{c} [HIT] \\ [RUN] \\ [SIT] \\ \dots \end{array} \right\} \end{array} \right]$   
 $\Leftrightarrow /t/$  /  $\left[ \begin{array}{c} \text{\_\_\_\_} \\ \left\{ \begin{array}{c} [FEEL] \\ [MEAN] \\ [LEAN] \\ \dots \end{array} \right\} \end{array} \right]$   
 $\Leftrightarrow /d/$  elsewhere

In this case, the elsewhere morpheme  $/d/$  wins insertion, since  $[SLEEP]$  is not on any of the lists conditioning the insertion of the irregular suffixes  $\emptyset$  or  $/t/$ .

(v) The Vocabulary Items specified for the individual-denoting  $[JOHN]_D$  (in fact, probably better represented in List 1 as a simple index which receives an interpretation under an assignment at LF) are accessed. There's only one:

$[JOHN]$   $\Leftrightarrow /dʒan/$

(vi) Phonological constraint satisfaction: The terminal nodes all having been realized with VIs, the structural representation is now something like this, with the vacuous T' brackets eliminated for clarity:

[[/dʒan/]]<sub>DP</sub>[/slɛpd/]<sub>VP</sub>]<sub>TP</sub>

The string of phonemes is then subject to English-specific phonological allomorphy, adjusting the voicing in the word-final consonant cluster /pd/ in /slɛpd/. The past-tense suffix surfaces as [t] in the environment of the stem-final voiceless consonant [p] to its left. The string is then phonetically interpreted, with the correct intonational contours, stress, allophonic selection, etc, surfacing as [ˈdʒan ˈslɛpt].

With this impression of the details of a DM derivation in mind, let us explore some of the semantic ramifications of the framework.

### 3. Differences with lexicalist approaches

#### 3.1. Absence of bracketing paradoxes

In DM the same interpretive mechanisms are employed to compute the meaning of complex syntactic phrases and complex word-forms; such computations are often interleaved. For example, assuming bottom-up composition, the denotation of the VP [<sub>VP</sub> love [<sub>DP</sub> Mary]] in the sentence *John loved Mary* will be computed before the contribution of the T° node is composed with the denotation of the VP; there is no need to compute a meaning for the phonological word *loved* before composition of the verb with the direct object. In a strongly Lexicalist model, *loved Mary* is a kind of bracketing paradox, since the interpretation of Tense scopes over the whole VP, while the morphological realization of Tense is within the domain of the verb only—inside the word *loved* that occupies the V° node in the tree. No such puzzles arise in DM. The fact that the past tense morpheme *-ed* is affixal and the future tense morpheme *will* is an independent word is an epiphenomenon of the particular Vocabulary Items which are inserted to realize the Tense node; it has no effect on the relative order of semantic composition. Tense and the VP in *John loved Mary* are composed in the same order that they are in *John will love Mary*. Similarly, the classic example *transformational grammarian* can be analyzed in the syntax and at LF as having the structure [[*transformational grammar*]-ian]; the fact that the element *-ian* is affixal becomes relevant only at PF.

#### 3.2. Mirror Principle is entailed

The architecture entails that a scopally-motivated order of affixation should be the norm, as in the analysis of Athapaskan morphology presented in Rice (2000). The observation that morpheme order generally reflects syntactic hierarchies—and hence the order of semantic composition—has been implemented in some form or other in Chomskyan grammar since Baker (1985) proposed the Mirror Principle. In DM, the Mirror Principle effect falls out of the architecture of the theory; deviations from it must be explained, but the general existence of the effect is entailed.

### 3.3. The special status of Roots

A consequence of treating syntactic and morphological composition with the same mechanism is that morphological phenomena must be taken seriously by those interested in clausal semantics. In DM, there is a guiding assumption that all overt morphological exponents represent the realization of some syntactic terminal node. This extends to derivational morphology, which has further consequences for syntactic structure and semantic interpretation. For example, it becomes important to characterize the syntactic and semantic role of the terminal nodes realized by derivational morphemes like *-ize* and *-ify* (verbal), *-tion* and *-ness* (nominal), and *-al* and *-y* (adjectival).

Such categorizing nodes have the special property of being able to compose directly with Root morphemes. DM suggests that Roots are a-categorial, and must Merge with a categorizing f-morpheme (or more than one, in cases like  $[[[[[nomin]_{\sqrt{al}}]_{\sqrt{iz}}]_{\sqrt{ation}}]_n]$ ). This categorizing morpheme provides the Root to which it attaches with a syntactic category. Further, since all Roots must occur with at least one such categorizer, the Encyclopedia provides the Root with a fixed interpretation in the context of particular categorizers. The hypothesis that Roots are acategorial, achieving interpretable status only through composition with  $v^\circ$ ,  $n^\circ$  and  $a^\circ$  heads, is a key component of the framework, allowing a characterization of the different but related contribution of, for example, the root  $\sqrt{ELECTR}$  in *electr-on* (Noun) and *electr-ic* (Adjective) and *electr-ify* (Verb). This theoretical feature has been particularly exploited in the DM analysis of Semitic root-and-pattern morphology proposed in Arad (2003, 2005).

(Note that the toy derivation provided in section 2.1 above does not include a separate  $\sqrt{\phantom{x}}$  projection for  $\sqrt{SLEEP}$  embedded under verbalizing  $v^\circ$  morpheme. Rather, it started with the result of the combination of  $v^\circ$  and  $\sqrt{SLEEP}$ , the verb *SLEEP*, although such decomposition is standardly assumed in the framework. The usual interpretation assumed for the individual terminal nodes of unergative verbs is based on Hale & Keyser (1993)'s proposal,  $[DO [SLEEP]_{\sqrt{v}}]_{\sqrt{p}}$ . See Harley (2005, forthcoming) for further discussion of the type-theoretic denotations of roots.)

### 3.4. The phonological word has no special status in semantic interpretation

Erasing the borders between morphological and syntactic composition in this way allows the resolution of several empirical conundrums. One positive consequence is that the typological differences between polysynthetic and isolating languages do not require the postulation of radically different combinatoric and compositional mechanisms in UG. For example, true noun incorporation constructions (Baker 1988), in which the incorporated nominal object forms part of the complex verb, can be structurally and semantically identical to pseudo-noun-incorporation constructions like those in Niuean (Massam 2001) and Hindi (Dayal 2003). In pseudo-noun-incorporation, a bare nominal acts semantically as if it's incorporated—it is interpreted in the same way as in cases of genuine morphological incorporation like those documented by Mithun, Baker, and others—even though it retains its morphophonological autonomy as a separate word. (See article 44 (Dayal) *Bare noun phrases* for relevant discussion.) In DM, at LF, status as a word or multiple words is irrelevant. In a more familiar example, the LF structure and

interpretation of English comparatives can be treated as uniform regardless of the variable affixal status of the comparative morpheme (*-er* vs. *more*, Embick 2007), without causing any major theory-internal upset at the morphology/syntax interface. What is more, semantic proposals about the LF operations required to interpret comparatives, for example QR of the Degree Phrase headed by *-er* after Spell-Out, need not necessarily be concerned with the question of whether the QR operation will dissociate a suffix and its host, since at the point at which QR applies, the issue of whether the actual phonological realization of the Deg head is an affix or not is irrelevant. (Thanks to Ora Matushansky for this point. Interesting questions still arise, however, concerning the realization of comparative adjectives, particularly with respect to suppletion in the realizations of certain Roots; e.g. the Root  $\sqrt{\text{BAD}}$  is realized alternatively as *bad*, *worse*, or *worst* depending on the content of the Deg feature bundle in its immediate context. See Bobaljik (2007) and article 53 (Beck) *Comparison constructions* for relevant discussion.)

The same point holds cross-linguistically. Both affixal and non-affixal complex forms can both be purely compositionally interpreted or idiosyncratically, idiomatically interpreted. A good example is the equivalent interpretations of the morphologically complex English *awaken* and the syntactically complex Persian complex predicate *bîdar shodan*, ‘awake become’ (Folli, Harley & Karimi 2005). More trivially, it is clear that phrases can have both literal (compositional) and idiomatic interpretations, as in *kick the bucket*. Similarly, morphologically complex words can also have both literal and idiomatic interpretations. The famous example case *transmission* can refer idiomatically to the relevant car part, or literally, compositionally, to the event or result of transmitting. There is no principled reason that morphophonological unification within a single phonological word should necessarily trigger a special semantic interpretation (Marantz 1997). Multi-morphemic and multi-word expressions can in principle represent the same structure and receive the same interpretations. Wordhood confers no privileged semantic status.

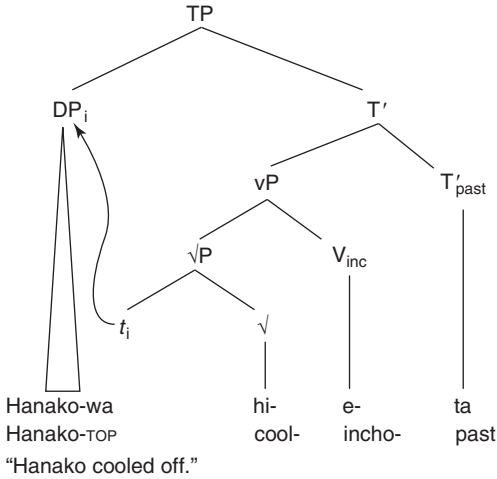
However, as noted above, although there is no morphophonologically motivated semantic domain, the acategorial Root hypothesis entails that there is at least one such morphosyntactic dividing line, at the point at which the categorizing head is composed with the Root (Marantz 2001, Arad 2003)

## 4. Morphosemantics in Distributed Morphology

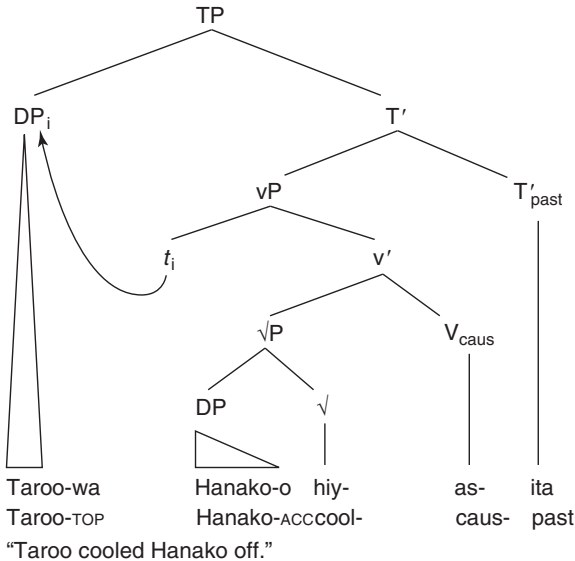
### 4.1. Argument structure

In many, perhaps most, languages, diathesis alternations are realized by the addition or alternation of overt verbal morphology. In DM, this entails that argument structure alternations are effected syntactically. The notion that external arguments are introduced by a separate verbal projection, for example, first proposed by Hale & Keyser (1993), provided DM approaches with a natural first hypothesis concerning the locus of causative and inchoative verbal morphology, which is cross-linguistically common (indeed, such morphology was part of the original motivation for the proposal.) For example, the unaccusative Japanese verb *hie-*, ‘cool, intr.’ is made up of a root *hi-* plus an inchoative morpheme *-e-*. Its causative counterpart, *hiyas*, is the same root *hi-* plus the causative morpheme *-as-*. The additional external argument correlates with the change in suffixal morphology; it is natural to ascribe the addition of the former to the semantic contribution of the latter:

a.



b.

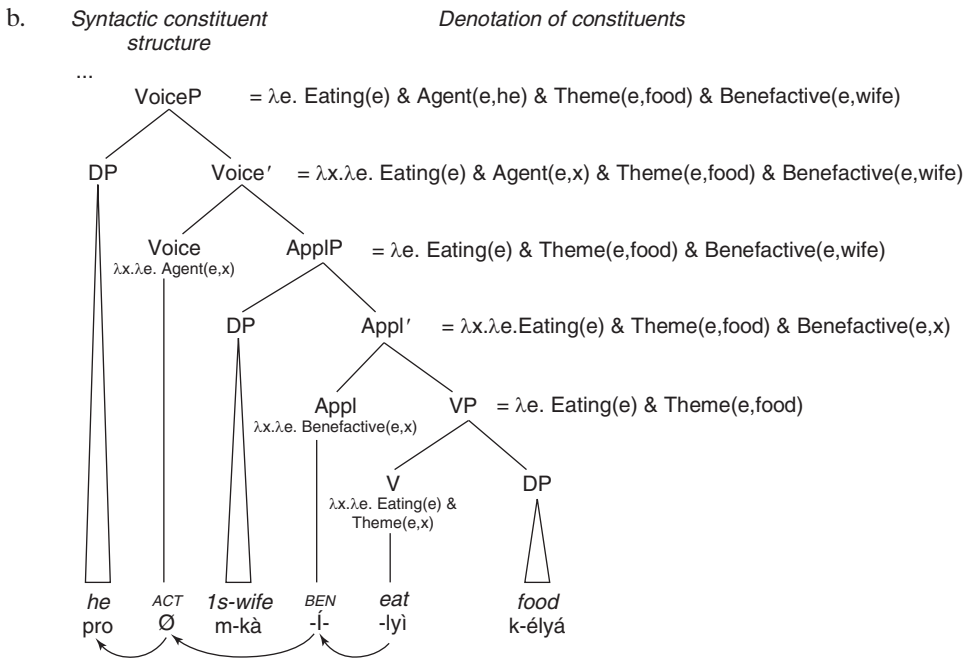


Given such complex syntactic structures for the causative and inchoative forms in Japanese, the source of apparently word-internal scope ambiguities with adverbials like *again* ('repetitive' vs 'restitutive' scope) should be clear: such scope ambiguities are syntactic ambiguities, resulting from the decomposition of the form into a constituent denoting 'cool' and another phrasal element meaning 'cause'. Such analyses thus represent the re-introduction of many of the key ideas of the Generative Semantics work in the late 60s and early 70s. (See article 17 (Engelberg) *Frameworks of decomposition* for relevant discussion.)

Given this kind of approach to argument structure, it is a short step to recognize that similar analyses are necessary for other argument-structure introducing morphology. For example, applicative morphemes, which add an internal argument to the argument

structure of agentive verbs, can occupy a position between the upper, external-argument-introducing head and the lower verb Root, which selects for the verb's usual internal arguments. This accounts for the syntactic prominence of the applied argument compared to other internal arguments (McGinnis 2003). Semantically, the Applicative head expresses a relationship between an individual (the applied argument) and an event (Pylkkänen 2002). The Applicative head composes with the lower VP and the higher vP via Kratzer (1996)'s Event Identification operation. It simply adds an event-modifying predicate and expresses the relationship between its new argument and the event. Nothing special needs to be said about the semantics of the VP or the vP; they have just the (Davidsonian) interpretation which they normally would. Pylkkänen's syntactic structure and semantic interpretation for a straightforward benefactive applicative sentence from Chaga is given below:

- a. N-~a-~i-lyi-i-à                      m-kà      k-élyá  
 FOC-1s-PR-eat-APPL-FV    1-wife    7-food  
 'He is eating food for his *wife*'  
 (Bresnan & Moshi 1993:49)



As indicated by the arrows in the diagram, head movement of V through Appl, Voice and the higher functional projections (not shown) assembles the complex constellation of feature bundles that will be realized as the final verb form and derives its sentence-initial position. (Kratzer and Pylkkänen use the term 'Voice' for the external-argument introducing position, rather than vP; Pylkkänen reserves the label 'vP' for a purely verbalizing head lower in the structure. For our purposes here, the difference is not crucial, however.)



## 4.2. Zero morphemes

In DM, it is frequently necessary to posit the existence of zero morphology. For example, the diathesis alternation between English *melt* (intr.) and *melt* (tr.) is accomplished without any overt change in morphology. The semantic and syntactic changes that are observed, however, require that a syntactic projection is present but not overtly morphologically realized. By hypothesis, this syntactic projection is realized by a zero morpheme. (The deployment of zero morphemes means that DM analyses are not literally engaging in lexical decomposition when the verb ‘melt’ is represented in a structure as  $[[\text{cause}]_v, [\text{melt}]_{v,p}]$ ; the ‘cause’ content is contributed by a separate head realized by a zero morpheme, not by the verb ‘melt’ itself.)

Similarly, a zero morpheme is needed to block the insertion of default *-s* into the PL terminal node which is necessarily present on the noun in the DP *These sheep*—without a zero morpheme, the form *These sheeps* would surface, given the mechanisms of the theory.

Above we saw that it is axiomatic in DM that a surface realization must correspond to some kind of structure in the morphosyntactic system, and hence can often be taken as evidence for the presence of some element in the semantic representation as well. The reverse is emphatically not the case: syntactic and semantic evidence can point to the existence of structure that receives no realization in the phonological representation. This is not a surprise—the existence of syntactically and semantically motivated empty elements has been a cornerstone of modern generative syntax—but it is a controversial point within morphological theory. Indeed, within DM, the nature of a ‘zero’ morpheme is a matter of some disagreement. Considering VIs to be sketches of instructions for the articulatory system, one possibility is that a zero morpheme could be considered an instruction to ‘do nothing’. However, no consensus has emerged on the correct way to model a ‘zero’ realization.

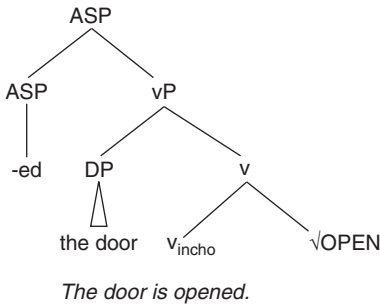
## 4.3. Underspecification

As we have seen above, in DM, the relationship between a terminal node’s feature content and the Vocabulary Item which realizes that terminal node is subject to underspecification: The Vocabulary Item which best fits the content of the terminal node realizes it phonologically, but the featural match between the two need not be exact. The DM framework thus helps break the assumption that a given piece of morphophonology should in principle correspond to only one meaning. This has proven helpful in understanding the syntacticosemantic structure involved in several puzzling cases where the same morphological formative appears to be behaving semantically in two or more distinct ways, as in for example, the analysis of the interaction of causative and reflexive morphology in Kannada in Lidz (2003).

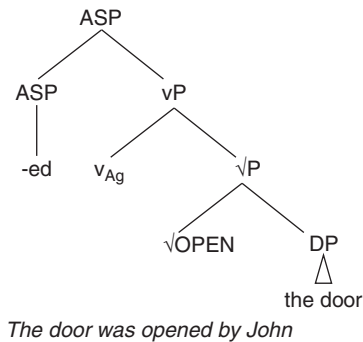
One particularly fruitful line of analysis along these lines has considered the composition of apparently identical morphological items with distinct levels of syntactic structure, dubbed in Harley (2008) the *High/Low Attachment Hypothesis*. Participial morphology in many languages seems to have the option of attaching to an event-denoting constituent in the verbal projection and receiving an eventive passive interpretation, or attaching to a lower constituent and receiving a stative interpretation (Marantz 1997, Embick 2004, Kratzer 2001, Jackson 2005, Alexiadou & Agnastopoulou 2008, *inter alia*). The point is

made in great detail in von Stechow (1998), in which the distinct semantics of no less than four constructions in German, all employing Participle II morphology, are analyzed and given distinct model-theoretic interpretations. The ‘Transparent Logical Form’ von Stechow argues for is very much in line with the elaborate vP syntax proposed in the related Distributed Morphology work. The puzzle of how such distinct interpretations can be realized by identical morphology is resolved when it is realized that the morphology may be sensitive just to a subset of the syntacticosemantic features involved—even a very minimal subset, such as category information. Below, I illustrate Embick (2004)’s distinct structures for English resultative participles and eventive passive participles. The key feature of the analysis is that both involve an Asp(ect) head (though see Maienborn 2009 for an opposing view). The default ‘elsewhere’ morpheme for spelling out this Asp head is the *-ed* suffix, which is why the same morphology can appear in structures with such very different kinds of interpretations:

a. Resultative participle



b. Eventive passive participle



Similar effects have been observed cross-linguistically in causative morphology (Miyagawa 1998, Travis 2000, Svenonius 2005, *inter alia*.) Harley (2008) provides a detailed discussion of the Japanese case.

#### 4.4. Nominal features and their interpretation

The relationship between the morphological realization and the semantic interpretations of certain syntacticosemantic feature distinctions (for example, the various values of

person, number and gender features) has been a key question in DM and related research, e.g. Rullman (2004), Cowper (2005), McGinnis (2005a), Harbour (2007), Sauerland (2008), Acquaviva (2008), inter alia. It is axiomatic that the same alphabet of features constitutes the input to the semantics and the morphological component, and there has been a great deal of work on understanding the relationship between the features and the morphological exponents that realize them. The morphologist's traditional 'feature bundle' has usually been syntactically decomposed, as in Ritter (1992), but the semantic contributions and compositional reintegration of the various features, however, is less well understood. Several very interesting results have emerged, however.

Harbour (2006) reports the remarkable observation that the semantic content of the feature [ $\pm$ augmented] (a cardinality-neutral alternative to the [Plural] feature) has essentially the same semantics as Krifka (1992)'s crucial definition of cumulativity.

Harbour gives the following definition of augmented:

A predicate, P, is *augmented* iff

$$\exists x \exists y [P(x) \wedge P(y) \wedge x \supset y]$$

i.e. iff it is satisfied by two individuals, one containing the other, an individual being an atom or a set of atoms.

The notion of augmentation was first proposed as the correct way to characterize number systems like that of Ilocano, which has a 1st person inclusive plural form, referring to speaker, hearer and at least one other. This plural form contrasts with another first person inclusive form referring just to the speaker and the hearer. The cardinality of the non-plural inclusive form is not 1, so it is inappropriate to use the feature [singular] (or [-plural]) to describe it. Since the form is of cardinality 2, the traditional terminology calls it a 'dual', but this results in positing the Dual category just for the first person inclusive non-plural, within such languages:

| Person | Singular | Dual | Plural |
|--------|----------|------|--------|
| 1 incl |          | -ta  | -tayo  |
| 1 excl | -ko      |      | -mi    |
| 2      | -mo      |      | -yo    |
| 3      | -na      |      | -da    |

Using the feature [+augmented], with the semantics given above, results in a much more satisfactory cross-classification:

| Person | -Augmented | +Augmented |
|--------|------------|------------|
| 1 incl | -ta        | -tayo      |
| 1 excl | -ko        | -mi        |
| 2      | -mo        | -yo        |
| 3      | -na        | -da        |

Harbour treats the person specification as the basic predicate of the pronominal which the [+augmented] feature modifies, so, for example, a '1 incl' pronoun has as its denotation the predicate 'includes Speaker and Addressee'. '1 excl' is the predicate 'includes Speaker and excludes Addressee'. Given the semantics for 'augmented' above, consider

the denotation of the [incl, +aug] pronoun *tayo*. The [+aug] feature asserts that  $\exists x \exists y [\text{INCLUDESSp\&Ad}(x) \wedge \text{INCLUDESSp\&Ad}(y) \wedge x \supset y]$ —that is, it says that the model must contain two individuals, both containing ‘Speaker’ and ‘Addressee’, the one individual contained in the other. Minimally, then, the model contains {Speaker, Addressee, Other}, since this model contains the individual {Speaker, Addressee} and the individual {Speaker, Addressee, Other}, and the former is contained in the latter.

Applied to 2nd person, on the other hand, [+augmented] just requires that the model contain minimally {Addressee, Other}. 2nd person is the predicate ‘includes Addressee’. Applied to this predicate, the {+aug} feature asserts  $\exists x \exists y [\text{INCLUDESAd}(x) \wedge \text{INCLUDESAd}(y) \wedge x \supset y]$ —that, the model must contain two individuals, both containing Addressee, such that one individual contains another. The minimal model {Addressee, Other} can accomplish this, since it contains {Addressee} and {Addressee, Other}, the former contained in the latter. Of course, models with more than one ‘Other’ entity will also satisfy a [+aug] form. The potential referents for, e.g., the [+2, +aug] pronouns, then, will be exactly “Addressee and one or more others”—precisely the denotation necessary for a second person plural form. [+Augmented], then, allows for the expression of plurality without reference to specific cardinality.

Harbour goes on to show that augmentation entails additivity for non-cardinality predicates, and that augmentation and additivity together entail Krifka’s notion of strict cumulativity, and vice versa. Krifka could thus have characterized the event-object homomorphism in terms of [+augmented], rather than [+cumulative].

Acquaviva (2006, 2008) develops a related characterization of the contribution of the Num and Classifier heads within DP, in which Classifier Ns behave like Numberless measure terms, essentially taking the place of the Number head (*pound, liter, inch*, etc.) and are characterized by abnormal number morphology, adducing evidence from the semantic characteristics of nominals with irregular number morphology in the complex number systems of the Goidelic languages.

(See also articles 40 (Büring) *Pronouns* and 78 (Kiparsky & Tonhauser) *Semantics of inflection* for more developed discussion of nominal features and related issues.)

#### 4.5. Interpretation of idioms

The characterization of idiomatic expressions has been a recurrent theme in the Distributed Morphology and related literature (Kratzer 1996; Marantz 1996, 1997, 2001; Richards 2002; Arad 2005, *inter alia*.) As noted above, one issue has concerned the semantic contribution of the Root element, which necessarily has an arbitrary, Encyclopedic interpretation (see Harley 2005 for some discussion of the semantic ontology for Root elements). Recall that while Root elements have Encyclopedia entries, while functional morphemes do not; consequently Roots can be specified for idiomatic interpretation, sometimes restricted to very elaborate interdependent syntactic and semantic contexts, while functional morphemes cannot. Functional morphemes must contribute their standard denotation to any structure which they find themselves in. So, for example, the expression *Put a sock in it!* does not literally instruct the addressee to do anything with a sock. Nonetheless, it is still formally and effectively an imperative, and it does consequently instruct the addressee to do *something*. The semantic contribution of the functional elements in the clause is inescapable.

McGinnis (2002) puts these assumptions together with the results of recent work showing a deterministic relationship between a predicate's event structure and the functional superstructure of the clause, including the definiteness, plurality, etc. of the object or other verbal complement. She argues that, while idiomatic interpretations of particular phrases can vary dramatically from their literal counterparts, they should *not* be able to vary from them in their event structure characteristics. So, for example, the idiom *She was the cat's pyjamas* is stative, as shown by standard tests such as the (in)ability to occur in the progressive (*#She was being the cat's pyjamas*); similarly, the (nonsensical) literal interpretation of the same sentence is also a state. The idiom *Harry jumped through hoops* is an atelic activity predicate, as diagnosed by its ability to co-occur with *for an hour* adverbials; similarly, the literal interpretation of the same sentence is also an atelic activity predicate (with an iterative atelicity contributed by the plural DP *hoops*).

Importantly, roughly synonymous non-idiomatic expressions need *not* have the same Aktionsart properties as their idiomatic synonyms. So, for example, while the phrase *kick the bucket* is commonly glossed as *die*, *die* and *kick the bucket* behave differently with respect to certain event structure tests. The well-formedness of the progressive in *He was dying for weeks*, which exhibits the pre-event focus typical for Achievement predicates in the progressive, is not paralleled in *kick the bucket*: *#He was kicking the bucket for weeks* is impossible, or at best gives the impression that he was dying, coming back to life, and dying again for weeks. That is, *kick the bucket*, in its idiomatic interpretation, behaves exactly like its literal interpretation, a punctual semelfactive predicate which is coerced to an iterative reading in the environment of *for-an-hour* adverbials. McGinnis's observation, then, provides important confirmation of the fundamental DM distinction between the deterministic semantics of functional elements and the Encyclopedic content of Roots. (Glasbey (2003) objects to McGinnis' generalization, adducing a class of putative counterexamples; McGinnis (2005b) responds. See articles 20 (Fellbaum) *Idioms and collocations*, 34 (Maienborn) *Event semantics* and 48 (Filip) *Aspectual class and Aktionsart* for relevant discussion of idiomaticity, event semantics, and Aktionsart.)

#### 4.6. Psycholinguistic semantics, speech errors and Distributed Morphology

Finally, it is worth noting that the DM model has been shown to be isomorphic in many ways to the most broadly adopted psycholinguistic model of speech production. In a study of a large corpus of German speech errors, Pfau (2000, 2009) notes that a key feature of DM—Late Insertion of phonological material—is also a key feature of the two-stage speech production model first proposed in Garrett (1975) and developed further in Levelt (1989) et seq. Further, many DM mechanisms, understood in the context of a model of on-line production, can be useful in capturing certain patterns of behavior.

In the two-stage models, the message to be articulated, once conceptualized, is first syntactically organized, requiring access only to grammatical and semantic information. Only after this process is complete are the phonological exponents of the lemmas retrieved. That is, a two-stage model is essentially a Late Insertion model.

One of the crucial features of such frameworks is their ability to model the intriguing differences between “semantically-motivated” and “phonologically-motivated” speech errors. In semantically-motivated speech errors, an Encyclopedically-related word is

substituted for the intended production (e.g. *magazine* for *newspaper*). The model locates this error in the first, conceptually-driven, stage of lexical access—in DM terms, the point of access of List 1, the syntacticosemantic primitives that are the input to the syntactic derivation. This error consists of extracting a related but incorrect Root element from List 1 for inclusion in the derivation.

Semantically-driven errors occur prior to insertion of phonological material. Consequently, the realization of associated functional morphemes may be adjusted depending on the identity of the incorrect Root, if the morphemes happen to be conditioned by the Roots in their environment. Consider, for example, the speech error reported by Fromkin (1973), *I think it's careful to measure with reason*, an error for the intended production, *I think it's reasonable to measure with care*. In this error, two noun stems in the intended production are correctly selected, but are inserted into each other's places in the syntactic structure. The key thing to note is that this affects the adjective-forming suffix which appears. Rather than produce the result that would obtain from a straight swap—*careable*—the adjective-forming suffix is instead realized as *-ful*. In a non-Late-Insertion model, this would have to be modelled as a deletion and replacement of an already-present *-able* suffix. In DM, however, the adjective-forming morpheme has no phonological content at the point of exchange. When the phonological exponents are inserted at the end of the derivation, everything proceeds normally:  $[[\sqrt{\text{CARE}}]_{\downarrow} \text{adj}]_{\text{aP}}$  triggers insertion of the root 'care', and then the appropriate adjective-forming suffix conditioned by that root, *-ful* (not *-able*).

Pfau illustrates this basic point with a wealth of additional examples from German, showing, for example, that semantically-motivated noun-exchange errors in which the erroneous noun is of a different gender than the intended noun result in accommodation for gender agreement on determiners and adjectives in the DP—exactly as predicted if the derivation proceeds normally in the DM fashion, following the erroneous insertion of the nominal. The syntax will copy the nominal's gender features in agreement operations and consequently spell them out with the appropriate Vocabulary Items at Late Insertion. In a model in which the phonological form of the various feature bundles is present from the beginning, the selection of the erroneous nominal would result in feature clash between the nominal and the intended determiners, adjectives, etc., and an abnormal derivation would result. The production of the accommodated gender agreement would involve either rewriting the items and their features during the course of the derivation, or else a flat-out crash in the derivation; either way, speech errors of this kind would represent a major dysfunction in the production mechanism. With a Late Insertion, two-stage model, however, the whole derivation proceeds smoothly after the initial error is made—a scenario which appears to be much more consistent with the behavioral data.

## 5. Conclusion

For many semantic purposes, the issue of which particular syntactic framework is adopted can seem moot. However, in sincere attempts to determine the semantic contributions of specific morphological formatives, the choice of framework can push an analysis in widely differing directions. If the past tense formative composes with the verb, rather than the verb phrase, while the future tense formative composes with the verb phrase, they will have to have quite different types, for example. I hope to have shown that by adopting a Distributed Morphology view of the morphology/syntax connection, several issues in

semantic analysis can receive insightful analyses, carving the linguistic data at their joints, rather than at word boundaries.

## Acknowledgement

I would like to gratefully acknowledge the helpful suggestions of Paolo Acquaviva, Andrew Koontz-Garboden, Jeff Lidz, Ora Matushansky, Andrew Nevins, Milan Rezac and especially Andrew McIntyre. Any shortcomings in this discussion do not, of course, reflect in any way on them, and remain entirely my fault and responsibility.

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Heidi Harley, Tucson, AZ (USA)



## XVII. The syntax-semantics interface

### 82. Syntax and semantics: An overview

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10. The big picture
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#### Abstract

*Semanticists working in the tradition of Chomsky's GB-theory assume that there is a branching point (SS, more recently Spell-Out) where syntactic structures split into phonetic forms (PFs) and logical forms (LF). LFs are disambiguated structures that have a compositional semantic interpretation, which is introduced in the article. The most important rule for the creation of an LF is Quantifier Raising (QR), which creates  $\lambda$ -abstracts that serve as arguments for a moved phrase. The article illustrates the most important applications of the rule (problem of the object, scope ambiguities, pronoun binding). Compositional semantics is illustrated by the analysis of some non-trivial extensional and intensional constructions. We also discuss the integration of abstract semantic operators into the syntax (question, comparative, tense, negation, plural) and their interaction with morphology. The syntax of an LF is occasionally rather abstract and distant from its correspondent PF. The article contains a brief outlook to other approaches to semantics (type shifting, variable free semantics, dynamic semantics) and asks whether their LFs might be nearer to the surface.*

#### 1. Introduction

Syntax is a device for generating the expressions of language. Semantics is the device that interprets the expressions by assigning them meanings. This article presents the syntax/semantics interface for a generative grammar in the style of the GB-theory and later developments (PPT, MP). It does so in developing syntactic and semantic structures for a range of interesting constructions of English (and occasionally other languages). And it shows how the semantic structures are obtained from the syntactic ones by rules of construal. The semantic structures have a precise interpretation, which is indicated. The constructions considered are in most cases extremely simple and neglect complicated issues that have been discussed in the literature. But they are complicated enough to see what is needed for the syntax/semantics interface. And they give a concrete idea what the rules/

principles of construal might look like. If we looked at other languages, different principles might be needed. I have confined myself to a sort of toy box English, because this is the language that most linguists understand and use for theoretical investigations. The sketch of a theory of interpretation is appropriate for GB-theory and perhaps the Minimalist Program. Later architectures like Phases have not yet been explored by formal semanticists and are therefore ignored in this article. The picture I am drawing is certainly too simple (and occasionally wrong). But it is complicated enough. In particular, it makes an essential use of all sorts of LF-movements. There are theories like variable free categorial or combinatory grammars that try to do everything without movement. I am not seriously discussing these alternatives. They would be the topic for a different article. I have said something about these issues in von Stechow (1991), but the theory has developed since.

## 2. A Fregean conception of syntax/semantics

Most theoreticians doing formal semantics of natural language take the following principles attributed to the German philosopher Gottlob Frege as guiding lines:

1. *Compositionality* (“Frege Principle”): The meaning of complex expression is a function of the meaning of its parts and their syntactic composition.
2. *Context principle*: Make the meaning of words (and parts) so that the sentence meanings come out correctly by compositionality.
3. *Sentence meanings*: The meaning of an unembedded sentence is a truth-value (an *extension*). The meaning of an embedded sentence is a proposition (an *intension*).

The precise spell-out of the principles is under debate. We will see that sentence meanings can be more complicated depending on the range of semantic phenomena to be considered. In some theories, sentence meanings are context change potentials (functions from propositions to propositions), in other theories sentence meanings are (Kaplanian) characters (functions from contexts to propositions) and so on. We will touch upon these issues in the development of the article.

Note that this is a narrow concept of semantics. All pragmatic aspects are ignored such as illocutionary force, implicatures of different kind, social constraints for use and so on. Similarly, presuppositions are not treated, though one might count these as belonging to the domain of semantics proper. Thus semantics is understood as truth-conditional semantics.

Here is a first illustration of Frege’s guide-lines.  
Consider the sentences:

- (1) a. Bill likes Mary.  
b. Mary likes Bill.

The sentences are made of the same material, but they obviously mean something different. Thus it is not enough to know the meanings of the words **Bill**, **likes** and **Mary** to determine the sentence meaning. The computation must take into account the syntactic structure. To calculate the meaning of (1a), we first compute the meaning of the VP **likes Mary** from the meaning of **likes** and **Mary** by an appropriate semantic function/

operation. Then we go on and compute the meaning of the sentence by combining the meaning of the subject **Bill** with that of the VP by means of another (or perhaps the same) semantic operation. The calculation of the meaning of (1b) uses the same semantic operations for the calculation, but the input is different, and therefore it doesn't come as a surprise that the result reached for the sentence might be different. Suppose Bill likes Mary, but she doesn't like him. In that case, the first sentence is true but the second one is false.

The meanings of expressions are conventionally represented by the use of double square brackets  $\llbracket \cdot \rrbracket$ . For the truth-value "true" we use the number 1, for the truth-value "false" we use the number 0. The meaning of the two sentences can then be described as:

- (2) a.  $\llbracket \text{Bill likes Mary} \rrbracket = 1$  iff Bill likes Mary.  
 b.  $\llbracket \text{Mary likes Bill} \rrbracket = 1$  iff Mary likes Bill.

An inspection of the example shows the usefulness of the context principle. We have a clear intuition of what the sentences mean. But what do the words mean? Everyone would say that **Bill** and **Mary** denote particular persons known to the user in the context of use. But what does **likes** denote? We may say "the attitude/state of liking". But this description would give us no idea of how we could combine this meaning first with the object and then with the subject, following the syntax of the sentences, i.e. the structure  $[_S \text{NP} [_{VP} \text{V NP}]]$ . According to the context principle the following function is a useful meaning for **likes**:

- (3)  $\llbracket [_V \text{likes}] \rrbracket =$  that function  $f$  from individuals such that for any individual  $x$ ,  $f(x)$  is that function  $g$  from individuals such that for any individual  $y$ ,  $g(y) = 1$  if  $y$  likes  $x$  and  $g(y) = 0$  if  $y$  doesn't like  $x$ .  
 Short:  $\llbracket [_V \text{likes}] \rrbracket = \lambda x. \lambda y. y \text{ likes } x$

We assume that the meaning of the VP is obtained by applying the meaning of the verb to the meaning of the object via *functional application* (FA). Similarly the meaning of S is computed by combining the meaning of the VP with the meaning of the subject via FA. Here is the calculation of (2b):

$$\begin{aligned}
 \llbracket [_{VP} [_V \text{likes}] [_{NP} \text{Bill}]] \rrbracket &= \llbracket [_{VP} [_V \text{likes}]] \rrbracket (\llbracket [_{NP} \text{Bill}]] \rrbracket) && \text{by FA} \\
 &= [\lambda x. \lambda y. y \text{ likes } x] (\llbracket [_{NP} \text{Bill}]] \rrbracket) && \text{meaning of likes} \\
 &= [\lambda x. \lambda y. y \text{ likes } x] (\text{Bill}) && \text{meaning of Bill} \\
 &= \lambda y. y \text{ likes Bill} && \text{function conversion ("}\lambda\text{-conversion")} \\
 \llbracket [_S [_{NP} \text{Mary}] [_{VP} [_V \text{likes}] [_{NP} \text{Bill}]]] \rrbracket &= \\
 &= \llbracket [_{VP} [_V \text{likes}] [_{NP} \text{Bill}]] \rrbracket (\llbracket [_{NP} \text{Mary}]] \rrbracket) && \text{FA} \\
 &= [\lambda y. y \text{ likes Bill}] (\text{Mary}) && \text{former calculation and lexicon} \\
 &= \text{Mary likes Bill} && \text{FA} \\
 &= 0 && \text{by assumption}
 \end{aligned}$$

An even more dramatic illustration of the context principle would involve functional words like **not**, **or**, **and**, **if...then**, **every**, **some** or modals like **must** or **can**. No rational person would claim that he has a pre-theoretical intuition of their meanings.

Let us illustrate the third principle of Frege's: embedded sentences don't express truth-values but propositions (*senses* in Frege's terminology). It is easy to convince oneself that embedded sentences cannot express truth-values in the general case. Consider the following two examples:

- (4) a. Bill believes that he, Bill, likes Mary.
- b. Bill doesn't believe that Mary likes him.

The complement clauses are synonymous with (1a) and (1b) respectively. Suppose that both sentences are true, i.e., their meaning is 1. Then Bill would be an irrational person because he would believe and not believe the same meaning. But the scenario does not imply any irrationality of the subject. Possible world semantics solves this problem by providing propositions as meanings. The propositions for the complements in question are the sets of worlds  $[\lambda w. \text{Bill likes Mary in } w]$  and  $[\lambda w. \text{Mary likes Bill in } w]$ . The two propositions are different though they are both true in the actual world. So Bill might believe the first and disbelieve the second without being irrational. The semantics has to say, of course, how it is possible that sentences have different meanings in different contexts. The interpretation principle that achieves that will be introduced below. For the beginner the idea that (unembedded) sentences should denote truth-values is puzzling. In order to understand that we have to think of sentences as presenting facts or non-facts of the real world: if a sentence presents a fact, it is true and if it represents a non-fact, it is false.

*A note on the literature.* Frege's Principle is never stated explicitly in the above form by Frege himself. The passage that is mostly quoted is Frege (1923: 23). The Context Principle is stated in Frege (1884). The sense/meaning dichotomy is introduced in Frege (1892). The method of splitting an  $n$ -place function into a sequence of one-place functions is due to Schönfinkel (1924). I write functions in the  $\lambda$ -notation with the conventions of Heim & Kratzer (1998: ch. 3). Metalinguistic sentences such as  $y$  *likes*  $x$  stand for truth-values.

For the varieties of meaning in linguistics, see article 1 (Maienborn, von Heusinger & Portner) *Meaning in linguistics*; for an extensive discussion of Fregean semantics, see article 3 (Textor) *Sense and reference*.

### 3. The syntax/semantics interface in Generative Grammar

#### 3.1. Generative conceptions of grammar

The toy grammar underlying the examples of the last section is so to speak an ideal realisation of Frege's theory of language. The syntax of a language generates trees and each node has a semantic interpretation. The interpretations of the terminal trees are taken from the lexicon. The interpretation of a branching node is obtained by the semantic values of its daughters via functional application (FA). Grammars of this kind exhibit *surface compositionality*: each constituent has exactly one semantic interpretation that is obtained from the meaning of its direct components by an appropriate semantic operation. There are grammars that try to realise this conception, e.g. variable free categorial grammars (see Szabolcsi 1989, Jacobson 1999, Steedman 2000, among others).

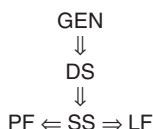
The widely accepted architecture among linguists working in the Chomsky tradition is that of GB-theory and more recent developments building upon it; cf. Chomsky (1981,



1992). In this theory syntax generates structures, which may be called *Syntactic Structures (proper)* (SSs). These structures are transformed into semantic representations called *Logical Forms* (LFs) on the one hand and *Phonetic Forms/Representations* (PFs) on the other hand. The rules that translate SSs into LFs are called *rules of construal*, those that transform SSs into PFs are called *PF-rules*. The LFs are interpreted by semantic operations in the style of the previous sections. Thus the LFs form a language that has a Fregean interpretation. The PFs are the input for phonological rules.

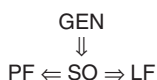
It is important to note that SSs might be quite far away both from PFs and from LFs though for some simple constructions, like the examples discussed, the three structures might coincide. Chomskyan syntax is therefore an abstract system that typically does *not* meet the slogan WYSIWYG (“What you see is what you get”). The article will provide some examples that speak for the soundness of this conception. Here is the organisation of the GB-model:

(5) The GB-model



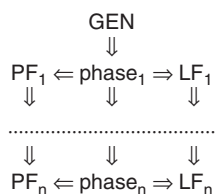
The syntax proper (GEN) generates a *deep structure* (DS), which encodes grammatical functions: everything is in ‘its’ position, i.e. movement hasn’t occurred yet. After application of movement rules (e.g. A-movement as in passives, A-bar-movement as in relative clause or interrogatives, head movement like the movement of the finite verb to COMP in German) we reach the level of *surface structure* (SS). SSs are translated into LFs by rules like *Quantifier Raising* (QR) (see below) and by deletion of uninterpretable material (*Full Interpretation*). They are translated into PFs by rules like cliticization, Focus Interpretation and perhaps others. The model of the Minimalist Program is alike with the difference that DS is eliminated and SS is called *Spell-Out* (SO).

(6) The MP-model



The innovation of the Phase-model (Chomsky 1995) is cyclic branching: there is not only one branching point SS or SO but one at every “phase”, vP or CP, substructures that occur in the recursive generation of a syntactic structure.

(7) The Phase-model



Different architectures of grammar may differ by:

- The type of grammar used for generating syntactic structures (Context-Free Grammars, Categorical Grammars, Tree Adjunction Grammars, Montague-Grammar, Transformational Grammars and many others)
- The type of grammars used for the LF generation (typed languages with abstraction and possibly other syncategorematic rules, categorical grammars with type shifters, context change semantics, DRT and so on)
- The PF rules and phonological rules in general
- The interface organisation

Linguists working in the Chomskyan tradition usually assume that LFs are made of the same material as SSs, i.e. they are trees. An important difference between syntactic trees and semantic trees is that the nodes of the former carry syntactic categories (N, A, P, V, and possibly others) but the latter carry semantic categories, called logical types such as *e*, *t*, *et*, and so on. In what follows I will use the term *surface structure* (SS) and *spell-out* (SO) synonymously. This might be confusing because one might think that surface structure is “what we see”. But recall that we have syntactic rules that operate on the way from SS/SO to PF. The PFs are what we see, and a PF may be very different from its SS/SO and *a fortiori* from its LF.

The heart of the syntax/semantics interface consists of the *rules of construal*, which convert SSs into LFs. The most restrictive interface theory is one that does it without such rules. Syntactic and semantic structures coincide and each node is directly interpreted. Some categorical grammars try to realise this ideal. A less restrictive (but more realistic) framework derives LFs from SSs by rules of construal. The GB-theory assumes that we first generate a complete SS, which we then transform into an LF. The LF is interpreted semantically. A phase model is more restricted. It translates each phase into an LF. These LFs may not undergo any essential change in later steps of the generation. The interpretation should use the meaning of the previous phase plus some syntactic information stemming from the current LF.

### 3.2. Building structures: External and internal merge

In this article we stick to the GB/MP-model. We assume that SS/SOs can be generated by a lexicon, phrase structure rules (nowadays called *External Merge*), and movement rules (called *Internal Merge*). The LFs will be trees with logical types as categories. The language has variables for each type and certain syncategorematic symbols like the  $\lambda$ -operator.

The SOs of a language are generated by the rules External and Internal Merge on the basis of a *lexicon* consisting of *lexical trees*, i.e. words dominated by a *syntactic category* and a *logical type*. We will represent lexical trees by labelled brackets or by terminating context-free phrase structure rules. Phrase structure rules have the advantage that they can be used for writing many trees at once. For instance, the rules (8a) stand for the trees [<sub>Ne</sub> **Bill**] and [<sub>Ne</sub> **Mary**].

- (8) Some lexical entries
- $N_e \rightarrow \text{Bill, Mary}$
  - $N_{et} \rightarrow \text{boy, child, student}$
  - $V_{et} \rightarrow \text{sleeps, snores}$
  - $V_{e(et)} \rightarrow \text{likes, hates}$
  - $Det_{(et)((et)t)} \rightarrow \text{every, a, no}$
  - $A_{et} \rightarrow \text{nice, obnoxious}$

The rule *External Merge* (EM) takes two trees  $\alpha$  and  $\beta$  and combines them to the new tree  $[_X \alpha \beta]$ , where  $X$  is either the syntactic category of  $\alpha$  or that of  $\beta$ . The daughter that projects its category to the new tree is called *head*. Here is a derivation of a SS for the sentence **Bill hates every obnoxious child**. For the time being, we ignore the types for the generation.

- |                                                                                                                                      |         |
|--------------------------------------------------------------------------------------------------------------------------------------|---------|
| 1. $[_A \text{ obnoxious}]$                                                                                                          | Lexicon |
| 2. $[_N \text{ child}]$                                                                                                              | Lexicon |
| 3. $[_N [_A \text{ obnoxious}] [_N \text{ child}]]$                                                                                  | EM(1,2) |
| 4. $[_{Det} \text{ every}]$                                                                                                          | Lexicon |
| 5. $[_{Det} [_{Det} \text{ every}] [_N [_A \text{ obnoxious}] [_N \text{ child}]]]$                                                  | EM(4,3) |
| 6. $[_V \text{ hates}]$                                                                                                              | Lexicon |
| 7. $[_V [_V \text{ hates}] [_{Det} [_{Det} \text{ every}] [_N [_A \text{ obnoxious}] [_N \text{ child}]]]]]$                         | EM(6,5) |
| 8. $[_N \text{ Bill}]$                                                                                                               | Lexicon |
| 9. $[_V [_N \text{ Bill}] [_V [_V \text{ hates}] [_{Det} [_{Det} \text{ every}] [_N [_A \text{ obnoxious}] [_N \text{ child}]]]]]]]$ | EM(8,7) |

Following common practice, we will write  $X'$  for intermediate projections,  $XP$  for complete phrases. A complete  $V$  projection is also written as  $S$ , and a  $V$  with one or two objects is written as  $VP$ . In other words, the last line will also be written as:

- (9)  $[_S [_{NP} \text{ Bill}] [_{VP} [_V \text{ hates}] [_{DP} [_{Det} \text{ every}] [_{NP} [_{AP} \text{ obnoxious}] [_N \text{ child}]]]]]]]$

*Internal Merge* (IM) is used to generate structures that involve movement. Consider, e.g. the complement clause in **Bill wonders who Mary likes**. It has the following structure:

- (10)  $[[[_{NP} \text{ who}]_i [_{C'} C [_S \text{ Mary} [_{VP} \text{ likes } t_i]]]]]$

Suppose we have already generated the structure  $[_{C'} C [_S \text{ Mary} [_{VP} \text{ likes } [_{NP} \text{ who}]]]]$  using the lexicon and **EM**. (The generation involves the lexicon entry  $C$ , i.e. a lexical tree dominating the empty string and the NP **who**.)

- n.  $[_{C'} C [_S \text{ Mary} [_{VP} \text{ likes } [_{NP} \text{ who}]]]]]$  generated via Lexicon and EM

The next step of the generation is this:

- n+1.  $[[[_{NP} \text{ who}]_i [_{C'} C [_S \text{ Mary} [_{VP} \text{ likes } [_{NP} \text{ who}]_i]]]]]$  by Internal Merge

*Internal Merge* takes a subtree from a tree and adjoins it to the tree. As the name indicates, the material adjoined is not taken from outside but from inside of the structure. The

lower copy in the movement chain is called *trace* of the moved constituent, here **who**. The moved constituent is called *antecedent* (of the trace). The Minimalist Program assumes that both constituents **who** are fully present in the structure. The lower is deleted at PF, i.e. not pronounced. Most semanticists assume that the lower copy is empty in the syntax already. Furthermore they assume co-indexing between the higher copy, the antecedent, and the trace. (The latter assumption is not shared by minimalism either, but it is important for the interpretation.) So a more convenient representation of step  $n+1$  for semantic purposes is therefore:

$$n+1. \quad [[_{NP} \textbf{who}]_1 \text{ } [_{C'} C \text{ } [_S \textbf{Mary} [_{VP} \textbf{likes} [_{NP} t_1]]]]]$$

where  $t_1$  is the empty string with an index. Another instance of the movement rule is *head movement*, e.g. the movement of the finite verb to COMP in German matrix clauses. As an instance, consider the sentence:

- (11) **Der Fritz mag jedes Kind**  
the Fritz likes every child

A standard assumption in German syntax is that the sentence is generated by moving **mag** to C and subsequently moving **der Fritz** to [Spec, CP]:

$$\begin{array}{lll} n. & [_{CP} C \text{ } [[\textbf{der Fritz}] \text{ } [[\textbf{jedes Kind}] \text{ } \textbf{mag}]]] & \\ n+1. & [_{CP} [\textbf{mag}_1 C] \text{ } [[\textbf{der Fritz}] \text{ } [[\textbf{jedes Kind}] t_1]]] & \text{IM} \\ n+2. & [_{CP} [\textbf{der Fritz}]_2 \text{ } [_{C'} [\textbf{mag}_1 C] \text{ } [t_2 [[\textbf{jedes Kind}] t_1]]]] & \text{IM} \end{array}$$

It is obvious that the two rules Merge heavily overgenerate. We have to build in constraints that rule out undesirable (“ungrammatical”) structures. This is the real work to be achieved by syntax, which however is not the concern of this article. It is sufficient to have an idea of how syntactic structures of language come into life by simple principles. I should add that the SSs in recent generative syntax are more complicated than the ones assumed in this article. There are many additional functional projections used for case checking and other purposes.

In the next section we will see how this kind of syntax can be combined with semantic interpretation.

*A note on the literature.* The different interface organisations of Generative Grammars are outlined in Chomsky (1981, 1995, 2001). The claim that the following analyses belong to these frameworks is to be taken *cum grano salis*. Many details, even important ones, will differ from current syntactic research. The overall picture of the syntax/semantics interface is however consistent with the architecture of Generative Grammar, I believe. The first clear conception of the syntax/semantics interface is presumably due to R. Montague. Montague said that syntactic rules have meanings. Each syntactic rule is associated with a particular semantic operation (typically FA), which puts the meanings of the arguments of the rule together. This is a direct implementation of the Frege Principle; see Montague (1970a, 1970b, 1970c). We will see that Montague’s conception can be applied in a straightforward way to the Minimalist Program: The standard interpretation of External Merge will be FA, and that of Internal Merge will be FA plus  $\lambda$ -abstraction.

## 4. A $\lambda$ -language and the interpretation of external and internal merge

### 4.1. Logical Form

The majority of semanticists use a typed language for the representation of LFs. The structures of these languages are rather close to SSs and they have a simple and transparent interpretation. A typed language consists of trees whose nodes are labelled with *logical types*. A type represents the type of meaning a node denotes. LF languages may differ in the following way:

1. The types are different. Apart from the basic types *e*, *t* mentioned in the first section we may have types like *s* (world), *i* (time), *l* (place), *v* (event). Accordingly, the complex types might be different from language to language as well.
2. The types may encode different kinds of meaning.
  - a. In an extensional language, types encode extensions unambiguously.
  - b. In an intensional language, types ambiguously encode extensions and intensions.
  - c. In a character language, types ambiguously encode extensions, intensions and characters.
  - d. In a dynamic language, types encode context-change potentials.
  - e. There are typed languages that don't make the distinction between extension and intension at all, e.g. Cresswell's  $\lambda$ -categorical languages.
3. The trees of LF-languages may differ with respect to the types admitted at the branching nodes. Every language admits the splitting of a type into a functor type and an argument type. But other splits are possible depending on the semantic operations available for the interpretation.
4. A language may differ with respect to the syncategorematic rules and symbols they admit. Most LF languages have variables and  $\lambda$ -abstraction.

### 4.2. Syntax and semantics of EL

We start with an extensional  $\lambda$ -categorical language. It is the system used in the first twelve chapters of Heim & Kratzer (1998) [henceforth H&K]. We call this language *EL* ("Extensional Language"). The categories of the language are the following types.

#### (12) The type system for *EL*

The basic types are *e* ("entities") and *t* ("truth-values"). The complex types are generated by the rule: if *a* and *b* are types, then (*ab*) is a type.

Types of form (*ab*) are called *functional types*. We will mostly omit the outermost brackets. There are other notational conventions for functional types: H&K use  $\langle a, b \rangle$ , Montague uses  $b/a$ ,  $b//a$  or  $b///a$ , Kratzer (1977) uses  $b:a$ , and Ajdukiewicz (1935) uses  $\frac{b}{a}$ ; there are still more variants. The basic types are written in different ways as well. Most categorical grammarians follow Ajdukiewicz and write *n* ("name") for *e* and *s* ("sentence") for *t*. Cresswell (1973) uses 1 for *e* and 0 for a propositional type. He writes our functional types

(ab) as  $\langle b, a \rangle$ . So there is no uniformity in the literature and the reader has to be aware of the particular notation used by different authors. Our type system is a simplified version of the H&K-notation.

The *semantic domains* for these types are the following ones.

- (13) a.  $D_e = E$  = the set of individuals  
 b.  $D_t = \{1, 0\}$  = the set of truth-values  
 c.  $D_{ab} = D_b^{D_a}$  = the set of (partial) functions from  $D_a$  into  $D_b$ .

The LF-language EL consists of a *lexicon*, *variables* for any type and the following structures:

- (14) *Syntax of EL*
1. If  $\alpha$  is a lexical tree of type  $a$ ,  $\alpha$  is a tree of type  $a$ . (L)
  2. If  $x$  is a variable and  $a$  is a type, then  $[_a x]$  is a tree of type  $a$ . (Var)
  3. If  $\alpha$  is a tree of type  $ab$  and  $\beta$  is a tree of type  $a$ , then  $[_b \alpha\beta]$  is a tree of type  $b$ . (FA)
  4. If  $\alpha$  and  $\beta$  are trees of type  $et$ , then  $[_{et} \alpha\beta]$  is a tree of type  $et$ . (PM)
  5. If  $\alpha$  is a tree of type  $b$  and  $x$  is a variable of type  $a$ ,  $[_{ab} \lambda x \alpha]$  is a tree of type  $ab$ . ( $\lambda$ )

The syntactic rules have names reminding of their semantic interpretation (L = lexicon, Var = variable rule, FA = functional application, PM = predicate modification,  $\lambda$  =  $\lambda$ -abstraction). H&K use the notation  $[_{ab} x\alpha]$  for our tree  $[_{ab} \lambda x \alpha]$ .

The *lexicon* consists of lexical trees that are labelled with types. We have entries such as  $[_e \textbf{Mary}]$  or  $[_{et} \textbf{snore}]$ . To simplify the notation, we write these as **Mary**<sub>*e*</sub> and **snore**<sub>*et*</sub> respectively. The LF for the sentence **Mary snore** is the following tree:

- (15)  $[_t [_e \textbf{Mary}] [_{et} \textbf{snore}]]$

The interpretation of the language is given by interpreting the lexicon and by stating recursive interpretation principles for the syntactic structures. The lexicon is interpreted by a function  $F$  that maps each word  $\alpha$  of type  $a$  to a meaning in  $D_a$ . Here is the interpretation for some lexical trees.

- (16) Some entries of the *semantic lexicon*
- $F(\textbf{Mary}_e) = \text{Mary}$   
 $F(\textbf{snore}_{et}) = \lambda x. x \in D_e. x \text{ snores.}$   
 $F(\textbf{child}_{et}) = \lambda x. x \in D_e. x \text{ is a child.}$   
 $F(\textbf{hates}_{e(et)}) = \lambda x. x \in D_e. \lambda y. y \in D_e. y \text{ hates } x.$   
 $F(\textbf{obnoxious}_{et}) = \lambda x. x \in D_e. x \text{ is obnoxious.}$   
 $F(\textbf{every}_{(et)((et)t)}) = \lambda P. P \in D_{et}. \lambda Q. Q \in D_{et}. (\forall x)(P(x) \rightarrow Q(x))$   
 $F(\textbf{some}_{(et)((et)t)}) = \lambda P. P \in D_{et}. \lambda Q. Q \in D_{et}. (\exists x)(P(x) \& Q(x))$   
 $F(\textbf{no}_{(et)((et)t)}) = \lambda P. P \in D_{et}. \lambda Q. Q \in D_{et}. (\neg \exists x)(P(x) \& Q(x))$

The semantic meta-language uses obvious abbreviations. In particular, I am using H&K's convention that meta-linguistic sentences stand for the truth-value 1 if they are true, for

the value 0 otherwise. In what follows I will even use a shorter notation and write  $\lambda f_a$  for  $\lambda f.f \in D_a$ .

Given the semantic lexicon, we are in a position to state a recursive interpretation  $\llbracket \cdot \rrbracket$  for the entire language. This function depends on the structure  $M = (E, \{0,1\}, F)$  and a variable assignment  $g$ .  $M$  is called a *model*.

(17) The interpretation  $\llbracket \cdot \rrbracket^{M,g}$  for EL

1. Let  $\alpha$  be a lexical tree of type  $a$ . Then  $\llbracket \alpha \rrbracket^{M,g} = F(\alpha)$ . (L)
2. Let  $x$  be a variable of type  $a$ . Then  $\llbracket x \rrbracket^{M,g} = g(x)$ . (Var)
3. Let  $\gamma$  be a branching tree of type  $b$  with daughters  $\alpha$  of type  $ab$  and  $\beta$  of type  $a$ . Then  $\llbracket \gamma \rrbracket^{M,g} = \llbracket \alpha \rrbracket^{M,g} (\llbracket \beta \rrbracket^{M,g})$ . (FA)
4. Let  $\gamma$  be a branching tree of type  $ab$  with daughters  $\alpha$  and  $\beta$  both of type  $ab$ . Then  $\llbracket \gamma \rrbracket^{M,g} = \lambda x \in D_a. [\llbracket \alpha \rrbracket^{M,g}(x) \ \& \ \llbracket \beta \rrbracket^{M,g}(x)]$ . (PM)
5. Let  $\alpha$  be a tree of type  $ab$  of the form  $[_{ab} \lambda x \beta]$ ,  $x$  a variable of type  $a$  and  $\beta$  a tree of type  $b$ . Then  $\llbracket [_{ab} \lambda x \beta] \rrbracket^{M,g} = \lambda u \in D_a. \llbracket \beta \rrbracket^{M,g[x/u]}(\lambda)$

The most complicated interpretation principle is the abstraction rule  $\lambda$ . We will illustrate it below.  $g[x/u]$  is a variable assignment that is defined like  $g$  with the possible exception that  $g[x/u](x) = u$ . (There are other notations: H&K use  $g[x \rightarrow u]$ , sometimes we find  $g[x \setminus u]$  and so on.) The relativisation of the interpretation function to a model is omitted if the model is self-understood from the context. Similarly, reference to the assignment function  $g$  is ignored if we don't need it. The LF in (15) can now be interpreted along the lines indicated in section 2.

### 4.3. Interpretations of external merge

Here is a first overview of the relation of languages of the EL-type and those of the MP-type. This comparison reveals which kind of interpretation rules (rules of construal) we have to expect.

The rule *External Merge (EM)* combines two expressions  $\alpha + \beta$  to a new expression  $\gamma$ . The following cases may arise.

- (a) One of the two expresses a function and the other expresses an argument of the right type. In this case the Interpretation is Functional Application. This is the case if **Mary** + **snores** combine to a sentence by EM.
- (b) The two expressions are of the same type, say  $et$ . In this case EM is interpreted as Predicate Modification. An example will be the combination of an NP with a relative clause, e.g. **woman** + **that snores**.
- (c) One of the two expressions is semantically empty. In this case, we delete the semantically void expression at LF. An example is the preposition **of** in **the mother of Mary**. **mother** expresses a function of type  $e(et)$ . **Mary** has the type  $e$  and is a good argument. The preposition **of** doesn't add anything to the content and is therefore deleted at LF.
- (d) The two expressions have types that fall neither under (a) nor (b). In this case we need a special interpretation rule. We won't be concerned with such cases in this article. Cases like this are the domain of generalized categorial grammar.



These are the simplest standard interpretations. More fancy interpretation rules are possible and in fact used in categorical grammar. See section 6.2 (“IFA”) and 9.2 (“Geach’s rule”) to get an idea.

#### 4.4. Interpretation of internal merge

The interpretation of *Internal Merge* (IM) will deal with the following cases.

1. A head is moved, e.g. a verb. In this case the meaning of the expression is not affected and the head is *reconstructed* to its base position at LF.
2. An argument expression is moved. If the argument is of the logical type required by the argument position, the moved expression might be reconstructed at LF.
3. The argument position is of type  $e$  and the expression located there is of type  $(et)t$ . In this case, the argument is moved for type reasons. This movement will create a trace of type  $e$  and an abstract of type  $et$ . The interpretation of this kind of movement will be the rule QR (*Quantifier Raising*). QR will typically be a covert movement and apply at the LF branch. QR will play a central rule in this survey.
4. An argument position is occupied by a semantically empty pronoun. This is an expression without meaning and without logical type, often called PRO. This expression is moved at the left periphery and creates a  $\lambda$ -abstract. We will call this kind of movement *PRO-movement*. It can be used to create any kind of  $\lambda$ -abstract. PRO movement plays an important role for the treatment of quantifiers in DPs or PPs. It is also used for question formation and plays a central role for the interpretation of tense and aspect. At LF, PRO is deleted. PRO originates in a case-less position. Semantically empty pronouns that are base-generated at a case position are called WH(-operators). The movement of WH is called WH-movement. A typical instance of WH is the relative pronoun. Semantically, there is no difference between PRO and WH. Both are semantically void.

*A note on the literature.* There are many versions of typed languages. The versions used in linguistics, especially the semantics for  $\lambda$ -abstraction, go perhaps back to different writings of Montague, e.g. Montague (1970c). The tradition of these languages is, however much older and goes back to Frege’s abstraction of the graph of a function, Russell’s type theory and so on. Montague uses an intensional system (see below). An influential extensional system is the Ty2 language by Gallin (1975).

### 5. The two most important rules of construal: FI and QR

This section introduces two important interface principles: the *Principle of Full Interpretation* (FI) and the rule *Quantifier Raising* (QR). We will discuss three tasks performed by QR: (a) resolution of type conflicts, (b) spelling out scope ambiguities of a quantifier, and (c) variable binding.

#### 5.1. Full Interpretation

Let us see first how the LF for **Mary snores** is obtained from the syntax. Recall that lexical trees come from the syntax with both a syntactic category and a logical type. (More

accurately, the lexicon contains for each word a pair of lexical trees  $\langle \alpha, \beta \rangle$ , where  $\alpha$  is for the syntax and  $\beta$  is for the LF.)

(18) SS: [<sub>S</sub> [<sub>N<sub>e</sub></sub> **Mary**] [<sub>V<sub>et</sub></sub> **snores**]]

The syntactic categories S, V and N are not relevant for the LF-language. Therefore we delete them and obtain the intermediate sequence of lexical trees:

[[<sub>e</sub> **Mary**] [<sub>et</sub> **snores**]]

The rule FA tells us that these combine to a tree of type t, i.e., the derived LF is the tree

(19) LF: [<sub>t</sub> [<sub>e</sub> **Mary**] [<sub>et</sub> **snores**]]

The personal ending **-s** is not important for the interpretation and may be deleted as well (but we ignore this possibility). We call the principle that is responsible for the deletion of semantically inert material the *Principle of Full Interpretation* (**FI**). A version of this principle is stated in Chomsky (1986).

(20) **FI**: An LF tree contains only material that is important for the semantic interpretation. (Similarly a PF tree only contains material that is important for phonetic interpretation.)

FI is the first important interface principle.

## 5.2. QR resolves type-clashes

Let us construct next an LF for the SS in (9), here repeated as:

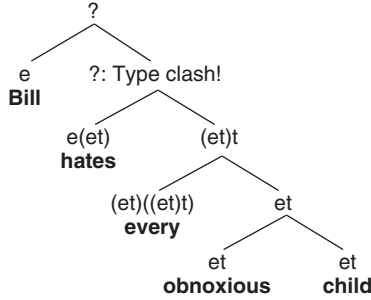
(21) [<sub>S</sub> [<sub>N<sub>P</sub></sub> **Bill**] [<sub>V<sub>P</sub></sub> [<sub>V</sub> **hates**] [<sub>D<sub>P</sub></sub> [<sub>D<sub>et</sub></sub> **every**] [<sub>N<sub>P</sub></sub> [<sub>A<sub>P</sub></sub> **obnoxious**] [<sub>N</sub> **child**]]]]]]]

We assume the following lexical rules for the generation with EM.

(22) Some lexical entries  
 $N_e \rightarrow \mathbf{Bill, Mary}$   
 $N_{et} \rightarrow \mathbf{boy, child, student}$   
 $V_{et} \rightarrow \mathbf{sleeps, snores}$   
 $V_{e(et)} \rightarrow \mathbf{likes, hates}$   
 $Det_{(et)((et)t)} \rightarrow \mathbf{every, a, no}$   
 $A_{et} \rightarrow \mathbf{nice, obnoxious}$

If we proceed according to the principle FI, i.e., we delete the syntactic categories and try to project the logical types according to the rules of the LF-syntax, we get as far as this:

## (23) A type clash



There is no way to assign a type to the VP-node in our system. The daughters of that node can neither be combined by FA nor by PM. This is due to the fact that the object is a *generalised quantifier*, i.e., a function that assigns truth-values to sets of individuals. H&K call this the *problem of the object*. Before we solve this problem, we calculate the meaning of the object because the calculation illustrates the usefulness of the rule PM.

$$\begin{aligned}
 & \llbracket [_{(et)t} \text{ every}_{(et)((et)t)} [_{et} \text{ obnoxious}_{et} \text{ child}_{et} ] ] \rrbracket \\
 &= \llbracket \text{every}_{(et)((et)t)} \rrbracket ( \llbracket [_{et} \text{ obnoxious}_{et} \text{ child}_{et} ] \rrbracket ) && \text{FA} \\
 &= [\lambda P_{et}. \lambda Q_{et}. (\forall x)(P(x) \rightarrow Q(x))] ( \llbracket [_{et} \text{ obnoxious}_{et} \text{ child}_{et} ] \rrbracket ) && \text{L} \\
 &= [\lambda Q_{et}. (\forall x)( \llbracket [_{et} \text{ obnoxious}_{et} \text{ child}_{et} ] \rrbracket (x) \rightarrow Q(x))] && \lambda\text{-conversion} \\
 &= [\lambda Q_{et}. (\forall x)(\lambda y [ \llbracket \text{obnoxious}_{et} \rrbracket (y) \ \& \ \llbracket \text{child}_{et} \rrbracket (y) ](x) \rightarrow Q(x))] && \text{PM} \\
 &= [\lambda Q_{et}. (\forall x)( \llbracket \text{obnoxious}_{et} \rrbracket (x) \ \& \ \llbracket \text{child}_{et} \rrbracket (x) \rightarrow Q(x))] && \lambda\text{-conversion} \\
 &= [\lambda Q_{et}. (\forall x)([\lambda y_e. y \text{ is obnoxious}](x) \ \& \ [\lambda y_e. y \text{ is a child}](x) \rightarrow Q(x))] && \text{L: } 2 \times \\
 &= \lambda Q_{et}. (\forall x)(x \text{ is obnoxious} \ \& \ x \text{ is a child} \rightarrow Q(x)) && \lambda\text{-conversion: } 2 \times
 \end{aligned}$$

This is the correct meaning, viz. the property that is true of a set if every obnoxious child is a member of that set. The derivation illustrates what the rule Predicate Modification (PM) achieves: it is set-theoretical intersection.

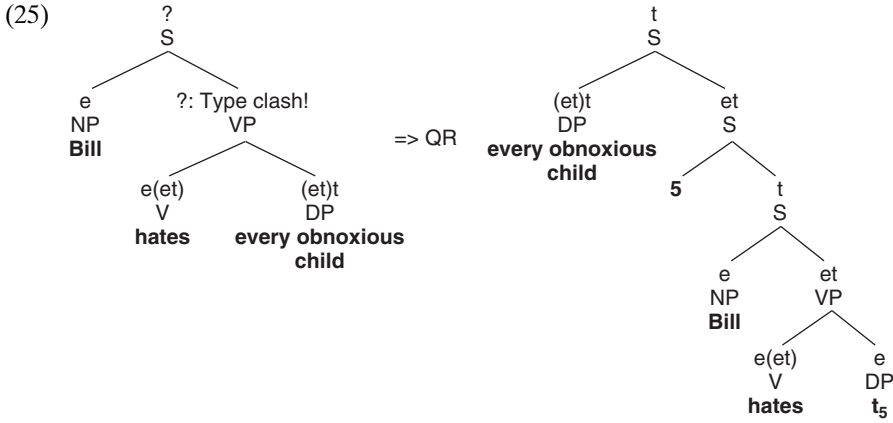
Since we know that there is a compositional interpretation for the object in (23), we can simplify the structure by letting the general quantifier unanalysed, i.e., we assume that we have a lexical entry  $[_{(et)t} \text{ every obnoxious child}]$ , which has the meaning just calculated.

The type clash is resolved by May's rule *Quantifier Raising* (QR); cf. May (1977, 1985), which creates a  $\lambda$ -abstract by movement.

## (24) The rule QR

Move an NP or DP out of an XP and adjoin it to XP. Leave a co-indexed trace. If  $i$  is the index created by the rule, the trace  $t_i$  is interpreted as a variable of type  $e$ , the movement index  $i$ , i.e., the index of the moved NP/DP, is spelled out as  $\lambda i$  at LF.

QR may be regarded as an instance of Internal Merge. We apply the rule before we delete uninterpretable stuff by FI. Here is a picture that illustrates the solution of the problem of the object by means of QR:



We see that the types project according to the syntactic rules of the LF-language. We delete the syntactic categories, interpret the movement index **5** as  $\lambda_5$  and the trace  $t_5$  as a variable of type  $e$ . Thus we derive the LF-tree:

$$(26) \quad [{}_t [{}_{(et)t} \text{every obnoxious child}] [{}_{et} \lambda_5 [{}_t \text{Bill}_e [{}_{et} \text{hates}_{e(et)} t_5]]]]$$

To see how the abstraction rule ( $\lambda$ ) works, let us calculate the meaning of the  $\lambda$ -abstract. Let  $g$  be any variable assignment.

$$\begin{aligned}
 & \llbracket [{}_{et} \lambda_5 [{}_t \text{Bill}_e [{}_{et} \text{hates}_{e(et)} t_5]]] \rrbracket^g \\
 &= \lambda u_e [ \llbracket [{}_t \text{Bill}_e [{}_{et} \text{hates}_{e(et)} t_5]] \rrbracket^{g[t_5/u]} ] \\
 &= \lambda u_e [ \llbracket [{}_{et} \text{hates}_{e(et)} t_5] \rrbracket^{g[t_5/u]} ( \llbracket \text{Bill}_e \rrbracket^{g[t_5/u]} ) ] \\
 &= \lambda u_e [ \llbracket [{}_{et} \text{hates}_{e(et)} t_5] \rrbracket^{g[t_5/u]} (\text{Bill}) ] \\
 &= \lambda u_e [ \llbracket \text{hates}_{e(et)} \rrbracket^{g[t_5/u]} ( \llbracket t_5 \rrbracket^{g[t_5/u]} (\text{Bill}) ) ] \\
 &= \lambda u_e [ \llbracket \text{hates}_{e(et)} \rrbracket^{g[t_5/u]} (g[t_5/u](t_5)) (\text{Bill}) ] \\
 &= \lambda u_e [ \llbracket \text{hates}_{e(et)} \rrbracket^{g[t_5/u]} (u) (\text{Bill}) ] \\
 &= \lambda u_e [ [ \lambda x_e. \lambda y_e. y \text{ hates } x ] (u) (\text{Bill}) ] \\
 &= \lambda u_e [ \text{Bill hates } u ]
 \end{aligned}$$

$\lambda$ -rule: Variable binding!  
 FA  
 L  
 FA  
 Var  
 Def. of  $g[t_5/u](t_5)$   
 L  
 $\lambda$ -conversion:  $2 \times$

The essential step in the computation, i.e. the binding of the variable  $t_5$  is achieved by the  $\lambda$ -rule. The rest of the computation is straightforward.

Now we combine the two immediate constituents of the LF in (26) by means of FA. In other words, we have for an arbitrary assignment  $g$ :

$$\begin{aligned}
 & \llbracket [{}_t [{}_{(et)t} \text{every obnoxious child}] [{}_{et} \lambda_5 [{}_t \text{Bill}_e [{}_{et} \text{hates}_{e(et)} t_5]]] \rrbracket^g \\
 &= \llbracket [{}_{(et)t} \text{every obnoxious child}] \rrbracket^g ( \llbracket [{}_{et} \lambda_5 [{}_t \text{Bill}_e [{}_{et} \text{hates}_{e(et)} t_5]] \rrbracket^g ) \quad \text{FA}
 \end{aligned}$$

We substitute the two meanings computed before and obtain:

$$\begin{aligned}
 &= [ \lambda Q_{et}. (\forall x)(x \text{ is obnoxious} \ \& \ x \text{ is a child} \rightarrow \\
 &\quad Q(x)) ] ( \lambda u_e [ \text{Bill hates } u ] ) \quad \text{previous calculation} \\
 &= (\forall x)(x \text{ is obnoxious} \ \& \ x \text{ is a child} \rightarrow \text{Bill hates } x) \quad \lambda\text{-conversion } 2 \times
 \end{aligned}$$

Thus the rule QR solves the problem of the object. More generally, the rule QR helps to overcome many type clashes arising with DPs that express generalised quantifiers. QR is therefore a further very important interface principle mediating between SS and LF.

### 5.3. QR resolves scope ambiguities

The best-known job done by QR is the spelling out of quantifier scope. Consider Cresswell's (1973) favourite sentence:

(27) Everyone loves someone.

It has two readings:

- (28) a.  $(\forall x)[x \text{ is a person} \rightarrow (\exists y)[y \text{ is a person} \& x \text{ loves } y]]$   
 b.  $(\exists y)[y \text{ is a person} \& (\forall x)[x \text{ is a person} \rightarrow x \text{ loves } y]]$

The two quantifiers involved have the type  $(et)t$ . Therefore the SS exhibits the same type clash as before. We resolve the conflict by QR. QR-ing the object gives us the following structure:

- (29)  $[[_{DP} \text{someone}_{(et)t}]_1 [s [_{DP} \text{everyone}_{(et)t}] [_{VP} [v \text{ loves}_{(e(et))}] t_1]]]$  (from SS by QR)  
 $\Rightarrow$  (FI)  $[_t [\text{someone}_{(et)t}] [_{et} \lambda_1 [_t [\text{everyone}_{(et)t}] [_{et} [\text{loves}_{(e(et))}] t_1]]]]]$

The deletion of the syntactic categories by FI and the projection of the types according to the LF-syntax gives us an LF with the reading in (28b). Note that we did not have to QR the subject because we can apply the subject to the VP.

If, however, we QR the subject in a second step and adjoin it to the entire structure, we obtain an LF that expresses the reading in (28a):

- (30)  $[[_{DP} \text{everyone}_{(et)t}]_2 [[_{DP} \text{someone}_{(et)t}]_1 [s t_2 [_{VP} [v \text{ loves}_{(e(et))}] t_1]]]]]$   
 (from SS by QR:  $2\times$ )  
 $\Rightarrow$  (FI)  $[_t [\text{everyone}_{(et)t}] [_{et} \lambda_2 [_t [\text{someone}_{(et)t}] [_{et} \lambda_1 [_t t_2 [_{et} [\text{loves}_{(e(et))}] t_1]]]]]]]$

The somewhat tedious computation of the meanings of the LFs is left to the reader. We presuppose obvious interpretations for the words **everyone**, **someone** and **loves**.

A note to the terminology *scope*: The scope of a phrase is its c-command domain. A quantifier  $\alpha$  has wide scope with respect to a quantifier  $\beta$  (" $\alpha$  out-scopes  $\beta$ ") if  $\alpha$  c-commands  $\beta$ . At SS, **everyone** has wide scope with respect to **someone**. The LF in (30) preserves the scope relation. But the LF in (29) reverses the relative scope: **someone** out-scopes **everyone**.

### 5.4. QR binds pronouns

To illustrate *pronoun binding* by QR, consider the following sentences with their intended interpretations:

- (31) **Every actor<sub>1</sub> admires himself<sub>1</sub>**  
 $(\forall x)[\text{if } x \text{ is an actor, } x \text{ admires } x]$

- (32) **Every student<sub>1</sub> owns the computer in front of him<sub>1</sub>**  
 $(\forall x)[x \text{ is a student} \rightarrow x \text{ owns the unique } y[y \text{ is a computer} \& y \text{ is in front of } x]]$

The co-indexing represents binding. A notation like this is used in the GB-theory and its followers, but it is not explained there. Let us interpret it. The pronouns **himself<sub>1</sub>** and **him<sub>1</sub>** both represent the variable 1 of type *e* and hence have the same meaning, viz. they denote the individual  $g(1)$ , where  $g$  is the relevant variable assignment. The difference in use come from different binding conditions, to which we will return in due time.

Here is the SS of the first sentence:

- (33) [<sub>S</sub> [<sub>DP(et)</sub> **every actor**]<sub>1</sub> [<sub>VPet</sub> [<sub>Ve(et)</sub> **admires**] [<sub>NPe</sub> **himself<sub>1</sub>**]]]

Up to the VP, there is no type conflict. If we ignored the index of the subject, we could combine the subject with the VP by means of FA. That would yield the wrong reading, viz.  $(\forall x)[x \text{ is an actor} \rightarrow x \text{ admires } g(1)]$ . Suppose  $g(1) = \text{Bill}$ , then the LF would be true if every actor admires Bill. The sentence cannot have this meaning.

Recall H&K's interpretation of movement indices: they are regarded as  $\lambda$ -operators. Let us adopt the convention, that an index is interpreted as a  $\lambda$ -operator if it cannot be a "referential" index of a variable, i.e. a diacritic that distinguishes the variable from others of the same type. The indices of non-pronominals (e.g. quantifiers or names) are interpreted as  $\lambda$ -operators.

Returning to (33) it appears that we haven't gained anything by this move. Suppose, the index 1 of **every actor** were  $\lambda 1$ . Then the  $\lambda$ -abstract  $[_{e(et)}\lambda 1 [_{VPet} [_{Ve(et)} \text{admires}] [_{NPe} \text{himself}_1]]]$  would have the type of a transitive verb. This generates our familiar type clash. So this is not an option. Suppose therefore, we adopt the convention that the index of **every actor** is regarded as a movement index: it tells us that the DP has to be QR-ed and has that index after movement. In other words, the  $\lambda$ -operator is already there, but the DP has not yet been moved. According to this recipe the SS in (33) is transformed into the following structure by QR:

- (34) [[<sub>DP(et)</sub><sub>t</sub> **every actor**]<sub>1</sub> [<sub>S</sub> **t<sub>1</sub>** [<sub>VPet</sub> [<sub>Ve(et)</sub> **admires**] [<sub>NPe</sub> **himself<sub>1</sub>**]]]]]

Applying FI and projecting the types, we obtain the desired LF:

- (35) [[<sub>(et)</sub><sub>t</sub> **every actor**]<sub>[et]</sub>  $\lambda 1$  [<sub>t</sub> **t<sub>1</sub>** [<sub>et</sub> [<sub>e(et)</sub> **admires**] [<sub>e</sub> **himself<sub>1</sub>**]]]]]

The reader may compute for himself that the LF is true if the condition in (31) holds. In particular, he should check that the  $\lambda$ -abstract expresses the property  $[\lambda u_e.u \text{ admires } u]$ . If we apply the meaning of the generalised quantifier expressed by the subject to this, the claim follows immediately.

The SS in (32) is construed along the same lines. The LF is something like this:

- (36) [[<sub>(et)</sub><sub>t</sub> **every student**]<sub>[et]</sub>  $\lambda 1$  [<sub>t</sub> **t<sub>1</sub>** **owns** [<sub>e</sub> **the** [<sub>et</sub> **computer** [<sub>et</sub> **in\_front of him<sub>1</sub>**]]]]]]]

We QR the subject and thereby bind the variable **him<sub>1</sub>**. The rule for the definite article is this:

(37) *The definite article*

**the** has the type  $(e)t$ .  $F(\mathbf{the})(P_{et})$  is only defined if  $P$  is a singleton. If defined,  $F(\mathbf{the})(P) =$  the unique element of  $P$ .

The modifier  $[_{et} \mathbf{in\_front} \text{ of } \mathbf{him}_1]$  is combined with the head noun **computer** by **PM**. I am assuming the preposition **of** is semantically empty and therefore deleted at LF. The semantic lexicon entry of the complex preposition **in\_front** is this:

- (38)  $[_{Pe(et)} \mathbf{in\_front}]$  selects a PP with head *of*. *of* has no type and no meaning. (That's why it doesn't deserve a bold face print.)  
 $F([_{Pe(et)} \mathbf{in\_front}]) = \lambda x_e. \lambda y_e. y$  is in front of  $x$ .

The SS  $[_{Pe(et)} \mathbf{in\_front}] [_{PP} \text{ of } _{NP_e} \mathbf{him}_1]$  is transformed into  $[_{e(et)} \mathbf{in\_front}] [_e \mathbf{him}_1]$  by **FI**. The reader may convince himself that the LF in (36) expresses indeed the truth-condition stated in (32). Again, a full computation is tedious.

QR applies on the way to LF. At SS we have the DPs in argument positions, where they might cause a type conflict. QR solves the type conflict. After the application of QR we delete semantically vacuous material according to FI and project the types according to the rules of the logical syntax.

Summary: In this section we have shown that QR serves three purposes: (a) it solves (certain) type clashes; (b) it spells out scope ambiguities arising with more than one quantifier; (c) it performs pronoun/variable binding. In section 9 we will ask whether we really need the rule QR. The problem of the object can be solved by type-lifted lexical entries. Pronoun binding can be done by special rules of composition. Ambiguities can be resolved by certain type shifting rules. Still, the rule QR is the most transparent method for solving the three problems and all the alternative methods hide the rule somewhere else in the rules of composition.

*A note on the literature.* QR has been introduced into the literature in May (1977). May doesn't give a semantics for the rule, however. The only use he makes of QR is the spell out of quantifier ambiguities. The present semantics has been developed by Irene Heim in lecture notes. Montague has a rule of *Quantifying-in*, which does the same job with a different syntax and precise semantics (cf. the Rule S14<sub>n</sub> in Montague 1970c). The term *Generalised Quantifier* has become popular through Barwise & Cooper (1981). Ajdukiewicz (1935: last page) is presumably the inventor of the Generalised Quantifier. For a detailed discussion of quantifiers, see article 43 (Keenan) *Quantifiers*. For the semantics of definiteness, see article 41 (Heim) *Definiteness and indefiniteness*. The three tasks of QR are addressed in article 62 (Szabolcsi) *Scope and binding*, too.

## 6. Intensionality

### 6.1. Intension and extension

The language EL correctly describes whether a declarative sentence is true or false in our world, but it cannot grasp sentence meanings in general. The reason is very simple: there are only two truth-values but infinitely many sentence meanings. As said in the beginning, sentence meanings must be more complicated entities, at least propositions. Most semanticists are adherents of possible world semantics according to which a sentence expresses

a set of possible worlds (or the characteristic function of such a set). Consider the following sentences:

- (39) a. **Bill believes that Mary is obnoxious.**  
 b. **Bill doesn't believe that Mary snores.**

Suppose both sentences are true. Suppose further that both complement clauses are true. In the language EL the two complement clauses would then have the same meaning and Bill would be an irrational person because he would believe and not believe the same thing at the same time. But the scenario is perfectly possible without Bill being irrational. We have indicated Frege's solution for this problem: in certain embedded contexts a sentence doesn't express a truth-value ("Bedeutung") but a proposition ("Sinn"). Here are the propositions expressed by the two complements:

- (40) a.  $\llbracket \text{Mary is obnoxious} \rrbracket = \lambda w. \text{Mary is obnoxious in } w.$   
 b.  $\llbracket \text{Mary snores} \rrbracket = \lambda w. \text{Mary snores in } w.$

A proposition reconstructs what Wittgenstein called the *truth-condition* of a sentence: We know the meaning of a sentence when we know under which conditions it is true. Think of possible worlds as scenes presented on a TV screen. We want to find out of some person whether he knows the meaning of **Mary snores**. We show him scenes in which Mary snores and others in which she doesn't. The test person has to answer the question: Is the sentence **Mary snores** true in this scene or not? If he gives the correct answer for each scene, we conclude that he has understood the sentence. In fact, the function in (40b) assigns 1 to every scene in which Mary snores and 0 to every scene in which she doesn't. So this notion of proposition is a reasonable approximation to the truth-condition of a sentence.

Sentence meanings like those in (40) are called *intensions*. Not only sentences have intensions but also every expression of the language has one, be it basic or complex. The language IL is designed to reconstruct that idea. The name IL reminds of Montague's *Intensional Logic*; cf. Montague (1970a, 1970c, 1973). The system used here has, however, a slightly different syntax from Montague's IL. It is the system sketched in chapter 12 of H&K. For a systematic discussion of intensional semantics and related issues, see article 33 (Zimmermann) *Model-theoretic semantics*.

## 6.2. Syntax and semantics of IL

The initially rather confusing feature of the language IL is that the types are largely as before but they encode something different, namely *intensions*. For instance the meaning of **snores<sub>et</sub>** will be the intension  $[\lambda w \in W. \lambda x. x \text{ snores in } w]$ , where  $W$  is the set of *possible worlds*. Only when we apply the verb meaning to a particular world  $w$ , we obtain an *extension*, viz. the set  $[\lambda x. x \text{ snores in } w]$ . I will say something more about this in a moment. Let us introduce the syntax first.

The type system for the language is slightly richer. There are the types of EL plus a new type  $s$  ("sense") that can be prefixed to any EL-type producing an IL-type. The type grammar is therefore this:



(41) The type system for IL

The basic types are  $e$  and  $t$ . The complex types are generated by two rules:

- (a) If  $a$  and  $b$  are types, then  $(ab)$  is a type.
- (b) If  $a$  is a type,  $(sa)$  is a type.

The system of semantic domains belonging to IL is the following one:

(42) a.  $D_e = E$  = the set of individuals

b.  $D_{(ab)} = D_b^{D_a}$

c.  $D_{(sa)} = D_a^W$ , where  $W$  is the set of possible worlds.

The functions in  $D_{sa}$  are called *a-intensions*. If  $f$  is an *a-intension* and  $w$  is a possible world,  $f(w)$  is the *extension of  $f$  in  $w$* .

The syntax of IL is more or less the same as that of EL. The only innovation is the rule IFA, which is due to H&K.

(43) *The syntax of IL*

consists of the same rules as the syntax of EL with the addition of the following rule:

If  $\alpha$  is an IL-tree of type  $(sa)b$  and  $\beta$  is an IL-tree of type  $a$ , then  $[_b \alpha \beta]$  is an IL-tree of type  $b$ . (IFA)

The rule is called *Intensional Functional Application*.

The interpretation of IL depends on a semantic lexicon, i.e. a function  $F$  that interprets the lexical trees.

At this step we have to be aware of the main characteristics of IL: *the meanings of expressions of type  $a$  are  $a$ -intensions*. In other words, if  $\alpha$  is of type  $a$ , then  $\llbracket \alpha \rrbracket$  will not be in  $D_a$  but in  $D_{sa}$ . Here are some entries of our EL-lexicon in (16) adapted to this IL-requirement. (Instead of “ $\lambda w \in W$ ” I will write “ $\lambda w$ ”.)

(44) Some entries of the semantic lexicon

$F(\mathbf{Mary}_e) = \lambda w. \text{Mary}$

$F(\mathbf{snore}_{et}) = \lambda w. \lambda x_e. x \text{ snores in } w.$

$F(\mathbf{child}_{et}) = \lambda w. \lambda x_e. x \text{ is a child in } w.$

$F(\mathbf{hates}_{e(et)}) = \lambda w. \lambda x_e. \lambda y_e. y \text{ hates } x \text{ in } w.$

$F(\mathbf{obnoxious}_{et}) = \lambda w. \lambda x_e. x \text{ is obnoxious in } w.$

$F(\mathbf{every}_{(et)((et)t)}) = \lambda w. \lambda P_{et}. \lambda Q_{et}. (\forall x)(P(x) \rightarrow Q(x))$

In order to be able to interpret the sentences in (39), we add the entries for **not** and **believes**.

(45)  $F(\mathbf{not}_{tt}) = \lambda w. \lambda x_t. x = 0.$

$F(\mathbf{believes}_{(st)(et)}) = \lambda w. \lambda p_{st}. \lambda x_e. x \text{ believes } p \text{ in } w.$

The interpretation for **believes** looks rather trivial because it does not analyse what it means to believe something. Following Hintikka (1969), the standard analysis for **believe** is that of a verbal quantifier: “ $x$  believes  $p$  in world  $w$ ” is true if  $p$  is true in every world  $w'$

compatible with what  $x$  believes in  $w$ . For our purposes this analysis is not relevant. The important point is that the object of **believe** has to be a proposition and not a truth-value. If we look at the types of our lexical entries we see that the entry of **believes** is the only one that has an intensional type as an argument. Functors with such a type are called *intensional*. Functors that only have extensional types as arguments are *extensional*. The intensions expressed by extensional functors are constant functions.

Given the semantic lexicon, we are in a position to state a recursive interpretation  $\llbracket \cdot \rrbracket$  for the language IL. This function depends on the model  $M = (E, \{0,1\}, W, F)$  and a variable assignment  $g$ .

(46) The interpretation  $\llbracket \cdot \rrbracket^{M,g}$  for IL

1. Let  $\alpha$  be a lexical tree of type  $a$ . Then  $\llbracket \alpha \rrbracket^{M,g} = F(\alpha)$ . (L)
2. Let  $x$  be a variable of type  $a$ . Then  $\llbracket x \rrbracket^{M,g} = \lambda w.g(x)$ . (Var)
3. Let  $\gamma$  be a branching tree of type  $b$  with daughters  $\alpha$  of type  $ab$  and  $\beta$  of type  $a$ . Then  $\llbracket \gamma \rrbracket^{M,g} = \lambda w[\llbracket \alpha \rrbracket^{M,g}(w)(\llbracket \beta \rrbracket^{M,g}(w))]$ . (FA)
4. Let  $\gamma$  be a branching tree of type  $b$  with daughters  $\alpha$  of type  $(sa)b$  and  $\beta$  of type  $a$ . Then  $\llbracket \gamma \rrbracket^{M,g} = \lambda w[\llbracket \alpha \rrbracket^{M,g}(w)(\llbracket \beta \rrbracket^{M,g})]$ . (IFA)
5. Let  $\gamma$  be a branching tree of type  $at$  with daughters  $\alpha$  and  $\beta$  both of type  $at$ . Then  $\llbracket \gamma \rrbracket^{M,g} = \lambda w.\lambda x_a. [\llbracket \alpha \rrbracket^{M,g}(w)(x) \ \& \ \llbracket \beta \rrbracket^{M,g}(w)(x)]$ . (PM)
6. Let  $\alpha$  be a tree of type  $ab$  of the form  $[\lambda_{ab} \lambda x \beta]$ ,  $x$  a variable of type  $a$  and  $\beta$  a tree of type  $b$ . Then  $\llbracket [\lambda_{ab} \lambda x \beta] \rrbracket^{M,g} = \lambda w.\lambda u \in D_a. \llbracket \beta \rrbracket^{M,g[\lambda^u]}(w)$  ( $\lambda$ )

### 6.3. Complement clauses: IFA or FA + $\wedge$

There are two methods to compose a complement clause with the embedding verb: either we need H&K's new rule IFA or we insert a covert operator in front of the complement, viz. Montague's operator  $\wedge$ . In the latter case we can work with FA.  $\wedge$  is a type shifter. It shifts any type  $a$  to the type  $sa$ . This is the first example that we have to insert covert operators in the syntax for reasons of interpretation, or we have to enrich the semantic composition rules. We will be faced with this alternative many more times.

We are now in a position to analyse the sentences in (39). The SS of (39a) is this:

(47)  $[_S \text{Bill}_e [\text{believes}_{(st)(et)} [_{CP} \text{that } [_S \text{Mary}_e [_{VP} \text{is } [_{AP} \text{obnoxious}_{et}]]]]]]$

I am assuming that “that” and “is” are semantically empty and hence deleted by **FI**. After type projection we obtain the following IL-tree:

(48)  $[_t \text{Bill}_e [_{et} \text{believes}_{(st)(et)} [_t \text{Mary}_e [_{et} \text{obnoxious}_{et}]]]]$

At first sight it looks as if we had a type clash between the types of the daughters of the matrix VP-node, because its daughters are of type  $(st)(et)$  and  $t$  respectively. These cannot be put together by the rule FA, but the rule IFA takes care of them. Let us see how this works. I leave it to the reader to convince herself that  $[_t \text{Mary}_e [_{et} \text{obnoxious}_{et}]]$  expresses indeed the proposition in (40a), i.e. we assume:

$\llbracket [_t \text{Mary}_e [_{et} \text{obnoxious}_{et}]] \rrbracket = \lambda w'. \text{Mary is obnoxious in } w'.$

We calculate the meaning of the matrix VP:

$$\begin{aligned}
 & \llbracket [_{\text{et}} \text{believes}_{(\text{st})(\text{et})} [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]] \rrbracket \\
 &= \lambda w [\llbracket \text{believes}_{(\text{st})(\text{et})} \rrbracket (w) (\lambda w'. \text{Mary is obnoxious in } w')] \quad (\text{IFA}) \text{ and assumption} \\
 &= \lambda w [\lambda w. \lambda p_{\text{st}}. \lambda x_e. x \text{ believes } p \text{ in } w] (w) (\lambda w'. \text{Mary is obnoxious in } w') \quad (\text{L}) \\
 &= \lambda w [\lambda x_e. x \text{ believes } [\lambda w'. \text{Mary is obnoxious in } w'] \text{ in } w] \quad \lambda\text{-conversion: } 2\times
 \end{aligned}$$

Next we calculate the meaning of the entire sentence:

$$\begin{aligned}
 & \llbracket [_{\text{t}} \text{Bill}_e [_{\text{et}} \text{believes}_{(\text{st})(\text{et})} [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]]] \rrbracket \\
 &= \lambda w [\llbracket [_{\text{et}} \text{believes}_{(\text{st})(\text{et})} [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]] \rrbracket (w) (\llbracket \text{Bill}_e \rrbracket (w))] \quad (\text{FA}) \\
 &= \lambda w [\lambda w [\lambda x_e. x \text{ believes } [\lambda w'. \text{Mary is obnoxious in } w'] \text{ in } w] (w) (\lambda w. \text{Bill}(w))] \\
 & \quad (\text{L, FA, previous calculation}) \\
 &= \lambda w [\lambda x_e. x \text{ believes } [\lambda w'. \text{Mary is obnoxious in } w'] \text{ in } w] (\text{Bill}) \quad \lambda\text{-conversion: } 2\times \\
 &= \lambda w [\text{Bill believes } [\lambda w'. \text{Mary is obnoxious in } w'] \text{ in } w] \quad \lambda\text{-conversion}
 \end{aligned}$$

It is revealing to compare the rule IFA with Richard Montague's method to deal with intensional operators. Montague's IL contains a logical operator  $\wedge$ , which may be called *up-operator*. It converts an expression of type  $a$  into one of type  $sa$ . Here is the syntax and semantics.

(49) *Montague's  $\wedge$ -operator*

If  $[_a \alpha]$  is a tree of type  $a$ , then  $[_{sa} \wedge [_a \alpha]]$  is a tree of type  $sa$ .

$$\llbracket [_{sa} \wedge [_a \alpha]] \rrbracket^{M,g} = \lambda w [\lambda w' [\llbracket [_a \alpha] \rrbracket^{M,g}(w')] = \lambda w. \llbracket [_a \alpha] \rrbracket^{M,g}]$$

Thus the intension of  $\wedge \alpha$  is a function that assigns to any world  $w$  the intension of  $\alpha$ . In other words, the extension of  $\wedge \alpha$  in world  $w$  is the intension of  $\alpha$ . Montague assumes that *that*-clauses are translated into IL-trees prefixed with  $\wedge$ . If we do that, we don't need the rule IFA, FA suffices. Let us see how this works. Let us assume that the LF of (39a) is not (48) but the following tree instead:

(50)  $[_{\text{t}} \text{Bill}_e [_{\text{et}} \text{believes}_{(\text{st})(\text{et})} [_{\text{st}} \wedge [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]]]]$

The matrix VP doesn't exhibit a type conflict, and we can use FA for the evaluation. The reader may compute for herself that the complement now expresses the following intension:

(51)  $\llbracket [_{\text{st}} \wedge [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]] \rrbracket = \lambda w [\lambda w'. \text{Mary is obnoxious in } w']$

Note that this is *not* the proposition that Mary is obnoxious. It is the intension that assigns any world the proposition that Mary is obnoxious. This is the correct meaning for the computation of the VP-meaning via FA. The reader may check that the following evaluation is true:

$$\begin{aligned}
 & \llbracket [_{\text{et}} \text{believes}_{(\text{st})(\text{et})} [_{\text{st}} \wedge [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]]] \rrbracket \\
 &= \lambda w [\llbracket \text{believes}_{(\text{st})(\text{et})} \rrbracket (w) (\llbracket [_{\text{st}} \wedge [_{\text{t}} \text{Mary}_e [_{\text{et}} \text{obnoxious}_{\text{et}}]]] \rrbracket (w))] \quad \text{FA} \\
 &= \lambda w [\lambda x_e. x \text{ believes } [\lambda w'. \text{Mary is obnoxious in } w'] \text{ in } w]
 \end{aligned}$$

This is the same intension we had computed using the H&K strategy, i.e. IFA and no  $\wedge$ -operator. The answer is that both methods are equivalent. We may regard the  $\wedge$ -operator as a logical operation that helps to eliminate the type conflict between an operator of type  $(sa)b$  and an argument of type  $a$ . We prefix the argument with  $\wedge$  and the conflict is solved. H&K's IFA put the information that the functor does not apply to the extension of the argument but to the intension into the composition rule. The lesson to be drawn from this is that type conflicts do not exist as such. Whether the types of the daughters of a branching node are in conflict or not is a matter of the composition rules that determine the interpretation of the language. Montague's system doesn't have IFA, but it has the  $\wedge$ -operator instead. In what follows, we will stick to H&K's rule IFA.

Here is the summary of this section. The meaning of complement clauses cannot be truth-values. They must be something more fine-grained, viz. propositions. This motivates the notion of intensions as functions from worlds to extensions. The expressions of intensional languages denote intensions. We obtain an extension if the expression is evaluated at some world. We have two methods to treat intensional functors. The first is the introduction of an additional interpretation of EM, viz. IFA. The second method is the insertion of a covert type shifter, Montague's  $\wedge$ -operator. Both methods do the same work. I know of no empirical argument that favours one method over the other.

## 6.4. Modality

The section makes the following points. We motivate the need of *Reconstruction*: a DP is interpreted at the position of its trace. Modals are raising verbs: the subject of a VP embedded under a modal is raised at SS to the subject position of the modal. If the subject is a generalised quantifier and it is interpreted at its SS-position, we obtain the so-called *de re* interpretation. But modal constructions have a second reading, the so-called *de dicto* interpretation. We obtain it, if we interpret the quantifier in the position of its trace.

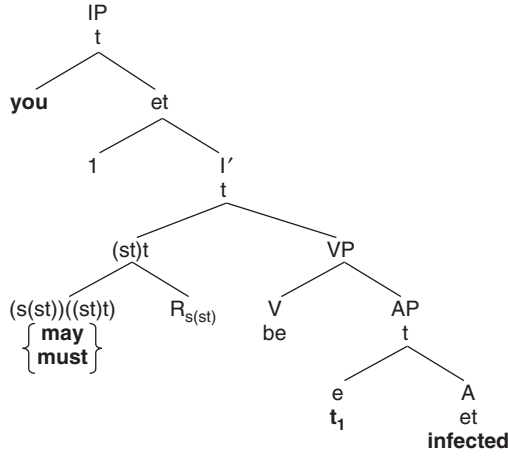
The second point concerns the status of the world parameter. An intensional interpretation depends on the world of evaluation. World variables do not appear in the syntax, they are implicit parameters. But quantifiers in modal constructions do not only have *de re* and *de dicto* readings. For indefinites we have a third reading, the so-called *non-specific de re* reading. This reading cannot be expressed in an intensional framework but requires world variables in the syntax. World variables are pronouns that are never pronounced.

### 6.4.1. de re/de dicto

Modals are quantifiers over possible worlds that are restricted by a contextually given set of worlds called *conversational background* (Kratzer) or *accessibility relation* (Kripke). They are raising verbs. If the subject of the modified VP ("the prejacent") is a quantifier, we observe the so-called *de re/de dicto* ambiguity. The latter reading requires *reconstruction* of the quantifier on the way from SS to LF. *Reconstruction* therefore is a rule of construal.

Here is a modalised sentence with its SS and LF:

(52) You may/must be infected.



The meanings of the two modals are these:

- (53) a. Possibility:  $F(\mathbf{may}) = \lambda w. \lambda R_{s(st)}. \lambda p_{st}. (\exists w') [R(w)(w') \ \& \ p(w')]$   
 b. Necessity:  $F(\mathbf{must}) = \lambda w. \lambda R_{s(st)}. \lambda p_{st}. (\forall w') [R(w)(w') \rightarrow p(w')]$

I am assuming that the subject originates as the subject of the adjective (or participle) **infected**. It is raised to [Spec, IP] by IM ("A-movement"). The interpretation of this movement is the same as that of **QR**. **FI** makes these structures fully interpretable. (We have to use **IFA** when we apply the modal to the prejacent.) With respect to a variable assignment *g*, the two LFs mean:

- (54) a.  $\lambda w. (\exists w') [g(R)(w)(w') \ \& \ \text{you are infected in } w']$   
 b.  $\lambda w. (\forall w') [g(R)(w)(w') \rightarrow \text{you are infected in } w']$

Think of *g(R)* as the function that assigns to each world *w* the symptoms you have in *w* plus the proposition that you are infected if you have symptom *x* and you are infected or drunk if you have symptom *y*. Consider a world *w*<sub>1</sub> in which you have symptom *x*. In this world both propositions are true. Next consider a world *w*<sub>2</sub> in which you have symptom *y*. In this world the proposition in (54a) is true but that in (54b) is false.

Next consider a sentence with a quantifier in subject position. It has the two readings indicated in (55a) and (b).

- (55) Everyone may be infected.  
 a.  $\lambda w. (\forall x) [x \text{ is a person in } w \rightarrow (\exists w') [g(R)(w)(w') \ \& \ x \text{ is infected in } w']]$   
 b.  $\lambda w. (\exists w') [g(R)(w)(w') \ \& \ (\forall x) [x \text{ is a person in } w' \rightarrow x \text{ is infected in } w']]$

The first reading is called *de re*: the quantifier ranges over persons in the evaluation world, the "actual" world. The second reading is called *de dicto*: the quantifier speaks about persons in the accessible worlds.

We obtain the *de re* reading immediately from the surface by **FI**:

(56) [**everyone** [ $\lambda_1$  [[**may**  $R_{s(st)}$ ] [ $t_1$  **infected**]]]]

To obtain the *de dicto* reading, two methods are available for this example: (a) We could abstract over a variable of type  $(et)t$ . Then the quantifier would be *semantically reconstructed* by  $\lambda$ -conversion. (b) We move the quantifier to the position of its trace (*syntactic reconstruction* (**Rec**)). Here is the derivation of a reconstructed LF:

- (57) a. [**everyone** [ $\lambda_1$  [[**may**  $R_{s(st)}$ ] [ $t_1$  **infected**]]]]  
 b.  $\Rightarrow$  (Rec) [[**may**  $R_{s(st)}$ ] [**everyone** **infected**]]

In Chomsky's MP, Rec is a rather natural process. Recall that the SS/SO obtained by Internal Merge has not exactly the form in (57a) but rather the following one:

(58) [**everyone**<sub>1</sub> [[**may**  $R_{s(st)}$ ] be [**everyone**<sub>1</sub> **infected**]]]]

FI says that we have to delete uninterpretable stuff. One way of doing that is to delete the copy in base position leaving the index, which is interpreted as a variable. This gives us (57a). The other possibility is to delete the moved DP with its index. The index at the copy in base position doesn't make sense semantically anymore, and it is therefore deleted. This gives us the *de dicto* LF in (57b).

6.4.2. Non-specific *de re*

There is a reading in modal constructions that cannot be obtained by means of the methods outlined. Consider the following sentence:

## (59) A friend of mine must win.

The scenario is this: My three friends Anna, Bertha and Cecile participate in a competition and I want one of them to win no matter which one, I like them with equal love. If I give the DP **a friend of mine** wide scope with respect to the modal, I have a wish about a particular friend. This is not the case. If I give it narrow scope, I seem to refer to the friends in the bouletic accessible worlds. There my friends might be very different from those in the actual world. The reading in question has been discovered by Fodor (1970), who gives the example "Mary wanted to buy a hat just like mine", and has been called *non-specific de re*. Von Stechow & Heim (2000: ch. 6.1) point out that the reading is best analysed by assuming a world pronoun **w-pro** as an argument of **a friend of mine**. **w-pro** has to be bound by stipulation. In other words, we must be able to refer to the hitherto implicit world argument in the syntax, i.e., we replace our intensional language by a purely extensional one. By convention we assume that the world argument is the first argument of a predicate. In order to form a proposition, von Stechow & Heim assume that these are formed by PRO-movement. The authors assume a **W-PRO** is generated at an s-position, where s is the type of worlds. **W-PRO** (but not **w-pro**!) is semantically empty and must be moved for type reasons generating a  $\lambda$ -operator. Here are some analyses:

- (60) SS: [<sub>t</sub> a friend of mine w-pro<sub>1</sub> [<sub>et</sub> wins W-PRO]]  
 $\Rightarrow$  PRO-movement (**QR**)

LF: W-PRO  $\lambda_1[t_1]$  **a friend of mine w-pro<sub>1</sub>** [<sub>et</sub> **wins**  $t_1$ ]]  
 =  $\lambda w.(\exists x)[x \text{ is a friend of mine in } w \ \& \ x \text{ wins in } w]$

The representation of the *de dicto* reading is this:

(61) W-PRO  $\lambda_2$  **must**( $t_2$ )(R) W-PRO  $\lambda_1[t_1]$  **a friend of mine w-pro<sub>1</sub>** [<sub>et</sub> **win**  $t_1$ ]]

Here, **w-pro<sub>1</sub>** is bound by  $\lambda_1$  (and therefore indirectly by the modal). The *de re* reading is generated by giving the indefinite term wide scope with respect to the modal:

(62) W-PRO  $\lambda_2$  **a friend of mine w-pro<sub>2</sub>**  $\lambda_3$  **must**( $t_2$ )(R) W-PRO  $\lambda_1[t_1]$   $t_3$  [<sub>et</sub> **win**  $t_1$ ]]

This time the **w-pro** of the indefinite is bound by the matrix **W-PRO** and hence will refer to the actual world, if the proposition is applied to it.

We now see what the method buys: we can represent Fodor's *non-specific de re* reading by leaving the indefinite in the scope of the modal but binding its **w-pro** by the matrix **W-PRO**:

(63) The non-specific *de re* reading  
 W-PRO  $\lambda_2$  **must**( $t_2$ )(R) W-PRO  $\lambda_1[t_1]$  **a friend of mine w-pro<sub>2</sub>** [<sub>et</sub> **win**  $t_1$ ]]

Note that our lexical entries haven't changed, but the types have changed. The first argument of a predicate will always be a world. For instance, the rule for **wins** will be

(64)  $F(\mathbf{wins}_{s(et)}) = \lambda w.\lambda x.x \text{ wins in } w.$

Fodor's observation shows that something like this is the correct approach and the switch to an extensional language with world arguments is ultimately mandatory. We will however stick to our intensional language IL because most semanticists assume something like this.

*A note on the literature.* The key idea for intensional semantics is that the meaning of a sentence can be identified with its truth-condition; it is due to Wittgenstein (1922/1984: 4.024). Cresswell (1991) takes difference in truth-conditions as the most certain principle for the non-identity of meaning. The semantics for modality was invented by Kripke (1959). The unification of Kripke's semantics for an application to natural language is due to different publications by A. Kratzer, e.g. Kratzer (1977, 1978, 1981). The intension/extension dichotomy is due to the Frege tradition in the philosophy of language. Important systems that do it with a unified system of meanings (basically intensions without extensions) are Lewis (1972) and Cresswell (1973). The detailed development of intensional logical languages and their application to the semantic interpretation is due to the work of Richard Montague; the milestones for the syntax/semantics interface are Montague (1970b, 1970a, 1973). The need for reconstruction in modal constructions is presumably first addressed in May (1985). The examples of section 6.4.2 are taken from von Stechow & Heim (2000). The theory of **w-pro/W-PRO** is due to these authors. Evidence that something like this is necessary is much older; see e.g. Heim (1991). The typed language needed for the implementation of the theory is Gallin's ty2-language; cf. Gallin

(1975). For a more extensive discussion of modality, see article 58 (Hacquard) *Modality*.

## 7. The interpretation of traces

Chomskyan Generative Grammar assumes the existence of traces, which are generated by movement. Ignoring reconstruction and complications stemming from the copy theory of movement, the simplest assumption is that all DP-traces are  $\lambda$ -bound variables. Recall that QR leaves a co-indexed trace and interprets the movement index as a  $\lambda$ -operator. Here we review different kinds of DP-movement and what they mean for the organization of the syntax/semantics interface. Another trace is generated by the semantically empty pronoun PRO that must be moved for type reasons, thereby creating a  $\lambda$ -abstract.

### 7.1. A-movement

Here are two typical raising constructions in the GB-style; see Chomsky (1981):

- (65) a. John<sub>1</sub> AGR [was arrested t<sub>1</sub>]  
           +Case        -Case  
       b. John<sub>1</sub> AGR [may [t<sub>1</sub> win]]  
           +Case        -Case

These traces are what Chomsky calls NP-traces (or anaphors) and the movement that generates the trace is called A-Movement (movement to an argument position). The verb meaning is generated by a passive operator, which applies to the participle. A passivized verb doesn't assign a case to its argument in the GB-theory. Therefore the DP **John** has to be moved to a case position, viz. the subject position of the finite sentence. Assuming that A-movement is interpreted like QR, the LFs of the two constructions are these:

- (66) a. **John**  $\lambda_1$  **was\_arrested** t<sub>1</sub>  
       b. **John**  $\lambda_1$  **may** t<sub>1</sub> **win**

In these cases, Raising is semantically inert because names are semantically scope-less. In other words, we can reconstruct the subject to its D-position and obtain the same interpretation. But when the subject is a quantifier, A-movement may affect the interpretation.

Suppose **was\_arrested** means  $\lambda w.\lambda x.(\exists y)[\text{person}(y) \ \& \ \text{arrest}(y,x,w)]$ , where tense is ignored. Consider the following constructions:

- (67) a. Everyone<sub>1</sub> AGR [was arrested t<sub>1</sub>]  
           +Case        -Case  
       b. Everyone<sub>1</sub> AGR [may [t<sub>1</sub> win]]  
           +Case        -Case

The LF for (67a) is the following:



- (68) **everyone**  $\lambda_1$  **was\_arrested**( $t_1$ )  
 $= \lambda w (\forall x)[\text{person}(x, w) \rightarrow (\exists y)[\text{arrest}(y, x, w)]]$

Since **was-arrested** is of type et, the quantifier cannot be interpreted at the position of its trace; it has wide scope with respect to the invisible logical subject of the passivized verb, viz. “someone”.

On the other hand, (67b) can have two LFs because the subject can be interpreted at the position of its trace:

- (69) a. **everyone**  $\lambda_1$  **may<sub>R</sub>** **t<sub>1</sub>** **win**  
 $= \lambda w. (\forall x)[\text{person}(x, w) \rightarrow (\exists w')[wRw' \ \& \ \text{win}(x, w')]]$   
 b. **may<sub>R</sub>** **everyone** **win**  
 $\lambda w. (\exists w')[wRw' \ \& \ (\forall x)[\text{person}(x, w') \rightarrow \text{win}(x, w')]]$

So in this case, a morpho-syntactically motivated movement has an impact on possible interpretations.

Since case checking is a morphological thing, A-movement must be done at SS and not at the LF-branch. This is an important difference with respect to applications of QR motivated for type reasons, for disambiguation or for variable binding. In these cases there is no morphological motivation for movement and the movement is done on the LF-branch. This is the reason why QR may be covert. Raising may be regarded as overt QR. As we have seen, Raising doesn't exclude Reconstruction, where the latter is done on the LF-branch and is therefore covert.

## 7.2. A-bar movement

In this section we consider the interpretation of relative pronouns. There is a long tradition among semanticists to interpret moved relative pronouns as  $\lambda$ -operators that bind a variable in the base position of the pronoun. English relative pronouns are either overt (*who*, *whose*, *whom*) or covert, i.e. unpronounced, represented as WH.

- (70) a. Bill is a boy  $\text{who(m)}_4$  C Mary likes  $t_4$   
 b. Bill is a boy  $\text{WH}_4$  that Mary likes  $t_4$

Relative pronouns occur in an argument position, so there is no morpho-syntactic reason such as case checking to move them. But they have to be moved for type reasons.

Assume that relative pronouns are semantically vacuous, i.e. they have no meaning and no type. When we move a relative pronoun, it leaves a co-indexed trace of type *e*. By FI we delete the pronoun at LF and are left with the adjoined index, the wanted  $\lambda$ -operator. This gives us the LF for the relative clause in (70b):

- (71)  $[_{\text{et}} \lambda_4 [_t \text{Mary}_e [_{\text{et}} \text{likes}_{e(\text{et})} t_4]]]$

Chomsky calls the kind of movement involved here A-bar as opposed to A-movement presented in the previous section. There is no semantic difference with respect to the interpretation of the trace. The difference is that in the previous case the moved DP had meaning whereas here it doesn't have meaning. Thus WH-movement in relative clauses amounts to  $\lambda$ -abstraction.

### 7.3. PRO-movement

In the GB-theory PRO is the subject of an infinitive clause and it is not moved at all:

- (72) a. Bill wants [<sub>CP</sub> PRO to win]  
 b. [<sub>CP</sub> PRO to win] is pleasant

With Chierchia (1989) many semanticists assume that non-finite CPs express properties, i.e., objects of type *s(et)*. It seems to be plausible then that these are generated in analogy to the relative clauses studied in the last section. H & K propose that PRO is a semantically empty pronoun without type and meaning. It follows that PRO must be QR-ed for type reasons. Somehow the theory has to make sure that this movement is local, i.e. PRO is adjoined to its CP. This theory would generate the LF [ $\lambda_n. t_n$  win] for the infinitival in the examples. **Want** and **pleasant** then have to select a property of type *s(et)*.

H&K launch the natural generalisation that PRO may be the subject of all the other lexical projections as well (NP, AP, PP). This theory easily explains the occurrence of quantifiers within such phrases, i.e. *Quantifying into NP*.

- (73) **Every owner of a Macintosh hates Windows.** (Quantifying into NP)

Note first that the N-object **a Macintosh** must have narrow scope with respect to the determiner **every**. If QR gave the quantifier wide scope with respect to **every**, we would obtain a reading that is at best marginal, viz.

- (74) ?  $(\exists x)[\text{Mac}(x) \ \& \ (\forall y)[y \text{ is an owner of } x \rightarrow y \text{ hates Windows}]]$

The reading we are after is:

- (75)  $(\forall y)[(\exists x)[\text{Mac}(x) \ \& \ y \text{ is an owner of } x] \rightarrow y \text{ hates Windows}]$

Here is the SS of the subject DP with **PRO** as the NP subject.

- (76) [<sub>DP</sub> **every** [<sub>NP</sub> **PRO** [<sub>N'</sub> **owner**<sub>e(et)</sub> [<sub>PP</sub> *of* [<sub>DP((et)t)</sub> **a Mac**]]]]] (SS)

Ignoring the intervening preposition **of**, we encounter the familiar type clash between the head noun **owner** and the object **a Mac**. The clash is resolved by QR. First we QR **a Mac** and then we QR PRO over **a Mac**. This gives us the following LF:

- (77) [**every** [**PRO**  $\lambda_1$ [**a Mac** [ $\lambda_2$  [ $t_1$  [**owner**  $t_2$ ]]]]]]]

We interpret **owner** exactly as if it were the transitive verb **own**. The reader may convince himself that this structure expresses the generalised quantifier  $\lambda P_{et}. (\forall y)[(\exists x)[\text{Mac}(x) \ \& \ y \text{ is an owner of } x] \rightarrow P(y)]$ .

An example requiring *Quantifying into PP* is analysed in H&K, p. 221 ff.:

- (78) Every student from a foreign country is admitted.

We analyse it exactly as before, i.e., the input for the rules of construal is the following SS for the subject:

- (79) **every student** [<sub>PP</sub> PRO from<sub>e(et)</sub> **a foreign country**]

An example involving an adjective might be the following:

- (80) **No guest** [<sub>AP</sub> PRO dissatisfied<sub>e(et)</sub> [<sub>PP</sub> with **something**]] **complained**  
 =  $\neg(\exists x)[x \text{ is a guest} \ \& \ (\exists y)[y \text{ is a thing} \ \& \ x \text{ is dissatisfied with } y] \ \& \ x \text{ complained}]$

Here *with* is a semantically empty preposition.

All these movements are covert. Hence they take place on the LF branch.

To summarise this section: the grammar has to assume semantically empty pronouns, which may be overt (the relative pronoun **WH**) or covert (**PRO**). These must be QR-ed for type reasons. Semantically empty elements thus provide a close link between the grammar of natural languages and that of  $\lambda$ -abstraction. The method helps to understand a large array of constructions.

*Notes on the literature.* Relative pronouns have always been interpreted as  $\lambda$ -operators by semanticists. The tradition goes back at least to Quine (1960b: 121). It remained, however, quite mysterious how the  $\lambda$ -operator was connected with WH-movement. The puzzle was solved by H&K's theory of semantically empty pronouns. In Heim & Kratzer (1998), the authors develop such a theory for **PRO** only, but the extension to relative pronouns is obvious. For a detailed discussion of questions, see article 66 (Krifka) *Questions*.

## 8. Abstract operators in syntax and the PF/LF-branches

Compositional semantics requires the assumption of many abstract (covert) operators, i.e. material that is not pronounced. For the syntax the problem arises how these operators are made visible. One method is that the operator carries a feature F that has a reflex somewhere in the morphology. The feature of the operator is usually called interpretable (prefix i) and its morphological reflex is called un-interpretable (prefix u). The implementation of the agreement relation between the features is one of the central topics of Minimalism. Most current syntactic approaches assume movement somewhere: the material carrying one feature is moved to a local environment of the other feature and there the features agree. Or there is abstract movement of one feature and the material stays in situ. Another method is long distance agreement (e.g. "Multiple Agree") or feature transmission under binding. For the syntax/semantics interface the important question is where features are checked. The discovery of the correct LF of an expression hosting an abstract operator may be obscured by PF rules such as Head Movement, Topicalization, Deletion (ellipsis) and others. PF rules don't influence semantic interpretation but they may prevent the analyst from finding the correct LF because he confuses PF with SS or even LF.

### 8.1. The question operator

Questions involve both overt and covert WH-movement and are therefore interesting constructions for understanding the interface rules. In Karttunen's (1977) theory of questions, the sentence in (81a) expresses the intension in (81b):

- (81) a. Which boy snores?  
 b.  $\lambda w.\lambda p_{st}.(\exists x)[x \text{ is a boy in } w \ \& \ p = [\lambda w'.x \text{ snores in } w'] \ \& \ p(w)]$

Suppose that Bill and John are the boys in  $w$  that snore in  $w$ . Then the question assigns to  $w$  the set of propositions {that Bill snores, that John snores}. The SS/SO of the question is this:

- (82)  $[_{CP} [\textbf{which boy}]_i [_{C'} [C \ Q_{(st)((st)t)} \ WH] [_s \ t_i \ \textbf{snores}]]]$

The determiner **which** has the same meaning as the indefinite article, in other words **which boy** means the same as **a boy**. The movement rule that places the wh-phrase to the position [Spec, CP] is called WH-movement. It has the same semantic characteristics as QR. To obtain the correct meaning for the question the covert interrogative operator  $Q$  in  $C$  is a crucial ingredient:

- (83) The *question operator*  
 $F(Q_{(st)((st)t)}) = \lambda w.\lambda p_{st}.\lambda q_{st}.p = q$

The pronoun  $WH$  is semantically void. It may be thought of as a relative pronoun of type  $st$ . In order to obtain an LF, we apply WH-movement and delete the uninterpretable material by FI. The result is this:

- (84) A *constituent question*  
 $[_{(st)t} \ \textbf{WH-PRO}_{2,st} [_t [\textbf{which boy}] [_{et} \ \lambda_1 [_{t[(st)t} \ Q_{(st)((st)t)} \ t_{2,st}] [_t \ t_{1,e} \ \textbf{snores}]]]]]]]$

The interpretation of the  $C'$ -node requires IFA. The reader may check that the LF gives us precisely the intension in (81b).

Apart from the movement of the empty pronoun  $WH$ , the LF is almost the same as the SS/SO. Multiple questions, however, require covert WH-movement of wh-phrases, i.e. the rule belongs to the rules of construal as well. Consider the following question:

- (85) **Which girl likes which boy?**

The SS is as before with the object left in base position. The LF is generated by WH-moving the object to [Spec,CP]:

- (86) A *multiple question*  
 $[_{(st)t} \ \textbf{WH-PRO}_{2,st} [_{t[\textbf{which boy}]} [_{et} \ \lambda_3 [_t [\textbf{which girl}] [_{et} \ \lambda_1 [_{t[(st)t} \ Q_{(st)((st)t)} \ t_{2,st}] [_t \ t_{1,e} \ \textbf{likes } t_{3,e}]]]]]]]]]$   
 $= \lambda w.\lambda p_{st}.(\exists x)[x \text{ is a boy in } w \ \& \ (\exists y)[y \text{ is a girl in } w \ \& \ p = [\lambda w'.y \text{ likes } x \text{ in } w'] \ \& \ p(w)]]$

The analysis of **whether**-questions is still under debate. The simplest analysis is presumably due to Guerzoni (2004). It treats **whether** as an existential quantifier over one-place truth-functions. The question **whether it is raining** is then interpreted as  $[\lambda w\lambda p.[p = \lambda w'.\text{rain}(w') \text{ or } p = \lambda w'.\neg\text{rain}(w')]]$  and  $p(w)]$ . The details are a bit complicated, therefore I will not introduce them. To make the question operator  $Q$  visible, it is assumed that it has the

feature [iWH], which agrees with the feature [uWH] of the wh-phrase. In the Karttunen semantics of questions the wh-phrase must move to [Spec,C] to make the question interpretable. It is therefore plausible to assume that the agreement between Q and the wh-phrases is checked in this position. Given that WH-movement may be covert, the features are checked at LF. As to be expected, languages differ with respect to wh-movement: in some languages we have multiple wh-movement at SS (e.g. Bulgarian) in others wh-phrases stay in situ at SS (e.g. Chinese). In a framework that distinguishes between SS/SO and LF it is straightforward to account for the difference.

Questions motivate the existence of QR in surface syntax and LF.

## 8.2. The comparative operator

Most comparative constructions are elliptic, i.e. they lack material that is needed for the interpretation. We will see that there are two ways of treating the ellipsis. Either the SS/SO contains already empty phrases and the missing material is inserted at the LF-branch by a copy rule, or the material is present at SS/SO and deleted at the LF-branch. Another interesting feature of comparative constructions is that the comparative operator ER is best analysed as covert. It is made visible by the comparative morphology of the adjective. The semantics of the constructions will require the application of QR.

Our first example is:

(87) The table is longer than the drawer is wide.

The standard assumption is that the *than*-clause is the complement of a comparative operator ER. The comparative morpheme *-er* of the adjective signalizes the presence of the operator. The DS/SS of the sentence is the following:

(88) SS: The table is [ER than the drawer is wide]-long(er)

The analysis assumes that ER is the head of a Degree Phrase (DegP), which is generated as a degree argument of the adjective. Let us assume that (88) is the input for PF and LF. Thus we have an example for an SS that is quite different from what we say. We assume that the DegP is extraposed at the PF-branch. The covert ER operator is deleted at PF after checking the comparative features.

(89) PF: The table is \_long(er) [~~ER~~ than the drawer is wide]

Starting from the SS in (88), the DegP is QR-ed at LF and we roughly obtain the following structure:

(90) [ER than the drawer is wide]  $\lambda_1$  the table is  $t_1$  long(er)

More precisely, the analysis works as follows:

(91) Degree adjectives type d(et)  
 $F(\mathbf{wide/long}) = \lambda w. \lambda d. \lambda x. \text{WIDTH/LENGTH}(x, w) \geq d$

d is the type of degrees. LENGTH is a measure function that assigns lengths to objects.

- (92) The *comparative operator* *ER*: category Deg, type (dt)((dt)t)  

$$F(ER) = \lambda w. \lambda P_{dt}. \lambda Q_{dt}. (\forall d)[P(d) \rightarrow Q(d)] \ \& \ (\exists d)[Q(d) \ \& \ \neg P(d)]$$

$$= \lambda w. P \subset Q$$

*ER* is thus simply a strong universal quantifier over degrees, which says that its restriction is a proper subset of its nuclear scope.

We know that generalised quantifiers must be QR-ed when they occur in object position. After deletion of the uninterpretable stuff by FI, we therefore obtain the following LF:

- (93)  $[(_{dt)t} \text{ER } [_{dt} \lambda_2 \text{the drawer } t_2 \text{wide}]] \lambda_3 [t \text{the table } \lambda_1 [t_{1,e} t_{3,d} \text{long}_{d(et)}]]]$   
 $= \lambda w. \lambda d [\text{the drawer in } w \text{ is } d\text{-wide in } w] \subset \lambda d [\text{the table in } w \text{ is } d\text{-long in } w]$

We have ignored tense and therefore deleted the auxiliary **is**.

Usually, the comparative operator is identified with the comparative morpheme **-er**, cf. e.g. Heim (2001). There is a problem for theories of this kind, however. The comparative morpheme **-er** is not pronounced at its SS-position. It is a part of the morphology of the adjective **long-er**. If *ER* were identical with the morpheme **-er**, it would be necessary to reconstruct it into the adjective at PF. Then the adjective must contain an **-er** trace. Recall, however, that *ER* is a sort of determiner. I don't know of any syntactic process that could move a part of the adjective to the quantifier position. Therefore, I will assume that *ER* is a phonetically empty operator that has the feature [iER], while an adjective with comparative morphology has the feature [uER]. The interpretable feature licenses the uninterpretable feature under binding. So the official representation is this:

- (94)  $[_s \text{the table}_1 [_{VP} \text{is } [_{AP} t_1 [_{DegP(dt)t} \text{ER}_{[iER]} [_{CP} \text{WH}_2 \text{than the drawer is } t_2 \text{wide}]] \text{long-er}_{d(et)[u-ER]}]]]]]$

The agreement between the two features is presumably mediated via binding: the operator *ER* binds the degree variable of the adjective **longer**.

Comparative constructions show rather different manifestations on the different levels of syntax SS/SO, LF, and PF. The example discussed is one of the few cases where the complement clause is a full CP. But in most cases, the *than*-clause is reduced:

- (95) a. Bill is taller than Mary is ~~tall~~  
 b. Bill is taller than Mary is ~~tall~~

In (a) the VP is deleted ("Comparative Deletion") and in (b) only the AP is deleted ("Comparative Subdeletion"); cf. Bresnan (1973).

In fact, "deletion" is not the right term if we apply the method of ellipsis interpretation introduced in Williams (1977), where empty VPs are present at SS. Consider the following sentence:

- (96) **Caroline observed more birds than Arnim did**  $[_{VP} \Delta]$

The symbol  $\Delta$  stands for a phonetically empty phrase. If we assume that DegP has been QR-ed at SS-structure already, the only thing that remains to do is to fill the VP-gap  $\Delta$  via copying:

1. [**ER** than **Arnim** did [<sub>VP</sub>  $\Delta$ ]]  $\lambda_1$ [**Caroline** [<sub>VP</sub> **observed**  $t_1$  **more birds**]] SS + QR
2. [**ER** than **Arnim** did [<sub>VP</sub> **observed**  $t_1$  **more birds**]]  
 $\lambda_1$ [**Caroline** [<sub>VP</sub> **observed**  $t_1$  **more birds**]] VP-copying

We have to QR the two DPs [**t more birds**] in object position and we have to apply **FI** and obtain a fully interpretable LF, which expresses the following proposition:

- (97)  $\lambda w. \lambda d$ [Arnim observes  $d$ -many birds in  $w$ ]  $\subset$   $\lambda d$ [Caroline observes  $d$ -many birds in  $w$ ]

The comparative adjective **more** means the same as **many**. Recall that the comparative morphology means nothing, but it points to the semantic operator *ER*. We assume that the plural DP in object position has a covert indefinite article, which denotes the existential quantifier for pluralities.

- (98)  $F(\mathbf{more}_{d(et)}) = F(\mathbf{many}_{d(et)}) = \lambda w. \lambda d. \lambda x. |x| \geq d$ , where  $|x|$  denotes the cardinality of  $x$

- (99)  $F(\exists_{(et)((et)t)}) = \lambda w. \lambda P_{et}. \lambda Q_{et}. P \cap Q \neq \emptyset$

The precise structure of the object DP in the example is therefore:

- (100) [<sub>DP(et)t</sub> [<sub>D</sub>  $\exists$ ] [<sub>NP,et</sub> [<sub>AP,et</sub>  $t_1$  **more**] [<sub>N,et</sub> **birds**]]]  
 $= \lambda w. \lambda P_{et}. (\exists x)[x \text{ are birds in } w \ \& \ |x| \geq d \ \& \ P(x)]$

(The trace  $t_1$ , i.e., the free variable  $d$  is bound by *ER*, which is located higher up in the LF.) We will say later how plural predication works. If we take it for granted, this is precisely the meaning we need for the construction.

Comparative deletion as exhibited by example (95a) is analysed exactly alike. The same holds for the subdeletion in (95b); the only difference is that this time the gap is an AP in the **than**-clause. I leave it to the reader to work out the ellipsis resolution for that example.

For the derivation of the LF, it is crucial that VP-copying applies after the application of QR because before the application of QR, the VP to be copied contains the [<sub>VP</sub>  $\Delta$ ]. Therefore an early copy process would lead us to an infinite loop. The phenomenon exhibited by the example is called *antecedent contained deletion*, where the term is motivated by a different treatment of ellipsis. Suppose that the SS/SO doesn't contain the empty VP but a full form. In order to find a matching VP that licenses the ellipsis, we first have to QR the DegP.

1. Caroline [<sub>VP</sub> observed [ER than Arnim did [<sub>VP</sub> observe many birds]]]-many birds]  
 SS/SO
2. [ER than Arnim did [<sub>VP</sub> ~~observe many birds~~]]<sub>i</sub> Caroline [<sub>VP</sub> observed  $t_i$  many birds]  
 QR + VP-deletion

At SS/SO we don't find a second VP that matches the VP **observe many birds**, but after QR we find one provided we ignore the trace. This second method is used by Fiengo & May

*Note on the literature.* Most approaches to the syntax of comparative constructions follow the seminal article Bresnan (1973). The semantics for *ER* and that of degree adjectives follows Heim (2001). Pioneer articles on the LF of comparatives are Cresswell (1976) and von Stechow (1984). For an extensive discussion of comparison constructions, see article 53 (Beck) *Comparison constructions*.

Tenses are abstract operators that are made visible by the tense morphology of the verb. In English, there are two semantic tenses Present and Past.

- N reminds of “now”. Verbs and other predicates have a temporal argument of type *i*. We assume that the argument is the first one. Up to now we have assumed that verbs like **called** have the type *et*. If we include tense, the verb has type *i(et)*. (If we included Aspect, the verb would have an event argument instead of a time argument. Semantic aspects like Perfective or Imperfective would then link the events with times. We are ignoring these complications.) The entry of the verb is this:

- It is important to keep in mind that **arrives** has a tenseless meaning. It means precisely the same as the infinitive form **arrive**. This is so because the tense morphology has no semantic interpretation. But the morphology points, of course, to a semantic tense located elsewhere in the clause. That semantic tenses must be separated from their verb is obvious by looking at the interaction with time adverbs: time adverbs like **yesterday** or **tomorrow** must have narrow scope with respect to a semantic tense but wide scope with respect to the verb:

- Here **yesterday** means  $[\lambda w.\lambda t.t$  is on the day preceding the speech time  $s^*$ ]. The semantics of **tomorrow** is analogous. The adverb and the VP are composed by PM. In English, the semantic Future is expressed by the auxiliary **will**, which means  $[\lambda w.\lambda t.\lambda P_{ir}.(\exists t' > t)P(t')]$ .

- (104) John will arrive tomorrow  
 $N \lambda_1 \mathbf{will}(t_1) \lambda_2 [\mathbf{John \ arrive}(t_2) \ \mathbf{tomorrow}(t_2)]$   
 $iN \quad uN$





(108)  $F(\text{NEG}) = \lambda w. \lambda t. T = 0$ .

The simplest realisation in language would be an adverb like the German particle **nicht** (“not”). In German, adverbs have scope to the right. Hence we would expect that the adverb occurs in a sentence initial position. But already Jespersen (1917) was wondering why German has the negation at the end of a sentence in many cases. He thought that German was quite exceptional in this respect. As a simple example consider the following sentence:

(109) Das glaube ich nicht            (German)  
           that believe I not

It looks as if the negation adverb **nicht** (“not”) occurs at a sentence final position. A closer inspection, however, shows that this puzzle has an easy solution. Every syntactician of German would agree that the analysis of the sentence is something like this:

(110) DS: [<sub>CP</sub> C [<sub>VP</sub> nicht [<sub>VP</sub> ich das glaube]]]  
       SS: [<sub>CP</sub> das<sub>1</sub> [<sub>C'</sub> glaube<sub>2</sub> [<sub>VP</sub> ich<sub>3</sub> [<sub>VP</sub> nicht [<sub>VP</sub> t<sub>3</sub> t<sub>1</sub> t<sub>2</sub>]]]]]]]

At SS the object is moved to [Spec, CP]. The finite verb is moved to C. The subject is moved to the subject position (or simply scrambled out of the VP; referential terms never occur in the scope of the negation **nicht** in German at s-structure). The negation particle **nicht** is not moved. If we disregard tense, it occupies a sentence initial position, exactly as Jespersen wants to have it. All these movements are *reconstructed* at LF and we are left with the configuration given by the DS. Another possible analysis is to say that Verb Movement and Topicalization are rules that apply at the PF-branch. In that case our DS would coincide with the SS and no reconstruction would be needed.

In Slavic languages (and Negative Concord languages in general), negation is expressed covertly as NEG and it is made visible at the verb and indefinites in the scope of NEG. In Russian the verb has the prefix **ne-** and the indefinites have the prefix **ni-**.

(111) Nikto    nichego ne videl.  
       n-person n-thing n-saw  
       ‘Nobody saw anything.’

The widely accepted analysis of the construction is due to Zeijlstra (2004). Negative indefinites mean the same as non-negative indefinites, i.e. n-person means **someone**, n-thing means **something**, and n-saw means **saw**. So we have no overt negation. But the n-words have an uninterpretable feature [uNEG], which must be checked by the negation operator NEG with feature [iNEG]. This checking process is called Multiple Agree. Disregarding QR, the LF for the construction is therefore the following:

(112) NEG [n-someone n-saw n-something]  
       =  $\neg(\exists x)[\text{person}(x) \ \& \ (\exists y)[\text{thing}(y) \ \& \ x \text{ saw } y]]$

Negative Concord has puzzled analysts for decades. Zeijlstra’s analysis relies on the assumption that there may be covert semantic operators in the syntax, and these operators must be made visible by the morphology via an agreement relation.

Thus we have here a construction with three negative forms but only one semantic negation. Again the relation between the operator and the morphology is an agreement relation. The examples from German tell us that certain syntactic rules like V-movement, Topicalization and Scrambling should better apply at the PF branch. The path to LF is before the application of these rules. The semantics of negation should be very simple.

*A note on the literature.* Negative Concord is not always such a clean phenomenon as in Slavic. There are mixed cases like Italian and French. Furthermore, some languages show the phenomenon of *scope splitting* (Germ. *Du (you) must (must) keine (no) Krawatte (tie) tragen (wear)* (= *It is not required that you wear a tie*): A negative indefinite is licensed by an abstract negation NEG across a modal. For a recent account of such and related phenomena see Penka (2010). See also article 63 (Herburger) *Negation*.

## 8.5. Plural operators

The plural operator for nouns may perhaps be regarded as a lexical operation PL, but VPs can be pluralized in different ways: transitive verbs can be pluralized by a one-place or a two-place plural operator, di-transitive verbs can be pluralized as well by a two-place plural operator PL<sup>2</sup> and a three-place plural operator PL<sup>3</sup> respectively. The pluralization of verbs happens in the syntax, i.e., a plural operator applies to the VP. Generalized quantifiers may have scope interactions with the covert plural operators and we can derive readings that cannot be derived without such operators.

To understand these remarks we need some definitions. With Schwarzschild (1996) we identify individuals with their singletons. (The principle stems from Quine's set theory.)

(113) For any individual  $x$ :  $x = \{x\} = \{\{x\}\} = \dots$  ("Quine's innovation")

The sum of two individuals is their union (fusion):

(114) a.  $x + y = x \cup y = \{x\} \cup \{y\} = \{x, y\}$   
 b.  $\Sigma M = \{x \mid (\exists y \in M) x \in y\}$ , for any set of individuals.

$x+y$  is the group consisting of the atoms  $x$  and  $y$ . This meaning is represented by non-Boolean **and**, a symbol of type  $e(ee)$ .  $\Sigma M$  is the generalized sum/fusion, which forms groups of any size. The one-place plural operator PL<sup>1</sup> gives us the power set of  $M$  (perhaps minus the empty set and the singletons, possibilities we disregard).

(115) The 1-place plural operator PL:  
 $\llbracket PL_{(et,et)} \rrbracket = \lambda w. \lambda P_{et}. \{M \mid M \subseteq P\}$

This is the power set of  $M$ . We are ready for the first plural sentence:

(116) [**Anna and Bertha**] [PL **laugh**]

$\llbracket \text{Anna and Bertha} \rrbracket = a+b$ . Suppose  $\llbracket \text{laugh} \rrbracket = \{a, b, c\}$ . Then  $\llbracket \text{PL laugh} \rrbracket = \{\emptyset, a, b, c, a+b, a+c, b+c, a+b+c\}$ . Since  $a+b$  is in the extension of the plural predicate, the sentence is true.

One might think that one could get the same result by defining the subject as the generalized quantifier  $[\lambda P. P(\text{Anna}) \ \& \ P(\text{Bertha})]$ . Cross-linguistic comparison shows that

this would be a mistake. All languages that have overt plural morphology for verbs have the verb in the plural in this construction, e.g. Germ. **Anna und Berta lachen/\*lacht**. Note that the denotation of the plural subject is not in the extension of the singular verb.

Next consider a sentence with a definite plural subject:

(117) [the [PL<sup>1</sup> girls]] [PL<sup>1</sup> laugh]

Here is a meaning for the *definite article* that works for singular and plural count nouns and for mass nouns likewise.

(118)  $F(\mathbf{the}_{(et)e}) = \lambda w. \lambda P_{et} : \exists x[P(x) \ \& \ \forall y[P(y) \rightarrow y \subseteq x]. \iota x[P(x) \ \& \ \forall y[P(y) \rightarrow y \subseteq x]]$

As an illustration we consider the LFs for **the girl** and **the [PL girls]**. Suppose,  $\llbracket \mathbf{girl} \rrbracket = \{a\}$ . So  $\llbracket \mathbf{girl} \rrbracket (a)$  is true. By Quine's innovation,  $a = \{a\} \subseteq \{a\}$ . This is the only girl. Therefore the presupposition is fulfilled and  $\llbracket \mathbf{the girl} \rrbracket = a$ . Suppose next,  $\llbracket \mathbf{girl} \rrbracket = \{a, b\}$ . Obviously, the presupposition is not fulfilled. So the article is undefined for this case. Now consider  $\llbracket \mathbf{the [PL girls]} \rrbracket$  for this scenario.  $\llbracket \mathbf{PL girls} \rrbracket = \{\emptyset, a, b, a+b\}$ . Obviously  $a+b$  contains every group in the noun extension as a part. So the presupposition is fulfilled and  $\llbracket \mathbf{the [PL girls]} \rrbracket = a+b$ .

So far we had no argument for the claim that PL is a covert operator that applies in the syntax. It would be possible to have both singular and plural predicates in the lexicon. So we go to more complicated cases:

(119) a. Carl kissed the girls  
b. [**the [PL girls]**] PL<sub>[λ<sub>1</sub> Carl kissed t<sub>1</sub>]</sub>

We assume that  $\llbracket \mathbf{girl} \rrbracket = \{a, b\}$ ,  $\llbracket \mathbf{Carl} \rrbracket = c$  and  $\llbracket \mathbf{kissed} \rrbracket = \{ \langle c, a \rangle, \langle c, b \rangle \}$ . Then  $\llbracket \mathbf{PL}[\lambda_1 \mathbf{Carl kissed t}_1] \rrbracket = \{\emptyset, a, b, a+b\}$ .  $\llbracket \mathbf{the [PL girls]} \rrbracket = a+b$ . Therefore the sentence is true in this scenario.

The construction of the LF is done as follows. First the object is QR-ed out of the *singular* VP. Then PL is inserted between the moved object and the λ-operator created by movement. This kind of insertion is called counter-cyclic in the recent literature.

The following example, which is due to Beck & Sauerland (2000), requires a two-place plural operator as we will see in a moment.

(120) The boys gave the girls a flower.

Here is a general definition of plural operators that modify n-place verbs. The definition is due to Sternefeld (1993):

(121) Let  $\phi$  be a n-place predicate (of type  $e^n t$ ). Then  $\mathbf{PL}^n \phi$  is of the same type.  
 $\llbracket \mathbf{PL}^n \phi \rrbracket$  is the smallest relation R such that  $\llbracket \phi \rrbracket \subseteq R$   
 $(\forall x_1, \dots, x_n, y_1, \dots, y_n)[R(x_1) \dots (x_n) \ \& \ R(y_1) \dots (y_n) \rightarrow R(x_1+y_1) \dots (x_n+y_n)]$ .

Sternefeld uses the notation \*\* for  $\mathbf{PL}^2$ , \*\*\* for  $\mathbf{PL}^3$  and so on. These operators are also called cumulation operators. The LF for the sentence in (120) is now this:

(122) **The PL boys [the PL girls [PL<sup>2</sup> λ<sub>2</sub> λ<sub>1</sub> a flower λ<sub>3</sub> gave(t<sub>3</sub>)(t<sub>2</sub>)(t<sub>1</sub>)]]**  
 “Every boy gives a flower to some girl and every girl gets a flower from some boy”

The construction of the LF proceeds as follows: we start from a statement with a singular verb. We QR the subject and then we QR the object under the subject. We then insert the two-place plural operator countercyclically between the object and the double abstract. Suppose the girls are  $a+b$  and the boys are  $c+d$ ,  $\llbracket \text{flower} \rrbracket = \{f_1, f_2, f_3\}$ ,  $\llbracket \text{gave} \rrbracket = \{ \langle c, f_1, a \rangle, \langle d, f_2, b \rangle \}$ . The relation  $\llbracket \lambda_2 \lambda_1 \text{ a flower } \lambda_3 \text{ gave}(t_3)(t_2)(t_1) \rrbracket$  is then  $\{ \emptyset, \langle c, a \rangle, \langle d, b \rangle, \langle c+d, a+b \rangle \}$ . Clearly the sentence is true in the scenario. To obtain this reading, it is crucial that the plural operator is inserted in the syntax.

It is interesting to think about the relation between the plural operators and the morphology. For NPs the case seems clear: PL has the feature [iPL] and agrees with the feature [uPL] of the noun. DPs inherit the feature. But what about plural VPs? A plural VP is always modified by a semantic plural, but the morphology may be singular as example (119) shows. So [uPL] of the verb is not checked by the PL-operator that modifies the verb but by the feature [iP] of the subject, a case of subject-predicate agreement.

*Notes on the literature.* The plural operator for nouns has been introduced into semantics by Link (1983). Cumulation of verbs goes back at least to Krifka (1989). A classic is Schwarzschild (1996), who has a slightly different architecture. The exposition given here closely follows Sternefeld (1993) and Beck & Sauerland (2000). The best survey of plural semantics is presumably Heim (1994). Issues arising with plural semantics are discussed in article 46 (Lasersohn) *Mass nouns and plurals*.

## 9. Getting rid of abstract syntax?

In the theory of LF outlined in this article, QR plays a central role. In most cases the rule is covert in the sense that it applies at the LF branch. As it stands, the rule is unconstrained and overgenerates in the sense that it produces LFs that have unattested readings. Much of the work done in Generative Grammar is devoted to constraints on overt movement, i.e. movement visible at SS. Since QR is a covert rule, the criterion for a correct restriction on movement must be that the rule doesn't produce unattested readings. The commonly accepted restriction is that QR is clause bound. This restriction would prevent QR out of a relative clause. For instance, (123a) cannot mean (123b), which is derived by long QR.

- (123) a. John knows a professor that every student likes.  
       b. For every student  $x$ , John knows a professor that  $x$  likes.

But there are other examples with indefinite DPs that seem to support long QR. QR is a covert rule and the restrictions for its application are not clear. Reasons like these have motivated many semanticists, notably categorical grammarians, to look for a syntax without such covert rules. So let us ask whether we need QR at all.

### 9.1. Type shifting

QR was motivated by three tasks that had to be performed: (i) Quantifiers in object positions had to be QR-ed for type reasons; (ii) scope ambiguities must be resolved by QR; (iii) variable binding, i.e., the binding of pronouns requires QR.

Consider the problem of the object first. A quantifier in object position requires QR to solve a type conflict. An alternative solution would be to introduce a type shifting operation in the syntax that applies to the transitive verb:

$$(124) \llbracket \text{SHIFT-1}_{(e(et))((et,t)(et))} \rrbracket = \lambda w. \lambda R_{e(et)}. \lambda Q_{(et,t)}. \lambda x. Q(\lambda y. R(y)(x))$$

The analysis of **Barbara knows every linguist** would then be

$$(125) \text{Barbara SHIFT-(knows) every linguist}$$

The reader may check for herself that this would give us the same result we obtain if we QR the object over the subject. It is not a problem to formulate an operation SHIFT-2 that raises the type of the direct and the indirect object of di-transitive verbs as for instance in **John (SHIFT-2 gave) every child a present**. I have introduced the type shifters as covert operators. An equivalent formulation would be to introduce one-place syntax rules that have the interpretation of the corresponding type shifters. For instance, SHIFT-1 would be the syntax rule  $V_{(et,t)(et)} \rightarrow V_{e(et)}$  with meaning  $\llbracket V_{(et,t)(et)} \rrbracket = \lambda w. \lambda Q_{(et,t)}. \lambda x. Q(\lambda y. \llbracket V_{e(et)} \rrbracket (y)(x))$ . The LF would then be

$$(126) \text{Barbara } [V_{(et,t)(et)} [V_{e(et)} \text{ knows}]] \text{ every linguist}$$

The type lifting of the verb would then be done by the meaning of the syntax rule SHIFT-1.

A general recursive definition for this kind of lifting rules is given in Buring (2005). So we don't need QR for solving the problem of the object, but we need type shifters, and these apply in the syntax. A third alternative would be to assume multiple entries for each verb in the lexicon, i.e., lexemes with the lifted types and the corresponding lifted meanings.

So the problem of the object doesn't require QR, but we need a considerable number of type shifting devices. And a closer look at the meta-language in which these type shifters are formulated shows that QR is hidden in the formulation of the rules. It is not clear whether there are empirical reasons that favour one method over the other. One could argue that these rules are local and therefore more constrained. But there is no reason why type shifters should not apply to entire phrases. Given the present state of the art, the rule QR still seems to be the most transparent method of dealing with the problem of the object.

Next let us take up the question of whether we need QR for resolving scope ambiguities. Consider the ambiguous sentence:

$$(127) \text{Everybody likes somebody.}$$

The reading with wide scope of the subject with respect to the object can be obtained by applying SHIFT-1 to the verb. To generate the reading where the object has wide scope with respect to the subject, we need a further shifter:

$$(128) F(\text{SHIFT-3}_{(e(et))((et,t)((et,t)t)}) = \lambda w. \lambda R_{(et)t}. \lambda P. \lambda Q_{(et)t}. P(\lambda x. Q(\lambda y. R(y)(x)))$$

As the reader may check for himself, the following LF gives us the intended reading:

$$(129) \llbracket \text{everybody } [ \text{SHIFT-3 (likes) } [ \text{somebody} ] ] \rrbracket \\ \lambda w. (\exists x)[\text{person}(x,w) \ \& \ (\forall x)[\text{person}(y,w) \rightarrow \text{likes}(y,x,w)]]$$

So QR is eliminated in favour of appropriate type shifters. The shifter (128) over-generates for it gives **everybody** wide scope over a negative quantifier in subject position:

- (130) \* $[\text{I nobody [SHIFT-3(likes) [everybody]]}]$   
 $\lambda w. (\forall y)[\text{person}(x, w) \rightarrow \neg(\exists y)[\text{person}(y, w) \ \& \ \text{likes}(y, x, w)]]$

This reading (“Nobody likes anybody”) is not possible for the sentence. So we have to block it somehow. Note, however, that a theory with QR faces the same problem. We have to forbid to QR over the negation. Thus QR is not necessary for disambiguation. Type shifters can do the same work.

Finally, let us ask whether we need QR for variable binding. If we look at the cases of legitimate pronoun binding by QR, we see that the movement is so local that we may ask whether we can get rid of QR for the purpose of binding. Buring (2005) offers a method. He proposes a surface interpretation of Chomsky’s indexed structures. He first formalizes the binding indices  $n$  of NPs that are not operators (i.e. no *wh*-phrases, relative pronouns etc.) by a binding prefix  $\beta_n$ . The following LF-rule does this:

- (131) *Binder rule* (Buring)  
 $[\text{NP}_n \ \varphi] \rightarrow [\text{NP} [\beta_n \ \varphi]]$

This is almost identical to H&K’s convention for QR, where the movement index is adjoined to the XP to be modified and interpreted as a  $\lambda$ -operator. The difference is that the binding index  $n$  is not created by movement. It might be thought to be present at SS as Chomsky assumed or it might be created by the Binder rule itself as Buring assumes. Our version of the Binder rule sticks closer to the GB-notation. Buring calls  $\beta_n$  *binding prefix*.

- (132) *Binder index evaluation*  
 Let  $\varphi$  be of type  $et$ . Then  $[\beta_n \ \varphi]$  is of the same type.  
 $[[[\beta_n \ \varphi]]^g] = \lambda x. ([\varphi]^{g[n/x]}(x))$

Here is a simple example illustrating the rule:

- (133) **everyone**  $[\beta_n \text{shaved himself}_n]$

The structure can be interpreted without QR, and it has the correct meaning. A closer inspection of the rule reveals that it is a lexicalised version of QR:  $\beta_n$  is not simply a  $\lambda$ -operator. It binds the variable  $n$  that occurs in the VP  $\varphi$ , it introduces the same variable as subject of the VP and identifies it with the interpretation of  $n$ . If we apply a generalised quantifier to that meaning, we get exactly the same result as if the quantifier had been QR-ed out of the subject position of the sentence.

Buring’s method can be applied to objects that bind variables, but we need a more complicated composition principle for this case:

- (134) a. **John gave everyone<sub>1</sub> a present that he<sub>1</sub> liked**  
 b. **John**  $[\text{et everyone} [_{((et)t)(et)} \beta_1 [_{(et)} \text{gave a present that he}_1 \text{ liked}]]]$   
 $= \lambda w. (\forall x)[\text{person}(x, w) \rightarrow \text{John gave } x \text{ a present in } w \text{ that } x \text{ liked in } w]$

The rule for binding prefixes that bind a dative position is this:

- (135) Let  $\gamma$  be of type  $(e(et))$ . Then  $[\beta_n \gamma]$  is of type  $((et)t)(et)$ .  

$$[[[\beta_n \gamma]]]^g = \lambda Q_{(et)t}. \lambda x. Q(\lambda y. ([\gamma]]^{g[n/y]}(y)(x)))$$

Again the meta-linguistic notation shows that QR is hidden in this rule.

With techniques of this kind we can deal with all standard cases of variable binding without QR in the syntax. But we need these alternative binding rules.

Obviously, there is a general method behind the different binding rules. We may generalize the compositional principles to get some general scheme. See Buring (2005) for details. For binding purposes this method seems to work rather well and it provides a viable alternative to block over-generation.

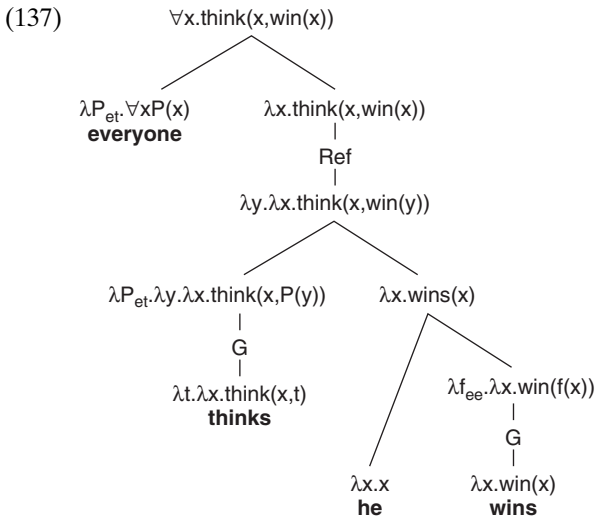
## 9.2. Variable free syntax/semantics

The alternatives to QR all assumed that pronouns or traces are variables, and variables are bound by an appropriate abstraction. A more radical approach that eliminates QR for the task of variable binding is a variable free semantics. If there are no variables in the syntax, there is no variable binding and we don't have QR. Already Quine (1960a) has shown that we can have a variable free predicate logic.

The main ideas for a variable free semantics are the following. Pronouns are not variables but functions expressing identity, i.e.  $\lambda x.x$ . In the syntax the information that a pronoun has been used is passed upward as  $\lambda x$ . This is done by Geach's type lifting rule G. We can identify two pronouns by Quine's reflexivization rule, which identifies two arguments of a relation. Here is an example.

- (136) Everyone thinks he wins

We have in mind a reading where **everyone** binds **he** in traditional accounts. Here is a variable free analysis:





To simplify the exposition, I have made the (untenable) assumption that the complement of **think** is a truth-value. Geach's type lifting rule raises the type of an argument: it inserts a function  $f$  that applies to an argument of the original type. The argument is abstracted away and passed higher up. As you can see from the tree the information that the pronoun **he** has been used is passed to the higher node until it is identified with the subject of **think** by Quine's rule Ref, which has the meaning  $\lambda R_{e(et)}.\lambda x.R(x)(x)$ . Note that we have variables in the semantic meta-language, but they are always bound. So this framework needs no variable binding and therefore no QR.

Is this kind of syntax less abstract, i.e. nearer to the surface? This is questionable. We need all sort of type lifting rules, which are covert logical operations. Beside of the rules G and Ref illustrated here we need the shifters discussed previously and a couple of other operations.

### 9.3. Dynamic semantics

Geach (1962) has brought our attention to sentences that contain bound pronouns that cannot be analysed by means of QR:

- (138) a. If a farmer owns a donkey, *he* beats it.  
       b. Every farmer who owns a donkey beats it.

In (138a), the pronoun **he** seems to be anaphoric to **a farmer**, and in (138a/b), **it** seems to be anaphoric to **a donkey**. Let us try to bind the pronouns of the first sentence by means of QR. The only way to do this consists of giving **a farmer** and **a donkey** scope over the entire conditional, i.e., the LF has to be something like the following construction:

- (139) **a farmer**  $\lambda_1$  **a donkey**  $\lambda_2$  **if  $t_1$  owns  $t_2$ ,  $he_1$  beats  $it_2$**   
       = There is a farmer  $x_1$  and a donkey  $x_2$  such that if  $x_1$  owns  $x_2$ , then  $x_1$  beats  $x_2$ .

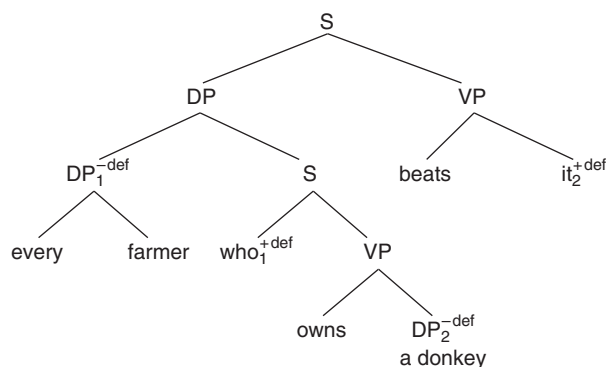
This LF speaks about a particular farmer and a particular donkey and says that the farmer beats this donkey in case he owns it. Even if there exists this reading, which is doubtful, it certainly isn't the prevailing interpretation. Sentence (138a) is synonymous with sentence (138b) and both seem to have a universal reading, something like:

- (140) For every  $x$  and  $y$ , if  $x$  is a farmer and  $y$  is a donkey and  $x$  owns  $y$ , then  $x$  beats  $y$ .

The problem raised by these "donkey sentences" is then how we can obtain this reading in a compositional way from surface syntax.

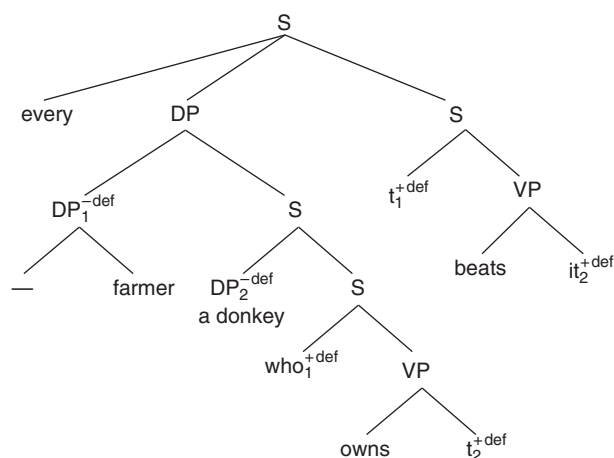
The binding problem for donkey pronouns can be resumed like this. Semantic binding is only possible if the antecedent c-commands the pronoun to be bound at SS. Donkey pronouns seem to have antecedents binding them. But the antecedents don't c-command the pronouns at SS. The problem has triggered a different approach to binding viz. the *Context Change Semantics* of Heim (1982, 1983) and the DRT of Kamp (1981). We stick to the system of Heim, because it is more explicit about the SS-LF interface. The SS of the sentence is this:

(141) SS/SO



From this the LF is generated by two rules, which we introduce below.

(142) LF



The system knows two kinds of variables, definite ones (feature [+def]) and indefinite ones (feature [-def]). Personal pronouns, relative pronouns and traces are definite. Non-pronominal DPs, i.e. those with an article are predicates that apply to their referential index, which is an indefinite variable. The indefinite article means nothing, but quantifiers like **every** or **most** are interpreted by a syncategorematic rule. In Heim's system DPs express truth-values (or propositions) and therefore they cannot be interpreted at the argument position of a VP. So we need an analogue of QR, which we call DR "DP-raising":

(143) **DR**: Adjoin DP to S and leave a co-indexed trace.

The other construction rule is:

(144) Quantifier Scope:  $[[_{DP} \text{ every NP}]_i S] \rightarrow [\text{every } [-NP]_i, S]$

The LF is constructed from the SS by two applications of the rule DR: the subject is scoped over its sentence and **a donkey** is scoped over its relative clause. Finally, the rule Quantifier Scope is applied and the tree is slightly restructured.

To make the analogy with the non-dynamic system clearer, consider the specific reading of the sentence **Every boy loves a girl**, i.e., the one where **a girl** has wide scope. The LF in Heim's system is:

(145) **a girl**<sub>2</sub> [**every** [\_ **boy**]<sub>1</sub> [<sub>t<sub>1</sub></sub> loves <sub>t<sub>2</sub></sub>]]

As before, the indefinite term must have wide scope over the quantified subject.

We now give a short sketch of the semantics for the system. Sentences don't have truth-values but a *context change potential* (CCP). A context *c* is a set of partial variable assignments. Dom(*c*) contains the variables used by the assignments in *c*. If *p* is a sentence and *c* is a context,  $\llbracket p \rrbracket(c)$  is the new context, written as *c* + *p*. The semantic language used consists of the following expressions: (a) Atomic formulae consisting of an *n*-place predicate *P* and *n* variables, where each is definite or indefinite; (b) molecular formulae of the form [*p* *q*], where *p* and *q* are formulae; (c) quantified formulae such as [**every** *p* *q*] or [**not** *p*].

As usual we assume that predicates *P* have extensions Ext(*P*). The recursive definition of the context change function + is given by the following rules, where *c* is an arbitrary context:

(146) Definition of +

- a. If *p* is an atomic formula of shape  $P(x_1, \dots, x_n)$ , then  $c + p = \{f \cup g \mid f \in c \ \& \ \langle g(x_1), \dots, g(x_n) \rangle \in \text{Ext}(P)\}$ , where  $\text{dom}(g) = \{x_1, \dots, x_n\}$  and  $c + p$  is only defined if the definite variables in *p* are in dom(*c*) and the indefinite variables in *p* are not in dom(*c*) (*familiarity/novelty-condition*)
- b. If *p* is a molecular formula of the form [*q* *r*], then  $c + p = (c + q) + r$
- c. If  $p = [\text{every } q \ r]$ , then  $c + p = \{f \in c \mid (\forall g \supset f) \text{ If } g \in c + q, \text{ then } (\exists h \supset g) h \in (c + q) + r\}$

It can now be calculated that  $c + (142) = \{f \in c \mid (\forall g \supset f) \text{ If } g(1) \in \text{Ext}(\text{farmer}) \ \& \ g(2) \in \text{Ext}(\text{donkey}) \ \& \ \langle g(1), g(2) \rangle \in \text{Ext}(\text{own}), \text{ then } \langle g(1), g(2) \rangle \in \text{Ext}(\text{beat})\}$ .

Since all the variables in this LF are new, the context is not changed if every farmer who owns a donkey beats it. If the latter is not the case, the new context will be empty.

A sentence *p* is true in *c* if there is at least one assignment in *c* + *p*.

In predicate logic, we can write the truth-condition of the donkey sentence as  $(\forall x)(\forall y)[\text{farmer}(x) \ \& \ \text{donkey}(y) \ \& \ \text{own}(x, y) \rightarrow \text{beat}(x, y)]$ . Similarly, the reader may convince himself that the LF in (145) amounts to the truth-condition  $(\exists x)[\text{girl}(x) \ \& \ (\forall y)[\text{boy}(y) \rightarrow \text{like}(y, x)]]$ .

It is interesting to think a moment about the consequences of dynamic semantic for the Binding Theory (= BT) of Chomsky (1981). Recall that an expression is A-bound if it is co-indexed with a *c*-commanding expression in argument position. BT says that A-elements (e.g. reflexive pronouns) are A-bound in their binding category, roughly the next finite clause (Principle A), that B-elements (e.g. personal pronouns) are A-free in their binding category (Principle B), and that C-elements (e.g. names and non-pronominal DPs) are free in their binding category (Principle C). The binding principles apply at SS.

Among other things, the binding theory gives a distribution of definite and indefinite terms. Consider the SS of the donkey sentence, i.e. (141). Both the C-element **a donkey**<sub>2</sub> and the B-element **it**<sub>2</sub> are A-free as required by BT. The compatibility of the dynamic system with BT can also be seen from the behaviour of names. In dynamic semantics **John**<sub>1</sub> is a definite DP. The prediction is that

(147) Every girl that knows him<sub>1</sub> likes John<sub>1</sub>

is a good sentence, because **John**<sub>1</sub> and **him**<sub>1</sub> are A-free. So one criterion for the correctness of a syntactic account is that Chomsky's BT can be implemented.

I know no really convincing alternative analysis of donkey sentences. Therefore a framework of this kind seems needed. Obviously the choice has repercussions to syntax. In particular, QR has to be replaced by the two rules discussed. As QR, the rule DR is needed for the problem of the object, for scope disambiguation and for binding. So a framework of this kind is not less abstract than the previous account.

*A note on the literature.* Heim's and Kamp's logical languages are first order. The syntax proposed by Heim is very elegant and there might come a time for its revival. Kamp's Discourse Representation Theory treats the same phenomena but it mostly gives only logical LFs in a box notation plus a comparable semantics. Kamp & Reyle (1993) give some rules that relate DRS's with syntactic structures; see also article 37 (Kamp & Reyle) *Discourse Representation Theory*. The architecture is rather different and we cannot give details here. Chierchia (1995) and Beaver (2001) embed Heim's dynamic semantics in a typed language, where Beaver is closer to Heim than Chierchia. There are a number of proposals for *Dynamic DRT*, e.g. Muskens (1996). For type shifting, see articles 25 (de Swart) *Mismatches and coercion* and 85 (de Hoop) *Type shifting*; for variable free semantics, see article 62 (Szabolcsi) *Scope and binding*; for dynamic semantics, see article 38 (Dekker) *Dynamic semantics*.

## 10. The big picture

The plot of this article was to give an idea of the syntax/semantics interface by studying concrete examples. The approach is Fregean, i.e. we assume that the meaning of a sentence is determined by its syntactic structure and the meaning of its parts, where the smallest parts are phrases and words. This means that syntactic rules have meaning, i.e., the semantic operations associated with them. We tried to get along with very few principles of semantic composition, above all FA and PM. In addition we needed  $\lambda$ -abstraction and movement rules creating it, above all QR. We could achieve quite a lot with these ingredients. But the theory relied on the assumption that the simple principles of composition mostly apply on LF, where we took LF as that structure that determines the truth-conditions of a sentence. Some researchers have called this kind of LF *transparent LF*. Now, why should LF be different from SS/SO and PF?

I am not concerned with obvious differences caused by phonological rules that form phonological phrases and phonological words, thereby destroying a lot of constituent structure. The more interesting cases are rules that alter the structure that is best for semantic composition such as Verb Movement, Topicalization in German, Scrambling in German, Extraposition, VP deletion and so on. If these rules don't affect the truth-conditions we can assume that they apply at the PF-branch. In many cases we could

give trivial interpretation to this kind of movement rules. Suppose, for example that verb movement never affects the truth-conditions in German. The movement rule could then leave a trace of the type of the verb and we would have semantic reconstruction via  $\lambda$ -conversion. The technique is not easily applicable when the moved material contains a bound variable. In these cases semantic reconstruction obviously needs more complicated methods like those used in variable free semantics. If the same result can be obtained by ignoring the movement (because it occurs at the PF branch), then this is a simpler and more attractive theory. But ultimately, this issue is an empirical one.

Suppose then that PF is different from SS/SO. Once we have made that step, there is nothing mysterious anymore in the assumption that LF is different from SS and therefore also different from “what we see”, i.e. PF. In particular there is no reason why we shouldn’t have a covert rule like QR.

On the other hand, we need abstract operators in the syntax anyway. Let us recapitulate: For questions we needed the operator Q, we needed overt WH-movement and also covert WH-movement. The relevant rule is QR.

In order to interpret the comparative, we had to QR the DegP. There is no known way to deal with the data without such a movement. The construction raises interesting questions for the LF-PF-interface. Either we have empty VPs at SS and have a copy rule at the LF-branch, or we have a deletion rule at the PF-branch.

Tense is an example that motivates the split between semantic and morphological tense. The semantic tense is related with the verb by QR. Semantic and morphological tenses are related by agreement. In SOT constructions the agreement relation can relate very distant items. This raises interesting issues for the PF-LF interface. If tense agreement is mediated via variable binding, the relevant configurations should be the input for PF. So some types of covert QR presumably occur at SS/SO.

Negation motivated the assumption that Verb Movement, Topicalization and Scrambling either occur at the PF-branch or they must be reconstructed at the LF-branch. Negative Concord in the Slavic languages shows that negation can be an abstract operator that is made visible by negative prefixes on indefinites and the verb. At LF these prefixes are deleted by the Principle of Full interpretation. In the semantics something covert, viz. NEG does the relevant job. The presence of NEG is made visible by Multiple Agree that relates NEG with the said negative morphemes.

The study of the plural showed that we can modify VPs by a covert plural operator  $PL^n$ . This operator may scopally interact with a generalized quantifier that is an argument of the verb. A semantically pluralized VP is not always a morphological plural: the morphological plural requires a plural subject. To get the facts right, covert QR is necessary, furthermore countercyclic insertion of  $PL^n$ .

We asked whether we can get rid of covert rules like QR and studied techniques from categorical grammar and variable free semantics, notably some type-shifting operations and a version of Geach’s type-lifting rule. We said that these principles sometimes hide QR in the semantic meta-language, and they are certainly not less abstract. (A personal remark to these techniques is that I understand variable free semantics only because I understand the meta-language that uses variables all the time.)

The semantic techniques discussed here are still too simple to deal with a broader range of phenomena of natural language. For instance, I haven’t touched *Alternative Semantics* at all, i.e. theories that deal with focus-sensitive operators; see e.g. Rooth (1996).

The theory requires different techniques, but I am convinced that it is compatible with the big picture outlined here.

Another problem was raised by dynamic semantics. This theory can treat phenomena that classical frameworks in the Montague style cannot treat at all. We saw that the theory outlined is in no way less abstract than the classical framework. We need movement rules of the QR type all the time. We discussed the compatibility of this theory with Chomsky's binding principles. Any syntax of natural language should have a place where the BT can apply.

So we assume that the general architecture of the system is correct, i.e. Chomsky's T-model as outlined in the GB/MP-theory. In particular, LFs are syntactic structures made of the same material as surface structures and PFs but without material that is semantically not interpretable. And LFs are unambiguous, they fully determine the interpretation.

I have nothing to say about the issue whether the approach is compatible with newer versions of Minimalism, e.g. the Phase Model. One would have to go through the examples and check whether the analyses can be carried over.

*I wish to thank Atle Grønn for correcting the many typos that were in the original version of this article.*

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Arnim von Stechow, Tübingen (Germany)

## 83. Argument structure

The article that was to appear in this section had to be omitted.



## 84. Operations on argument structure

1. Introduction
2. Argument reduction: passive, antipassive, reflexive, and others
3. Argument extension: causative, applicative, resultative, and others
4. Functor vs. incorporation
5. Parsimony in the set of exponents: polyfunctional affixes
6. Multiple operations and the order of derivation
7. Argument alternation through lexical marking
8. Argument alternation: dative shift, and others
9. References

### Abstract

*In a framework with lexical decomposition, argument hierarchy is determined by the depth of embedding, and in turn determines the realization of structural arguments (1). Operations that reduce the number of arguments operate directly on the argument hierarchy (2), while operations that extend the number of arguments add semantic predicates, and thus themselves contribute to semantic composition (3). Causatives add a highest argument, while applicatives add a non-highest argument – what kind of machinery is necessary to represent this difference (4)? Certain affixes realize a whole bundle of possible operations, some of them even opposite ones (5). Multiple operations are possible; their order reflects steps of semantic composition (6). Lexical marking can override the argument hierarchy (7). Argument alternations such as the dative shift reflect lexical alternatives with different argument hierarchies that are not derived from each other (8). – Various kinds of evidence is given that morphological operations reflect semantic properties and relations rather than syntactic ones.*

### 1. Introduction

Considering triplets such as those in (1), it is easy to see that *open* is an ambiguous lexical item, whose specifications belong to the same semantic classes as *dead*, *die*, and *kill*. That the main predicates of (1a), (1b), and (1c) belong to different semantic classes is attested by the different morphosyntactic contexts required by these predicates. The verbs in (1b) clearly differ in their argument structure from those in (1c), which is captured by the distinction between intransitives vs. transitives, while it is less obvious whether adjectives and intransitives differ in their argument structure. Probably most linguists would say yes, they do.

- |     |                          |                       |                        |
|-----|--------------------------|-----------------------|------------------------|
| (1) | a. The bear is dead.     | The door is open.     | Die Tür ist offen.     |
|     | b. The bear died.        | The door opened.      | Die Tür öffnete sich.  |
|     | c. Mary killed the bear. | Mary opened the door. | Maria öffnete die Tür. |

That *open* is threefold ambiguous raises the question of how these three meanings are related to each other. The answer provided in this article is that they are related by certain operations on argument structure. The adjective *open* denotes a relation between an object and a state holding at a certain time, while the intransitive *open* denotes a relation between

an object and an event that ends in such a state; finally, the transitive *open* denotes a relation between an agent, an object, and an event in which the object ends in such a state. This semantic description suggests that the predicates in (1a) to (1c) are increasingly more complex, which implies the derivational chain (a)  $\rightarrow$  (b)  $\rightarrow$  (c).

In contrast, the German equivalents of *open* seem to indicate the derivational chain (a)  $\rightarrow$  (c)  $\rightarrow$  (b). The verb, showing umlaut, is derived from the adjective, not showing umlaut. However, (b) is a special case of (c); more precisely, (b) *sich öffnen* is the reflexive form of (c) *öffnen*, often called medium (an intransitivization operation that has several semantic interpretations, see section 5). Note that the same operation is active in many languages, see, e.g., Latin (c) *aper-ire*  $\rightarrow$  (b) *se aper-ire*. Latin also shows the variant in which three different suffixes are attached to one and the same stem: (a) *aper-tus*, (b) *aper-iri*, (c) *aper-ire* – here, morphology does not show what derives from what, just as in English *dead*, *die*, *kill*.

There is some tension between morphological and semantic complexity. Insofar as one is concerned with particular languages, systematic morphological derivation leads one to assume underlying operations on argument structure – passive, causative, or medium being typical examples. There is no need of universality; certain operations may be active only in a small subset of languages. On the other hand, constellations such as English *dead/die/kill* vs. *open<sub>1</sub>/open<sub>2</sub>/open<sub>3</sub>*, force us to assume semantic relations between the individual elements, even if they are not supported by morphological familiarity (as in *dead/die/kill*) or by morphological distinctness (as in *open<sub>1</sub>/open<sub>2</sub>/open<sub>3</sub>*).

In the following, the notions ‘argument structure’ and ‘operations on argument structure’ will be made more precise.

Lexical items belonging to one of the major lexical categories (verb, noun, adjective, adposition) are generally considered to be predicates which have one, two, three, or even more arguments, represented by open slots or variables. An *n*-place predicate (of type  $\langle e_n, \langle \dots, \langle e_1, t \rangle \dots \rangle \rangle$  in the simplest case) together with *n* argument variables forms an open proposition (of type *t*), while  $\lambda$ -abstraction forms a more articulated predicate (of the same complex type) from it, for instance with *n* = 3:

$$(2) \quad \lambda z \lambda y \lambda x \text{ PRED}(x,y,z) \text{ of type } \langle e, \langle e, \langle e, t \rangle \rangle \rangle$$

If such an expression is applied to a series of argument expressions, it gets converted into a saturated proposition, for instance

$$(3) \quad \lambda z \lambda y \lambda x \text{ PRED}(x,y,z) (a)(b)(c) \text{ becomes } \text{PRED}(a,b,c).$$

Both  $\lambda$ -abstraction and  $\lambda$ -conversion are stepwise operations: stepwise  $\lambda$ -abstraction produces a  $\lambda$ -sequence, and stepwise  $\lambda$ -conversion works off this sequence backwards.

One can identify *PRED* with what an individual verbal, nominal, adjectival, or adpositional item contributes semantically, and the series of argument expressions with what the morphological or syntactic complements of that item contribute semantically.

There are some specific differences between the lexical categories. The maximal projections of nouns can be used predicatively (*this is John's house*) or referentially (*let us meet at John's house*), a fact that in some languages (e.g. the Semitic ones) is marked by a nominal vs. verbal clause type – all other categories only allow predicative use. The highest argument of a noun is said to be its referential argument *R*; in the referential use the

noun functions as the complement of another predicate expression (e.g., *meet\_at*), and R is identified with an argument of that predicate, while in the predicative use R is overtly expressed by a DP (e.g., *this*) the noun is predicating of. Although verbs can only be used predicatively, they still refer to some sort of temporal event and therefore can be said to have a referential argument E (cf. article 34 (Maienborn) *Event semantics*); E is specified (or bound) by functional elements such as aspect, tense, mood, but never by a complement. If the verb undergoes event nominalization (*our meeting at John's house*), E becomes R of the resulting noun (cf. Bierwisch 1989b, and article 51 (Grimshaw) *Deverbal nominalization*).

In view of these differences, the featural encoding of argument hierarchy (Wunderlich 1997a) disregards the event argument of a verb but pays regard to the referential argument of a noun. That is, for the working of grammar the highest argument of a transitive verb is usually taken to be the agent (rather than the event in which the agent is involved), while the highest argument of a relational noun must be R. Adjectives and adpositions are typically considered to lack a referential argument, so that no specific functional elements are found with them. To anchor the information of adjectives and adpositions, they must be construed together with some noun or verb as an attribute, adverbial, or secondary predicate.

The representations in (4) to (6) illustrate the predicate-argument structure of a few examples. The possessed noun is considered to be derived from the simple noun by possessivization, which operates on  $\lambda x N(x)$ , yielding  $\lambda y \lambda x [N(x) \ \& \ \text{poss}(y,x)]$  (Barker 1995). Similarly, the transitive variant of *cook* can be derived from the intransitive variant by causativization, which adds an agent argument ('one who causes that something cooks'). This result can undergo further operations: event nominalization, which only shifts the lexical category ('a process of cooking something by someone'), or agent nominalization, which binds the event argument existentially ('someone who cooks something'). Adjectives as well as adpositions can have one or two arguments.

(4) Nouns and possessed nouns

- |                             |                                                                 |         |
|-----------------------------|-----------------------------------------------------------------|---------|
| a. <i>house</i> :           | $\lambda x \text{HOUSE}(x)$                                     | $x = R$ |
| b. <i>someone's house</i> : | $\lambda y \lambda x [\text{HOUSE}(x) \ \& \ \text{POSS}(y,x)]$ | $x = R$ |

(5) Verbs and nominalizations

- |                                |                                                                            |         |
|--------------------------------|----------------------------------------------------------------------------|---------|
| a. <i>cook</i> , intransitive: | $\lambda y \lambda s \text{COOK}(y)(e)$                                    | $e = E$ |
| b. <i>cook</i> , transitive:   | $\lambda y \lambda x \lambda e [\text{AGENT}(x) \ \& \ \text{COOK}(y)](e)$ | $e = E$ |
| c. <i>cooking</i> , noun:      | $\lambda y \lambda x \lambda e [\text{AGENT}(x) \ \& \ \text{COOK}(y)](e)$ | $e = R$ |
| d. <i>cook</i> , noun:         | $\lambda y \lambda x \exists e [\text{AGENT}(x) \ \& \ \text{COOK}(y)](e)$ | $x = R$ |

(6) Adjectives and adpositions/adverbs

- |                    |                                            |                  |                             |
|--------------------|--------------------------------------------|------------------|-----------------------------|
| a. <i>proud</i> :  | $\lambda y \lambda x \text{PROUD}(x,y)$ ,  | <i>quick</i> :   | $\lambda x \text{QUICK}(x)$ |
| b. <i>behind</i> : | $\lambda y \lambda x \text{BEHIND}(x,y)$ , | <i>quickly</i> : | $\lambda x \text{QUICK}(x)$ |

Arguments other than R and E are sometimes called participants, they must be realized by some pronominal affix or syntactic complement – otherwise existential closure would have to take place in order to yield a saturated proposition. The sequence of  $\lambda$ -abstractors indicates that part of a lexical item which is morphosyntactically active.

Turning now to the concept of argument structure, three distinct but related notions come to mind.

- (i) Argument structure is identified with the list of semantic roles attributed to the participants  $x, y, z$  of the predication, for instance,  $x = \text{agent}(e)$ ,  $y = \text{recipient}(e)$ ,  $z = \text{theme}(e)$  for a ditransitive verb of the *give* type. This position is characteristic for Neo-Davidsonian approaches; although they mostly assume a flat structure (an unordered list of arguments), it is possible for them to induce additional structure by assuming a thematic role hierarchy (cf. article 18 (Davis) *Thematic roles*).
- (ii) Argument structure is identified with the morphosyntactic structure of complement expressions (a)(b)(c) that realize the argument requirements of a predicate. Of course, (a)(b)(c) can vary in various ways, including word order and morphological case. This position is characteristic for syntactic approaches, taking syntax as the generative source of language (cf. article 83 (Pesetsky) *Argument structure*).
- (iii) Argument structure is identified with the sequence of  $\lambda$ -abstractors, which models the need of complements. These  $\lambda$ -abstractors can be regarded as generalized  $\theta$ -roles.

In any case, the notion of argument structure plays a role for all lexical categories. Verbs are in the center when one considers (operations on) argument structure only because they are particularly complex. Stiebels (2006) argues, however, that nouns can in principle show the same types of operations as verbs.

In this article, I will argue for position (iii) above, thereby restricting the discussion to verbs. Let us call  $\lambda e \text{ VERB}(x, y, z)(e)$  the semantic CORE of a verb (in this case, of a ditransitive verb), and  $\lambda z \lambda y \lambda x \text{ CORE}$  the respective  $\theta$ -structure, representing an argument hierarchy with  $x$  as the highest and  $z$  as the lowest argument. For computational reasons, any list of arguments must be strictly ordered. Let us assume that the relative position of the  $\lambda$ -abstractors reflects the path in which the  $\theta$ -structure is abstracted from CORE. Bierwisch (1989a) proposed an algorithm to perform this abstraction from a lexical decomposition structure, which shows how the meaning of a word is built up from a set of more atomic components (cf. article 17 (Engelberg) *Frameworks of decomposition*). Intuitively, this algorithm reflects the depth of embedding: the deeper an argument is embedded, the lower it is placed in the  $\theta$ -structure, i.e. the respective  $\lambda$ -abstractor is positioned closer to the beginning of the sequence of  $\lambda$ -abstractors. (A similar account is found in Baker's (1997) relativized UTAH principle (Uniformity of Theta Assignment Hypothesis): the ordering of roles must correspond to their relative depth in D-structure.)

I take it for granted that for each individual predicate the arguments form a hierarchy. (If it appears that the arguments can be exchanged in their order, strictly spoken there exist two different, although similar predicates, see section 8.) It is often assumed that the argument hierarchy of an individual predicate is induced by a more general thematic hierarchy such as Agent > Instrument > Recipient > Theme > Goal (or similar ones). This requires that the typology of thematic roles be fine enough to capture all possible semantic roles of individual predicates, and that all these thematic roles can be ordered uniquely – which are probably just two unsolvable tasks (cf. article 18 (Davis) *Thematic roles*). Instead, the following tests can be used to determine the argument hierarchy of an individual predicate, without any reference to thematic roles.

- (i) Binding properties: Among others, the higher argument can asymmetrically bind the lower argument (Barss & Lasnik 1986, Larson 1988).
- (ii) Salience properties: According to harmonic alignment, the higher argument is more likely to be more salient (in terms of person, animacy, definiteness, topic, and so on) than the lower argument (Wunderlich 2006).

The  $\theta$ -structure thus preserves structural properties of a lexical decomposition structure in terms of argument hierarchy, which in turn is mapped onto a morphosyntactic structure; in other words, it interfaces between semantic core and morphosyntactic structure. The  $\theta$ -structure is the negative print of the hierarchy inherent to CORE and can produce various morphosyntactic positive copies of that hierarchy. For instance, the ordering  $\lambda z \lambda y \lambda x$  (with  $x$  as the highest argument) is mapped onto the default ordering  $X Y Z$  in the syntax.

Linguists in the tradition of Grimshaw (1990), Jackendoff (1990), Dowty (1991) and others assume a direct mapping from semantic core properties onto morphosyntactic structure. The assumption of a separate  $\theta$ -structure, however, is advantageous for a few reasons (Wunderlich 1997a).

Most importantly, the  $\theta$ -structure allows us to formulate a very elegant mechanism of argument linking, first proposed by Kiparsky (1992) (cf. also Kiparsky 2001, and the section on case in article 78 (Kiparsky & Tonhauser) *Semantics of inflection*). If both the argument hierarchy and the structural cases are encoded by the same set of relational features, argument linking can easily check which structural case pattern fits best with a given  $\theta$ -structure. Lexical Decompositional Grammar (Wunderlich 1997a, 2000, 2006) uses the features  $+hr$  = ‘there is a higher argument role’ (= ‘not the highest role’), and  $+lr$  = ‘there is a lower argument role’ (= ‘not the lowest role’); for reasons of markedness, these features differ slightly from those proposed by Kiparsky. The structural cases are specified as follows: dative =  $[+hr, +lr]$  is compatible with the medial argument, accusative =  $[+hr]$  with a non-highest, ergative =  $[+lr]$  with a non-lowest, and nominative =  $[ ]$  (the unspecified case) with any argument. (Cf. section 7 in article 17 (Engelberg) *Frameworks of decomposition*.)

- (7) Featural encoding of the argument hierarchy:
  - a. Er kaufte ihr einen Ring. (‘He bought her a ring’; NOM – ACC – DAT)
  - b. 

|             |             |             |                   |
|-------------|-------------|-------------|-------------------|
| $\lambda z$ | $\lambda y$ | $\lambda x$ | PRED( $x, y, z$ ) |
| $+hr$       | $+hr$       | $-hr$       |                   |
| $-lr$       | $+lr$       | $+lr$       |                   |

The actual case pattern (in this case NOM – ACC – DAT) follows as the optimal solution if a certain constraint ranking is observed. It should be clear that ergative appears under different circumstances than accusative, and that dative is present only in a subset of both the ergative- and the accusative-languages. Stiebels (2000, 2002) gives a full typology of structural case systems in terms of those constraint rankings. Wunderlich (2003) also includes lexical case marking, which interacts with structural case; he shows that all possible case patterns in German (11 different ones) as well as all possible case patterns in Icelandic (18 different ones), including those that appear in the passive, are determined by the same constraint ranking; the main difference is that Icelandic has more lexical case marking than German. Wunderlich (2006) points out that argument linking by case or pronominal

affixation is not the only possible system; he presents a typology of argument linking that goes beyond case.

There are further advantages of introducing a separate  $\theta$ -structure. First, expletive arguments can be represented by additional  $\lambda$ -elements that do not have a variable as semantic counterpart in CORE (so-called empty abstraction).

- (8) Expletive arguments
  - a. Es schneit. ('It snows.')
  - b.  $\lambda x \text{ GO}(\text{SNOW})$

Second, lexical case can be represented by associating a feature that overrides what the actual hierarchy of arguments would predict. For instance, verbs with dative for the highest argument must be lexically marked, in particular if verbs with the same meaning exist that have nominative instead, consider German *gefallen* vs. *mögen*, expressing the same psychological state.

- (9) Lexically marked vs. unmarked case.
  - a. Er gefiel ihr.      Sie mochte ihn.      (both: 'She liked him.')
  - b.  $\lambda y \lambda x \text{ LIKE}(x,y)$      $\lambda y \lambda x \text{ LIKE}(x,y)$   
       +hr

When lexical marking is lost historically, the DAT-NOM verb shifts into a NOM-ACC verb, compare Icelandic *líka*, a DAT-NOM verb, with English *like*.

Moreover, individual elements of a  $\theta$ -structure can be associated with sortal restrictions such as animacy, or subcategorization information such as prepositional case or infinitive/participle for dependent verbs.

- (10) Association with SUBCAT information
  - a. Er wartete auf Diana. ('He waited for Diana.')
  - b.  $\lambda y \lambda x \text{ WAIT}(x,y)$   
       AUF

Third, the working of certain valency-decreasing operations can easily be represented by existential binding; in that case, the respective argument is invisible for argument linking.

- (11) Valency-decreasing operations.
  - a. Er wurde geliebt. ('He was loved.' = 'Someone loved him.')
  - b.  $\lambda y \exists x \text{ LOVE}(x,y)$

Valency-decreasing operations such as passive and antipassive can be defined directly on the  $\theta$ -structure (section 2). In contrast, valency-increasing operations such as causative and applicative do not only add an argument but also a licensing predicate, and thus enrich the semantic core (section 3). The question of how exactly these valency-increasing operations function is dealt with in section 4. Cross-linguistically there is often a certain parsimony in the set of exponents; thus the problem arises that one and the same affix may, e.g., signal causative in one context but anticausative in another context – which is the subject

of section 5. The ordering of operations is considered in section 6. Two further types of argument alternations are only briefly touched upon: those that come about through lexical marking (section 7), and those that make a choice in a set of complementary core predicates (section 8).

Most operations on argument structure can be marked morphosyntactically (by derivational affixes or syntactic constructions), or be left unmarked and only visible by their effects in the morphosyntactic complement structure. Languages widely differ in the amount of marking, and, of course, in the specific means of realizing these operations. English, e.g., often leaves the causative unmarked but marks the passive (12), whereas Basque marks the causative and leaves the passive unmarked (13).

- (12) a. The horse galloped.  
       b. Someone galloped the horse.  
       c. The horse was galloped.
- (13) a. Mikel joan               da.                       ('Mikel is gone.')
- |       |         |      |  |
|-------|---------|------|--|
| Mikel | GO.PERF | 3.be |  |
|-------|---------|------|--|
- b. Mikel joan-araz-i    du.                       ('Someone made Mikel go.')
- |       |              |            |  |
|-------|--------------|------------|--|
| Mikel | go-CAUS-PERF | 3E/3N.have |  |
|-------|--------------|------------|--|
- c. Mikel joan-araz-i    da.                       ('Mikel was made to go.')
- |       |              |      |  |
|-------|--------------|------|--|
| Mikel | go-CAUS-PERF | 3.be |  |
|-------|--------------|------|--|

With GALLOP, a typical intransitive predicate, the two-argument clause (12b) is only intelligible if a further predicate introducing the extra argument is assumed. Conversely, a causativized verb with only one argument, as in (13c), suggests some invisible argument reduction. Operations that have to be inferred by the listener can only apply in canonical instances, whereas a morphologically marked operation can also apply in more peripheral instances and may also lead to idiomatic lexicalization.

A still open question is why languages have all these operations. The most plausible answer is that every participant of an event should get the chance to be expressed as the most prominent argument (discourse anchor or topic, syntactic pivot or subject). For that reason, many operations can even apply in series. In languages that allow for at most two structural arguments, argument extension often has the effect that another participant is promoted to structural object, which in a way means that it is made more 'visible' and could become the topic or subject.

A last general remark concerns the relationship between semantic operations and their morphosyntactic counterparts. The Latin deponential verbs (such as *auxiliari* 'help', *minari* 'threaten', *partiri* 'divide') are semantically active, but nevertheless require passive morphology when they are inflected (*auxili-or tibi* 'help-1sg.PRES.PASS you', 'I help you'). One can assume that these verbs have the *lexical* feature +pass, which triggers passive morphology, and at the same time blocks the semantic operation of passive (which would have to use the same morphology). This shows that the morphological exponent of an operation and the operation itself must be distinguished. In this article, mismatches between lexical features and morphosemantic operations will not be considered any further.

## 2. Argument reduction: passive, antipassive, reflexive, and others

Valency-decreasing operations reduce the number of syntactically active arguments; they apply directly on the  $\theta$ -structure. (14) shows the passive, which binds the highest argument existentially, so that it remains unexpressed. (The event argument is irrelevant here and therefore ignored.)

$$(14) \text{PASS}[\dots \lambda x \text{VERB}(x, \dots)] = \dots \exists x \text{VERB}(x, \dots) \\ \text{--hr}$$

Some languages only allow passivization of transitive verbs, while other languages also include some subclasses of intransitive verbs. The class of verbs that can be passivized is often restricted to agentive verbs, but certain nonagentive verbs can be included as well (e.g., *The garden is surrounded by a fence*). Existential binding causes the passivized n-place verb to be realized with at most n-1 morphosyntactic complements; thus, a transitive verb is detransitized, and an intransitive verb becomes impersonal. As a consequence, another argument is realized by nominative (the default case) and thus becomes morphosyntactic subject. (15) and (16) show that in the passive of ditransitive verbs there are different options regarding the choice of object that becomes nominative. In the two languages illustrated here (Yaqui and Georgian), both objects are marked by accusative in the active. If the recipient shifts to nominative in the passive (as in Yaqui) it is said to be the primary object, while if the theme shifts to nominative (as in Georgian) it is said to be the direct object (Dryer 1986).

### (15) Double accusative and passive in Yaqui (van Valin 2006)

- a. Joan Peo-ta ?uka vaci-ta miika-k.  
     Juan Pedro-ACC DET.ACC corn-ACC give-PERF  
     ‘Juan gave Pedro the corn.’
- b. Peo ?uka vaci-ta miik-wa-k.  
     Pedro DET.ACC corn-ACC give-PASS-PERF  
     ‘Pedro was given the corn.’
- c. \* U?u vaci Peo-ta miik-wa-k.  
     DET.NOM corn Pedro-ACC give-PASS-PERF  
     ‘The corn was given to Pedro.’

### (16) Double accusative and passive in the present series of Georgian (Joppen-Hellwig 2001: 50)

- a. Ketino Eka-s xalitša-s s-čukni-s.  
     Ketino Eka-ACC carpet-ACC 3D-present-PRES.3N  
     ‘Ketino presents Eka with a carpet.’
- b. xalitša e-čuk-eb-a Eka-s.  
     carpet PASS-present-TH-PRES.3N Eka-ACC  
     ‘The carpet is presented to Eka.’
- c. \* Eka e-čuk-eb-a xalitša-s.  
     Eka PASS-present-TH-PRES.3N carpet-ACC  
     ‘Eka is presented with a carpet.’



This shows that passivization is not only a test for subjecthood (answering the question of which argument is demoted in the passive) but also for objecthood, in that it makes a distinction between two types of double objects: primary vs. secondary object on the one hand, and direct vs. indirect object on the other (Dryer 1986, Wunderlich 2006: 136). Languages with symmetric objects (Bresnan & Moshi 1990) allow both alternatives: either the recipient or the theme becomes the syntactic subject in the passive. These differences clearly indicate that the promotion to nominative is not part of the passive operation, but a subsequent effect dependent on typological factors.

Passive is an operation found in nearly every language because it reflects a ubiquitous salience shift. If an argument other than the highest one is the actual topic, definite/specific, or a speech act participant, it might be more salient than the current highest argument; in that case, passive can shift it to a higher argument position, thus making its high salience also visible. (Aissen 1999 discusses subject choice in the framework of Optimality Theory.)

In most languages, the passive operation is marked by a verbal affix, a particle, or an auxiliary, but it can also be made visible by a shift in the complement pattern even if a separate marker of the passive is lacking. Some languages allow the so-called personal passive, in which the highest argument of a passivized verb is expressed by an oblique instrument, source, or agent phrase; such a phrase is best seen as an adjunct whose free argument is coindexed with the existentially bound argument. Assume that the sentence *John was kissed by Ann* is represented as  $\lambda y \exists e \{ \exists x \text{ KISS}(x,y)(e) \ \& \ \text{AGENT}(\text{Ann},e) \}(\text{John})$ , then  $x = \text{Ann}$  is a contextual default for the value of  $x$ .

Various theories of the passive have been proposed, among them the voice hypothesis (Kratzer 1994), claiming that verbs have a basic form without agent, and only if they are integrated into a voice phrase, is an agent either added (in the active voice) or not (in the passive voice). This hypothesis suggests that active voice is the more marked variant of a transitive verb, which, however, is only rarely observed cross-linguistically (e.g., in languages of the Austronesian family). Moreover, it does not describe the semantic effect of passive as existential binding but rather as the absence of an argument.

In view of examples such as those in (17), Keenan (1980) and Dowty (1982) argued that English passive must operate on transitive verb phrases rather than verbs, e.g., on the VP *think cancer to be unlikely to be caused by hot dogs* in (17a). However, already Bresnan (1982) showed that a lexical rule of passive is able to handle these more complex instances, too.

- (17) Passive of raising and control predicates (Bresnan 1982: 65)
- a. Cancer is now thought to be unlikely to be caused by hot dogs.
  - b. Intruders are now forced to be prepared to be attacked by dogs.

Let us assume that (18a) represents the passive of *think* and (18b) the embedded complex (itself being passivized), then (18c) results through functional composition as the approximate representation of (17a). This clearly shows that the most internal argument is shifted to the subject of the whole complex by means of two passive operations. (Note that in a polysynthetic language such as Greenlandic all the higher

predicates are affixes, thus the operations are necessarily word-internal rather than affecting VPs.)

(18) Analysis of raising + passive

- a.  $\lambda p \exists x \text{ THINK}(x, p)$
- b.  $\lambda z \exists y \text{ UNLIKELY}(\text{CAUSE}(y, z))$                       Raising
- c.  $\lambda z \exists x \text{ THINK}(x, \exists y \text{ UNLIKELY}(\text{CAUSE}(y, z)))$

Similarly, with the three pieces in (19a) one gets (19b) in the first step, and (19c) in the second step, representing (17b). Here, the most internal argument is stepwise identified with the subject of *be prepared* and the object of *force*; again, two passives are involved.

(19) Analysis of control + passive

- a.  $\lambda z \exists u \text{ ATTACK}(u, z)$   
 $\lambda P \lambda y \text{ PREPARED}(y, P(y))$                       Subject control  
 $\lambda Q \lambda x \exists v \text{ FORCE}(v, x, Q(x))$                       Object control
- b.  $\lambda y \text{ PREPARED}(y, \exists u \text{ ATTACK}(u, y))$
- c.  $\lambda x \exists v \text{ FORCE}(v, x, \text{PREPARED}(x, \exists u \text{ ATTACK}(u, x)))$

Antipassive is the counterpart to passive; it binds the lowest (rather than the highest) argument existentially, as shown in (20).

- (20)  $\text{ANTIPASS}[\lambda z \dots \text{VERB}(\dots, z)] = \exists z \dots \text{VERB}(\dots, z)$   
 -Ir

While the passive is induced by a particularly high salience status of the lower argument, the antipassive is induced by a particularly low status of that argument. It is therefore expected to be a less universal operation than passive. Whereas a canonical NOM-ACC verb turns into Ø-NOM by passivization, a canonical ERG-NOM verb turns into NOM-Ø by antipassivization; in both instances, a realization with a marked case is avoided. Although antipassive is particularly often found in ergative languages, it is not restricted to this type of language, the same way as passive is not restricted to accusative languages. A language can show both passive and antipassive by means of marked morphemes; an example is given in (21). One often finds a combination of causative with antipassive, as in (21c). Similarly, *he is cleaning* is derived from the causative verb *to clean* in English; ‘object deletion’ in languages such as English or German is just a form of antipassive without using a morpheme.

(21) Passive, antipassive, and causative+antipassive in Zoque (Johnson 2000)

- a. hu/c-/əm-wə      bi      wakaš.  
      stab-PASS-COMPL    DEF    cow  
      ‘(They) killed the cow.’
- b. behča      cəm-/oy-pa.  
      horse    carry-ANTIP-INCOMPL  
      ‘The horses will carry (it).’



contrast between the two arguments is not necessary. According to Bittner, the various semantic effects of the antipassive construction show up in the context of an operator such as negation, quantifier, tense, modality, or distributive plural. Unlike the nominative object-NP of the plain transitive clause, the corresponding instrumental NP of the antipassive may have narrow scope, and that reading is preferred if the construction is contrasted with the plain transitive; only in that case is the instrumental NP indefinite or unspecific. (24) to (26) show some of Bittner's examples. The a-sentences are transitive and only allow the wide scope reading A, whereas the b-sentences are antipassivized and allow the narrow scope reading B as well. The notation is Bittner's, except that ' $\forall y \in \{\text{they}\}$ ' is used for her distribution operator.

Narrow scope readings of Greenlandic antipassive (Bittner 1987)

- (24) a. *arnaq franskiq angirlaat-tar-pa-a.* = A, \*B  
 woman.NOM French.NOM [come.home.with]-HAB-TR.INDIC-3sgE/3sgN
- b. [*arnaq-mik franskiq-mik angirlaat-(ss)i]-tar-pu-q.* = A, B  
 [woman-INS French-INS come.home.with-AP]-HAB-TR.INDIC-3sgN  
 'He often comes home with French woman.'  
 A. It's always the same woman.  
 B. Different women on different occasions.  
 A.  $\exists x[x \text{ is a French woman \& often (he comes home with } x)]$   
 B. *often* ( $\exists x[x \text{ is a French woman \& he comes home with } x]$ )
- (25) a. *ullut tamaasa irinarsurtuq tusar-pa-a.* = A, \*B  
 days all singer.NOM [hear]-TR.INDIC-3sgE/3sgN
- b. *ullut tamaasa irinarsurtuq-mik tusar-si-pu-q.* = A, B  
 days all [singer-INS hear-AP]-INTR.INDIC-3sgN  
 'Every day he hears singer.'  
 A. Same singer every day.  
 B. Different singers on different days.  
 A.  $\exists x[x \text{ is a singer \& every day (he hears } x)]$   
 B. *every day* ( $\exists x[x \text{ is a singer \& he hears } x]$ )
- (26) a. *cigaretti [ikit]-pa-at* = A, \*B  
 cigarette.NOM [light]-TR.INDIC-3plE/3sgN
- b. [*cigaretti-mik ikit-si]-ppu-t* = A, B  
 [cigarette-INS light-AP]-INTR.INDIC-3plN  
 'They lit cigarette.'  
 A. What they lit was just one cigarette for the whole group.  
 B. They lit a cigarette each.  
 A.  $\exists x(x \text{ is a cigarette \& } \forall y \in \{\text{they}\}(\text{lit}(y, x)))$   
 B.  $\forall y \in \{\text{they}\}(\exists x(x \text{ is a cigarette \& lit}(y, x)))$

Inspired by these findings, Bittner detected similar effects of case alternations in Basque, Polish, Russian, and Finnish, where nominative has wide scope over negation, modals, etc., while genitive and partitive, triggered by these elements, can or must have narrow scope – this leads to the generalization in (27).

(27) *The Scope Generalization (Bittner 1987)*

If an argument can be expressed either by an NP in the case predicted by the parameter settings for the language [canonical argument structure] or by some other kind of phrase, then the parametric alternant [the NP] will obligatorily take wide scope with respect to sentential operators, such as negation, tense, aspect, modals, distributive operators, etc., while the nonparametric alternant [the other kind of phrase] will be permitted to take scope under these operators. It may in fact be restricted to take narrow scope.

This generalization suggests that argument structure alternations such as antipassive are motivated by the need to express different scope relations. Let us assume that a structural argument, in particular the nominative argument, is a good candidate for the topic, which usually has wide scope; then existential binding and/or a semantic case reduce the possibility of being the topic. Structurally, a semantic case typically indicates an adjunct rather than an argument; adjuncts belong to the VP predicating of the subject. The above-mentioned negation, modals, etc. are part of the VP, and therefore are able to take a semantic adjunct, but not the subject, into their scope.

Another argument reduction operation is the lexical reflexive. It establishes an anaphoric relationship by identifying a lower argument with the highest one. Such an operation is distinct from using a reflexive anaphora (such as *themselves*) in the syntax.

$$(28) \quad \begin{array}{ccc} \text{REFL}[\lambda z \dots \lambda x \text{ VERB}(x, \dots, z)] & = & \lambda x \text{ VERB}(x, \dots, x) \\ +\text{lr} \quad -\text{lr} & & -\text{lr} \end{array}$$

(29a) shows the canonical case, in which a transitive verb is detransitivized. In (29b) however, the verb remains transitive; in this case a possessor is added to the core arguments (which makes the verb ditransitive) and is then identified with the highest argument. In general, reciprocal functions similarly, but has a more complex semantics (Heim, Lasnik & May 1991, Williams 1991): the antecedent  $X$  must be plural and must receive a distributed interpretation, and any  $x \in X$  is paired with some (or every)  $y \in X$ , where  $y \neq x$ . Interestingly, (29c) illustrates a case in which the reciprocal morpheme must be combined with the reflexive in order to unfold its full semantics.

## (29) Reflexive and Reciprocal in Bolivian Quechua (van de Kerke 1996: 160, 146)

- a. Pedru maylla-ku-n  
Pedru wash-REFL-3sg  
'Pedro washes himself.'  
 $\text{REFL}[\lambda y \lambda x \text{ WASH}(x, y)] = \lambda x \text{ WASH}(x, x)$
- b. Pedru uya-n-ta maylla-ku-n  
Pedru face-3sg-ACC wash-REFL-3sg  
'Pedro washes his (own) face.'  
 $\text{REFL}[\lambda z \lambda y \lambda x \{\text{WASH}(x, z) \ \& \ \text{POSS}(y, z)\}] = \lambda z \lambda x \{\text{WASH}(x, z) \ \& \ \text{POSS}(x, z)\}$
- c. maylla-na-ku-yku  
wash-REC-REFL-1pl  
'We wash each other.'

Incorporation is quite a different type of argument reduction; in this case, an argument is realized by a morphologically integrated nominal predicate. For instance, a noun can be

prefixed to the verb stem, which indicates that this noun predicates of the lowest argument of the verb. Van Geenhoven (1998) analysed incorporated nouns as predicative indefinites. Formally, one can assume an operation that takes two elements in the input, a noun and a verb, and produces a coherent verb reading by argument identification, see (30).

$$(30) \text{ INCORP} < \lambda v \text{ NOUN}(v), \lambda z \dots \text{VERB}(\dots, z) > = \exists z \dots \{ \text{VERB}(\dots, z) \ \& \ \text{NOUN}(z) \} \\ -\text{lr}$$

This analysis suggests that noun incorporation always leads to a general or unspecific reading; however, some languages also allow a specific reading of the incorporated noun, as in (31a), where a demonstrative is stranded. Its referent has to be identified with the entity the complex N-V predicate predicates of, see (31b).

- (31) Noun incorporation with definite reading in Southern Tiwa (Baker 1988: 93)
- a. Yede a-seuan-mu-ban.  
that 2sg-man-see-PAST  
'You saw that man.'
  - b.  $R(\text{'that'}) = \iota z \{ \text{SEE}(\text{you}, z) \ \& \ \text{MAN}(z) \}.$

Noun incorporation cannot be iterated, and only the lowest argument can be incorporated – probably because canonical  $\lambda$ -application takes place, affecting the lowest  $\theta$ -role first. Noun incorporation creates a configuration where arguments other than the lowest one can function as structural object (or even as subject): a recipient (32a), an instrument (32b), a possessor (32c,d), or a goal (32e). A ditransitive verb is transitivized in (32a), and a transitive verb is detransitivized in (32b,c), but then either undergoes instrumental applicative (see next section) or inherits the possessor from the incorporated possessed noun, and thus again shows a transitive construction. Similarly, an intransitive verb again becomes intransitive when it undergoes applicative (32e) or inherits the possessor (32d). (The bracketing in the semantic representations shows the respective ordering of operations.)

- (32) Noun incorporation (Baker 1988)

- a. Ka-'u'u-wia-ban. *Southern Tiwa*  
1sg/2sg-baby-give-PAST  
'I gave you the baby.'  
 $\lambda y \lambda x \exists z \{ (\text{ACT}(x) \ \&_{\text{CAUS}} \text{BEC POSS}(y, z)) \ \& \ \text{BABY}(z) \}$
- b. Kua ta fakatino he tama e malala. *Niue (Polynesian)*  
PERF-draw-picture ERG-child NOM-charcoal  
'The child has been drawing pictures with a charcoal.'  
 $\lambda z \lambda x \{ \exists y (\text{DRAW}(x, y) \ \& \ \text{PICTURE}(y)) \ \& \ \text{INST}(z) \}$
- c. Wa-hi-nuhs-ahni:nu: John. *Oneida*  
PAST-1sg/3m-house-buy John  
'I bought John's house.'  
 $\lambda z \lambda x \exists y \{ \text{BUY}(x, y) \ \& \ (\text{HOUSE}(y) \ \& \ \text{POSS}(z, y)) \}$

- d. Hrao-nuhs-rakv    ne sawatis.    *Mohawk*  
 3m-house-white    John  
 ‘John’s house is white.’  
 $\lambda y \exists x \{ \text{WHITE}(x) \ \& \ (\text{HOUSE}(x) \ \& \ \text{POSS}(y,x)) \}$
- e. Am-seuan-wan-ban    liora-n.    *Southern Tiwa*  
 3pl-man-come-PAST    lady-pl  
 ‘The man came to the ladies.’  
 $\lambda y \{ \exists x (\text{COME}(x) \ \& \ \text{MAN}(x)) \ \& \ \text{GOAL}(y) \}$

### 3. Argument extension: causative, applicative, resultative, and others

The opposite of argument reduction is argument extension: valency-increasing operations extend the number of syntactically active arguments. Argument reduction always binds an existing argument, so the semantic core can remain unaffected. An additional argument, however, needs to be licensed by an additional predicate; therefore, argument extension always affects the semantic core itself. Either a higher predicate together with a higher argument is added, or a lower predicate together with a lower argument. A prototypical instance of the former type of operations is the causative, whereas different variants of the applicative are characteristic for the latter type of operations.

The causative adds a causer, who instigates the event expressed by the basic verb, either by direct coercion, or more indirectly by giving an order or admitting a certain course of affairs. Some version of causative is found in nearly every language, and many languages have more than one type of causative (differing morphosyntactically and often also in their finer semantic aspects). It is disputed in the literature whether the causative has to be represented explicitly by the predicate CAUSE (and whether this CAUSE is a relation between two events or between an entity and an event), or whether the causal relationship can be inferred from the lexical combination of an action predicate with another, simpler predicate (see, e.g., the different views advocated by Bierwisch 2002 vs. Wunderlich 2000, 2012). For the purposes of this article, I use the notion  $\&_{\text{CAUSE}}$ , taken as a contextually-induced reading of the connector AND. (Notice that  $\&_{\text{CAUSE}}$  is asymmetric, just as  $\&$ , when used in a lexical decomposition from which argument hierarchy is derived.) Moreover, the causative usually gets a factive reading, which is expressed by existential binding of the verb’s original event variable.

$$(33) \text{ CAUS } [\lambda e' \text{ VERB}(\dots)(e')] = \dots \lambda x \lambda e \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \exists e' \text{ VERB}(\dots)(e') \}(e)$$

In a typical causative formed from a transitive verb the causee becomes the medial argument; it is marked dative in an accusative language such as Japanese (see below (39a)), as well as in an ergative language such as Basque (34).

- (34) Causative in Basque  
 Ama-k            haurr-a-ri            zopa            jan-eraz-i            dio.  
 mother-ERG    child-DET-DAT    soup.NOM    eat-CAUS-PERF    have.3N.3sgD.3sgE  
 ‘Mother let the child eat the soup’  
 $\lambda z \lambda y \lambda x \lambda e \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \exists e' \text{ EAT}(y,z)(e') \}(e)$

In a double object construction the causee is realized as the primary object (which can become the subject under passive, can be co-indexed with an object affix, etc.). Besides this unmarked option, illustrated in (35a), there is also a marked option, in which the causee is obliquely realized and does not function as a structural object (35b). Such a marked option is found in various languages, even in those that otherwise have a dative; in Hungarian, for instance., it can be captured by the assumption that the causative morpheme lexically assigns instrumental case (36b) (Wunderlich 2002).

(35) Causative variation in Bantu: Chimwiini (a) vs. Chichewa-A (b) (Baker 1988: 183,163)

- a. Mwa:limu Ø-wa-andik-ish-ize wa:na xati.  
 teacher SU-OB-write-CAUS-ASP children letter  
 'The teacher made the children write a letter.'
- b. Anyani a-na-wa-meny-ets-a ana kwa buluzi.  
 baboons SU-PAST-OB-hit-CAUS-ASP children to lizard  
 'The baboons made the lizard hit the children.'

(36) Medial arguments in Hungarian

- a. Anna Péter-nek adott egy könyv-et.  
 Anna Peter-DAT gave a book-ACC  
 'Anna gave a book to Peter.'
- b. Anna könyv-et olvas-tat Péter-rel.  
 Anna book-ACC read-CAUS Peter-INST  
 'Anna has Peter read a book.'

Another possible variant of the causative is a construction formed with an object control verb, such as *force*, *make*, or *let* (*force him to go*, *make him go*, *let him go*). Such a verb adds two arguments, whereby it identifies the object with the subject of a dependent (infinitive) clause (37a). However, that a single morphological operation produces an object control configuration would be unexpected if a simpler alternative is available (37b).

(37) Object control vs. causative

- a.  $\lambda P \lambda y \lambda x \text{FORCE}(x, y, P(y))$   
 b.  $\lambda p \lambda x \{ \text{ACT}(x) \ \&_{\text{CAUSE}} p \}$

A few languages have operations that add a highest argument in a function distinct from causer. One such operation is the assistive in Quechua. (38) shows that causative and assistive are structurally alike in Quechua: either a causer or a helper is added as the highest argument. Note that a helper does not necessarily contribute an additional event because she is involved in the same type of action as the helpee. (Quechua lacks a dative, therefore all objects are realized as accusative; object agreement on the verb refers to the highest object, which is the causee or helpee in these cases.)

(38) Causative and Assistive in Bolivian Quechua (van de Kerke 1996: 153, 157)

- a. mama-y Maria-ta maylla-chi-wa-rqa  
 mother-1sg Mary-ACC wash-CAUS-1A-PAST





The most prototypical instance of applicative is the benefactive alternation, shown in (41); here, the transitive verb ‘buy’ becomes ditransitive by means of the applicative suffix in (41b). Following Baker (1988), one might say that the preposition ‘for’ is incorporated into the verb, so that the prepositional object becomes a direct argument of the verb. However, since *untuk* ‘for’ and the applicative *kan* are quite distinct morphemes, ‘incorporation’ would have to be understood in a rather abstract sense. Conceptually it is more convenient to consider the applicative as a way of expressing further participants, independently of whether corresponding prepositional means exist. Thus, the relationship between (41a) and (41b) is purely semantical, not generative; the applicative applies on the verb, not on a syntactic construction. The predicate variable ‘P’ in (41a) serves as a placeholder for the prepositional phrase, which could also be ‘with’, ‘in’, etc. Even if one concedes that the applicative could have a comitative rather than a benefactive meaning, the verb in (41b) is more specific than that in (41a) because it has a third structural argument.

(41) Benefactive alternation in Bahasa Indonesia (Chung 1976)

- a. Ali memi telefisi untuk ibu-nja.  
 Ali TR.buy television for mother-his  
 ‘Ali bought a television for his mother.’  
 $\lambda P \lambda z \lambda x \lambda e \{ \text{BUY}(x, z) \ \& \ P(z) \} (e)$
- b. Ali mem-beli-kan ibu-nja telefisi.  
 Ali TR-buy-APPL mother-his television  
 ‘Ali bought his mother a television.’  
 $\lambda z \lambda y \lambda x \lambda e \{ \text{BUY}(x, z) \ \& \ \text{BECOME POSS}(y, z) \} (e)$

A similar argumentation holds for the locative alternation as described for English, German, or Hungarian. The semantically related sentences in (42a,b) or (43a,b) can be assumed to be base-generated rather than derived from each other. (This does not exclude the possibility of preposition incorporation in instances like (44).) It has often been observed that there are finer semantic differences between the respective a- and b-sentences (Brinkmann 1995), which follow from the different status of the arguments involved. The a-sentences are preferred if one wants to communicate that all parts of the stuff (hay, paint) were located somewhere, whereas the b-sentences are preferred if all parts of a location were occupied by the stuff. The question why ‘hay’ in (42b) and ‘paint’ in (43b) cannot be expressed as structural arguments cannot be discussed here, but see Wunderlich (1997a,b).

(42) Locative alternation in Hungarian (Ackermann 1992)

- a. a paraszt (rá-)rakta a szénát a szekérre.  
 the peasant (onto-)loaded.3sg.DEF the hay.ACC the wagon.SUBJ  
 ‘The peasant loaded the hay onto the wagon.’  
 $\lambda P \lambda y \lambda x \lambda e \{ \text{LOAD}(x, y) \ \& \ P(y) \} (e)$
- b. a paraszt meg-rakta a szekeret (szénával).  
 the peasant PERF-loaded.3sg.DEF the wagon.ACC (hay.INSTR)  
 ‘The peasant loaded the wagon (with hay).’  
 $\lambda z \lambda x \lambda e \{ \text{LOAD}(x, y) \ \& \ \text{BECOME LOC}(y, \text{AT}(z)) \} (e)$

## (43) Locative alternation in German (Brinkmann 1995)

- a. Die Vandalen spritzten Farbe auf das Auto.  
 the vandals sprayed paint onto the car
- b. Die Vandalen be-spritzten das Auto (mit Farbe).  
 the vandals BE-sprayed the car (with paint)

## (44) Preposition incorporation in German

- a. Sie flogen über die Ostsee.  
 they flew over the Baltic Sea.  
 $\lambda P \lambda x \lambda e \{ \text{FLY}(x) \ \& \ P(x) \}(e)$
- b. Sie über-flogen die Ostsee.  
 they over-flew the Baltic Sea.  
 $\lambda y \lambda x \lambda e \{ \text{FLY}(x) \ \& \ \text{LOC}(x, \text{AT}(y)) \}(e)$

The examples (45a–c) illustrate some applicative variants in the Bantu language Kinyarwanda; benefactive, possessor-raising, and instrumental applicative are marked by different suffixes. As one can see, *-iish* is ambiguous; it either marks instrumental applicative or causative (45c, d). The reading depends on the sortal properties of the complements: usually a child but not a piece of soap is washed, while soap but not a child can be an instrument of washing.

## (45) Applicatives in Kinyarwanda (Polinsky &amp; Kozinsky 1992)

- a. umugóre y-a-som-e-ye umwáana igitabo.  
 woman 3sg-PAST-read-APPL-PERF child book  
 ‘The woman read the book to the child.’ (*benefactive applicative*)
- b. umugabo a-ra-kikir-ir-a umugóre umwáana.  
 man 3sg-PRES-hold-APPL-IMPF woman child  
 ‘The man is holding the woman’s child.’ (*possessor-raising applicative*)
- c. umugóre y-Ø-uhag-iish-ije umwáana isábune.  
 woman 3sg-PAST-wash-APPL-PERF child soap  
 ‘The woman washed the child with soap.’ (*instrumental applicative*)
- d. umugóre y-Ø-uhag-iish-ije umukoóbwa umwáana.  
 woman 3sg-PAST-wash-CAUS-PERF girl child  
 ‘The woman made the girl wash the child.’ (*causative*)

A further type of argument extension on the lower end of the argument hierarchy is the strong resultative, by which both an object and a predicate are added to the verb (Washio 1997, Wunderlich 1997b, Kaufmann & Wunderlich 1998, Wunderlich 2000). As the examples (46a,b) show, the object is only licensed by the result predicate, not by the verb itself. (46c) shows the general templatic operation.

## (46) Strong resultatives

- a. Paul ran the lawn flat. (\*Paul ran the lawn)  
 $\lambda y \lambda x \lambda e \{ \text{RUN}(x) \ \&_{\text{CAUSE}} \text{BECOME FLAT}(y) \}(e)$
- b. Paul drank the fridge empty. (\*Paul drank the fridge)  
 $\lambda y \lambda x \lambda e \exists z \{ \text{DRINK}(x,z) \ \&_{\text{CAUSE}} \text{BECOME EMPTY}(y) \}(e)$

- c.  $\text{RES}[\text{VERB}(\dots)] = \{\text{VERB}(\dots) \&_{\text{CAUSE}} \text{BECOME RESULT}(z)\}$ , where *RESULT* is a predicate variable.

Interestingly, unlike causatives, which are usually encoded by a generalized morpheme leaving the causing action unspecific, resultatives are rarely encoded by a generalized morpheme, but mostly by the presence of a predicate that specifies the result. This might be predicted by a general cognitive principle “A causal action can remain unspecific, but a result must be specified”. In any case, although they add a lower argument as well, resultatives crucially differ from applicatives in that they always specify the result property. The only generalized resultative marker I am aware of is Chinese *de*, derived from the verb ‘obtain’, which is used in a verbal compound as in (47).

(47) Chinese *de*-construction

- a. Ta ku-**de** shoujuan quan shi le.  
 he cry-DE handkerchief all wet FIN  
 lit. ‘He cried such that the handkerchief got all wet.’  
 ‘He cried the handkerchief all wet.’
- b. Lisi zhui-**de** Zhangsan hen lei.  
 L chase-DE Z very tired  
 lit. ‘Lisi chased somebody and [as a result] Zhangsan got very tired.’  
 ‘Lisi chased Zhangsan very tired.’

More specific markers of resultativity are found as prefixes or particles in languages such as Hungarian, Russian, or German. In (48), the prefix *er-* contributes the result predicate POSS.

(48) German prefix verbs (Stiebels 1996)

- a. Sie er-schrieb sich den Pulitzer-Preis.  
 She **er**-wrote herself the Pulitzer price.  
 ‘She won the Pulitzer price by her writing’
- b.  $\lambda v \lambda u \lambda x \lambda e \exists y \{\text{WRITE}(x,y) \&_{\text{CAUSE}} \text{BECOME POSS}(u,v)\}(e)$   
 y becomes non-structural here and cannot be realized as a complement  
 (Wunderlich 1997b).

## 4. Functor vs. incorporation

Derivational morphemes such as causative and applicative are usually considered to be morphological heads; they apply on a verb in order to form a more complex verb. Even if the Kinyarwanda suffix *-iish* is ambiguous between causative and applicative, there is certainly no difference in the headedness status between causatives and applicatives. However, as outlined above, the causative adds a new highest argument, while the applicative adds a non-highest argument; therefore, they must have a different status in functional composition. I take it for granted that the functor in a derivation contributes the highest argument. Thus, the causative morpheme is a functor that takes the verb, but,

in virtue of the same logic, the applicative morpheme cannot be the functor. Hence, in that case the verb itself must be the functor, but has to undergo a templatic predicate extension in order to incorporate a further predicate.

(49a,b) repeats the pair of sentences (45d,c) from above, and adds a benefactive formed from the same verb. Let (50a) represent the causative reading of *-iish*, and (50b) the verb ‘wash’. Then, (50c) derives via functional composition; a highest argument is added, and all original arguments of the verb are inherited.

(49) Causative, instrumental, and benefactive applicative in Kinyarwanda

a. umugóre y-Ø-uhag-iish-ije umukoóbwa umwáana.  
 woman 3sg-PAST-wash-CAUS-PERF girl child  
 ‘The woman made the girl wash the child.’

b. umugóre y-Ø-uhag-iish-ije umwáana isábune.  
 woman 3sg-PAST-wash-APPL-PERF child soap  
 ‘The woman washed the child with soap.’

c. umugóre y-Ø-uhag-e-ye umukoóbwa umwáana.  
 woman 3sg-PAST-wash-APPL-PERF girl child  
 ‘The woman washed the child for the girl.’

(50) The causative as a functor on the verb

- a. causative *-iish*:  $\lambda V \lambda u \lambda e \{ \text{ACT}(u) \ \&_{\text{CAUSE}} \ \exists e' V(e') \}(e)$   
 b. *uhag*:  $\lambda y \lambda x \lambda e \text{ WASH}(x,y)(s)$   
 c. *uhag-iish*:  $\lambda y \lambda x \lambda u \lambda e \{ \text{ACT}(u) \ \&_{\text{CAUSE}} \ \exists e' \text{ wash}(x,y)(e') \}(e)$

However, with applicatives preserving the original subject, the verb must function as functor. In order for that, the verb undergoes the templatic extension shown in (51), incorporating the predicate P, whatever it is.

(51) Predicate incorporation into a verb:

$$\mathbf{P-INCORP} \langle P, \dots \lambda e \text{ VERB}(\dots)(e) \rangle = \lambda P \dots \lambda e \{ \text{VERB}(\dots)(e) \ \& \ P(e) \},$$

which can be simplified as  $\{ \text{VERB}(\dots) \ \& \ P \}(e)$

Let us assume that the verb ‘wash’ is augmented in this way (52a), and that P is instantiated by an instrumental predicate (52b), then (52c) is derived via functional composition. Here, the original arguments of the verb remain the highest ones, whereas those of the incorporated predicate become lower ones. For the complex event denoted by the derived verb to be coherent, incorporans and incorporandum should share an argument. In principle, *v* can be identified with either *e* or *y* (with slightly different readings: ‘instrument of performing an action’, ‘instrument operating on an individual entity’), but certainly not with *x*. This yields one of the representations given in (52d); the difference is that the instrumental object is either the lowest or the medial argument of the complex verb. When combined with a transitive verb, the applied instrumental object (*u*) in the Bantu languages does in fact sometimes have properties of the lowest, and sometimes of a medial argument (Marantz 1993).

- (52) The (extended) verb as functor on the applicative
- $\text{P-INCORP}(uhag): \lambda P \lambda y \lambda x \lambda e \{ \text{WASH}(x,y) \ \& \ P \}(e)$
  - applicative *-iish*:  $\lambda v \lambda u \text{ INSTR}(u,v)$
  - uhag-iish*:  $\lambda v \lambda u \lambda y \lambda x \lambda e \{ \text{WASH}(x,y) \ \& \ \text{INSTR}(u,v) \}(e)$
  - $\lambda u \lambda y \lambda x \lambda e \{ \text{WASH}(x,y) \ \& \ \text{INSTR}(u) \}(e)$   
 $\lambda y \lambda u \lambda x \lambda e \{ \text{WASH}(x,y) \ \& \ \text{INSTR}(u,y) \}(e)$

In contrast, the applied beneficiary mostly shows properties of the medial argument, and the applied locative object shows properties of the lowest argument (Alsina & Mchombo 1990). This is expected, given that the predicate that integrates beneficiaries is assumed to be  $\text{POSS}(u,v)$ , with  $u$  being the applied object, whereas the predicate in the case of locative application is  $\text{LOC}(v, \text{AT } u)$ , again with  $u$  being the applied object. (McGinnis (2005) proposes a phase-theoretic analysis for the different behavior of these types of applicatives.)

Of course, one could think of representing the causative and applicative morphemes in a more uniform way, e.g. as  $\{ \text{CAUSER}(u) \ \& \ \text{VERB} \}$  vs.  $\{ \text{VERB} \ \& \ \text{INSTR}(u) \}$ , but in that case the actual hierarchy of arguments would not be determined by functional composition, and additional reasons would have to be found.

In the German prefix verbs, the verb is both the head and the functor. (53a) repeats (48a) from above. (53b) shows the verb extended by  $\text{P-INCORP}$ , and (53c) the semantic contribution of the prefix *er-*. Functional composition then yields the result in (53d). As a matter of fact, the document written ( $y$ ) cannot be expressed because it neither is in the position of a structural argument (Wunderlich 1997b) nor can be identified with the thing to become possessed ( $v$ ); therefore it must be bound existentially.

- (53) German prefix verbs (Stiebels 1996)
- Sie *er*-schrieb sich den Pulitzer-Preis.  
 She *er*-wrote herself the Pulitzer price.  
 ‘She won the Pulitzer price by her writing’
  - $\text{P-INCORP}(schreib): \lambda P \lambda y \lambda x \lambda e \{ \text{WRITE}(x,y) \ \& \ P \}(s)$
  - resultative *er-*:  $\lambda v \lambda u \text{ BECOME POSS}(u,v)$
  - er-schreib*:  $\lambda v \lambda u \lambda y \lambda x \lambda e \{ \text{WRITE}(x,y) \ \& \ \text{BECOME POSS}(u,v) \}(e)$   
 $\Rightarrow. \lambda v \lambda u \lambda x \lambda e \exists y \{ \text{WRITE}(x,y) \ \& \ \text{BECOME POSS}(u,v) \}(e)$

The representation (53d) is still unsatisfactory because it doesn’t make explicit the difference between a factual and an intended result. If I write a novel for Paul I intend Paul to become the possessor of the novel ( $\text{WRITE}(x,y) \ \&_{\text{INTEND}} \text{BECOME POSS}(u,y)$ ), however, if Paul then wins the Pulitzer price with this novel (pretending to have written it himself) the sentence ‘Ich erschrieb Paul den Pulitzer-Preis’ becomes true. The minimal repair in (53d) would be ‘ $\&_{\text{CAUSE}}$ ’ instead of ‘ $\&$ ’, but this would require a slightly different incorporation template to start with.

## 5. Parsimony in the set of exponents: polyfunctional affixes

In the Pama-Nyungan languages of Australia a single affix often functions as a general transitivity marker. For instance, the Kalkatunga suffix *-nti* adds a causer if it is

combined with an inchoative or stative verb (54a), but it adds a beneficiary, instrument, or location if it is combined with an agentive verb (54b). In a subgroup of these languages the same affix can be applied to transitive verbs as well, but usually only when they have first been detransitivized by antipassive, as in (54c), where the demoted object is realized by oblique dative marking.

(54) Transitivity in Kalkatunga (Austin 1997)

- a. iti 'return'      iti-nti 'send/bring back'  
     nguyi 'fall'     nguyi-nti 'push over'
- b. nuu 'lie'        nu-nti 'lie on (something)'  
     wani 'play'    wani-nti 'play with (something)'
- c. Nga-thu    kati-nti-mi    tharntu    kupangurru-u.  
     1-ERG    bury-TR-FUT   hole.NOM   old.man-DAT  
     'I will bury the old man in a hole.'

A canonical transitive verb can possibly be decomposed into an active (controller) and an affected predicate. Given that an intransitive verb is either active or affected, the function of the transitivity affix then is to derive a canonical verb, i.e. to add the respective complementary predicate.

(55) **TR** [VERB] results in a canonical transitive verb

- $$\begin{aligned} \text{TR} [\lambda y \text{ AFF}(y)] &= \lambda y \lambda x \text{ ACT}(x) \ \& \ \text{AFF}(y) \\ \text{TR} [\lambda x \text{ ACT}(x)] &= \lambda y \lambda x \text{ ACT}(x) \ \& \ \text{AFF}(y) \end{aligned}$$

A different type of affix such as *-e* in Japanese either transitivity or detransitivizes. Comrie (2006) lists 57 inchoative/causative pairs in which *-e* derives the causative verb (56a), and 36 pairs in which it functions as the opposite, namely derives the inchoative verb from the transitive one (56b). Even larger is the number of pairs where the two verbs are derived by different means (56c).

(56) Causatives vs. anticausatives in Japanese (Comrie 2006)

- a. ak-u 'open'                      ak-e-ru 'open (tr.)'  
     itam-u 'hurt'                tam-e-ru 'injure'  
     tat-u 'stand'                tat-e-ru 'raise'
- b. nuk-u 'remove'                nuk-e-ru 'come off'  
     or-u 'break (tr.)'            or-e-ru 'break'  
     tuka-u 'use'                tuka-e-ru (be usable)
- c. kowa-s-u 'destroy'            kowa-re-ru 'be destroyed'.

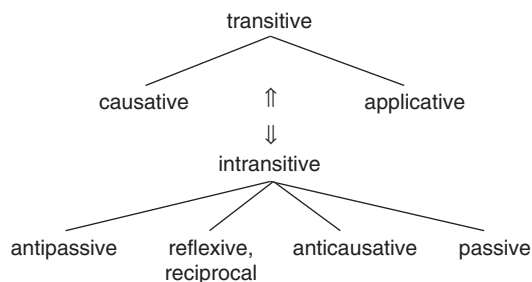
A similar phenomenon has been observed in other languages as well (Haspelmath 1993). The majority of languages tend to use the causative operation more frequently than its opposite, called anticausative. Only the semitic languages exhibit more anticausatives, however, they use a number of different prefixes. Formally, one can describe the function of Japanese *-e* as in (57). It is important to note that, unlike passive, the anticausative does not imply the presence of an agent.

- (57) VERB and -e[VERB] differ in their transitivity status
- $$-e [\lambda y \text{ AFF}(y)] = \lambda y \lambda x \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \ \text{AFF}(y) \}$$
- $$-e [\lambda y \lambda x \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \ \text{AFF}(y) \}] = \lambda y \text{ AFF}(y)$$

Obviously, the anticausative operation conflicts with the principle of monotonicity, which states that no semantic information is deleted in the course of derivation. Therefore it is hard to imagine that an affix could have emerged with a pure anticausative function; it would have been blocked by the monotonicity principle. What one indeed finds are morphemes with a broader function including the anticausative reading as a special case. One possibility is, within the inchoative/causative pairs, that a marker can choose either the more complex or the more basic item. Given a grammatical dimension in which pairs of lexical items derived from a common stem can be ordered, one member of the pair should have the semantic property *X*, while the other lacks it. Usually one expects pairs  $\langle \sigma, \sigma' \rangle$  such that  $\sigma = \langle \text{PF}, \text{SF} \rangle$  and  $\sigma' = \langle \text{PF} + \text{pf}, \text{SF} + \text{sf} \rangle$ , where  $\langle \text{pf}, \text{sf} \rangle$  is the contribution of an affix or some other morphophonological operation. However, if a form expressing  $\text{SF} + \text{sf}$  is more likely to be used than the alternative form expressing  $\text{SF}$  simpliciter it is conceivable that the more complex meaning is combined with the simpler  $\text{PF}$ , i.e., pairs  $\langle \sigma, \sigma' \rangle$  such that  $\sigma = \langle \text{PF}, \text{SF} + \text{sf} \rangle$  and  $\sigma' = \langle \text{PF} + \text{pf}, \text{SF} \rangle$  might become possible as well. (Bidirectional optimality theory would be able to model such a situation, see Blutner & Zeevat 2004).

The other possibility is detransitivization as a multi-functional operation, which derives several kinds of intransitive readings, depending on the specific meaning of the verb. The middle voice is typically known for its multiple readings. Unlike passive and antipassive as special operations for deactivating the higher or the lower argument (the agent or patient) respectively, the middle seems to be a general operation that basically contrasts intransitives (of any kind) with transitives. According to the diagram (58) general transitivizers and general detransitivizers can be distinguished from more specific operations. Above I illustrated the specific pair causative/anticausative; it would be interesting to know whether other specific pairs such as antipassive/applicative exist as well, and if not, why not.

(58) Transitivity alternations



A fusion of detransitivizing operations in a single affix is much more common than the fusion of causative and applicative in a single affix (see (54)). An extreme example of polyfunctionality is attested in Chukchi, where the suffix *-tku/-tko* not only functions as a general detransitivizer comprising anticausative, antipassive, reflexive, and reciprocal (59), but also derives both paucal ('island' → 'a group of islands') and iterative ('bite' →



‘bite several times’) readings; moreover, this affix also derives verbs from instrumental nouns (‘rifle’ → ‘to shoot’), and functions as 1pl object marker in the presence of a 2nd person subject (*pela-tko-tək* leave-1pl-2pl ‘you left us’); of course, some of the latter functions should be considered accidental homonymy.

(59) Detransitivization in Chukchi (Nedjalkov 2006: 222)

- |    |                                                     |                                                                                        |
|----|-----------------------------------------------------|----------------------------------------------------------------------------------------|
| a. | <i>ejpə-nin</i> ‘he closed it’                      | <i>ejpə-tku-γ<sup>2</sup>i</i> ‘it closed’ ( <i>anticausative</i> )                    |
| b. | <i>ʔətt<sup>2</sup>-e juu-nin</i> ‘the dog bit him’ | <i>ʔətt<sup>2</sup>-ən nə-jγu-tku-qin</i> ‘the dog bites’<br>( <i>antipassive</i> )    |
| c. | <i>tewla-nen</i> ‘he shook it off’                  | <i>tewla-tko-γ<sup>2</sup>e</i> ‘he shook himself’ ( <i>reflexive</i> )                |
| d. | <i>ommačajpə-nen</i> ‘he hugged him’                | <i>ommačajpə-tko-γ<sup>2</sup>at</i> ‘they hugged each other’<br>( <i>reciprocal</i> ) |

Thus, besides all its other functions, *-tku/-tko* provides a whole set of detransitivizing operations.

- (60) **-tku/-tko** [ $\lambda y \lambda x (\text{ACT}(x) \ \& \ \text{AFF}(y))$ ] =  
 $\{\lambda y \text{AFF}(y), \lambda x \exists y (\text{ACT}(x) \ \& \ \text{AFF}(y)), \lambda x (\text{ACT}(x) \ \& \ \text{AFF}(x)), \dots\}$

In Kharia, a South Munda language, every predicate must be voice-marked for either middle or active (where voice is always fused with tense-mood). Several verbs are middle-only or active-only, whereas the majority of verbs allow both options. The verb gets an inchoative reading in the middle, but a causative reading in the active (61a). Furthermore, verbs that are independently marked for passive/reflexive require the middle (61b), and those that are marked for causative require the active (61c).

(61) Middle/active pairs in Kharia (Peterson 2006)

- |    |               |                   |                           |
|----|---------------|-------------------|---------------------------|
| a. | <i>ayo</i>    | ‘become a mother’ | ‘accept s.o. as a mother’ |
|    | <i>khatam</i> | ‘come to an end’  | ‘finish’ (TR)             |
|    | <i>sebol</i>  | ‘become sweet’    | ‘make sweet’              |
|    | <i>tuta</i>   | ‘go down’         | ‘put down’                |
- b. *yo dom-ki-kiyar.*  
 see PASS/REFL-MIDDLE.PAST-DUAL  
 ‘They two were seen (by someone else). / They two saw themselves.’
- c. *yohan beta o-dam-e.*  
 John boy CAUS-arrive-ACT.IRR  
 ‘John will bring the boy.’

Besides some sorts of intransitivity, the middle characterizes habitual, persistent, self-directed, attempted (but not successful), spontaneous or unexpected actions, as well as those in which the subject participates only indirectly. As Peterson (2006) argues, the middle appears to mark those events which differ somewhat from prototypical actions, in contrast to the active, which marks events that are closer to prototypical actions.

Similarly, the middle voice in Greek, and the reflexive in Spanish, Russian, and other Indo-European languages of Europe are notoriously known for their multifunctionality, including the anticausative reading.

## (62) Spanish reflexives (Kaufmann 2004: 191)

- |    |                              |                                   |                          |
|----|------------------------------|-----------------------------------|--------------------------|
| a. | Juan se lava.                | ‘Juan washes himself.’            | ( <i>reflexive</i> )     |
| b. | La cuerda se rompe.          | ‘The rope splits.’                | ( <i>anticausative</i> ) |
| c. | El libro se publicó en 1952. | ‘The book was published in 1952.’ | ( <i>passive</i> )       |
| d. | Se vive bien aquí.           | ‘People live well here.’          | ( <i>impersonal</i> )    |
| e. | Estas frutas se comen.       | ‘These fruits are edible.’        | ( <i>modal</i> )         |

Kaufmann (2004) tried to find a general meaning of the middle affixes in Classical Greek and those in Fula from which the specific subreadings could follow as special contextual instances. Regardless of whether such a reconstruction succeeds for a number of readings, one might remain skeptical whether such an enterprise is on the right track in general. Could it be that the ‘reflexive’ *se* just marks intransitivity, contrasting with the transitive verb – whatever the preferred reading might be for the intransitive variant?

Watters et al. (2005) reports about Kusunda, a language isolate of Nepal, that a particular harmonic mutation on verbs marks the semantically more articulated category in a pair of categories, regardless of the particular dimension; it marks causative in the transitivity dimension, irrealis in the modality dimension, negation in the polarity dimension, and dependent in the dependency dimension. Thus, a single phonological feature (mutation) is paired with semantic markedness, whereas the concrete semantic operation has to be chosen from a set of alternatives.

In a language in which each verb has exactly one canonical semantic variant, in one of many possible dimensions, there would be no problem with maximal parsimony, marking all of the respective marked variants in the same way. Then, knowing the meaning of a marked item only requires knowing what the canonical semantic variant is. This does not exclude the possibility that non-canonical variants (differing in one of the other dimensions) are formed by more articulate means.

## 6. Multiple operations and the order of derivation

Operations on argument structure can be combined cyclically, so that the output of a first operation serves as the input for a further operation. In particular, argument reduction and argument extension often alternate. Yucatec Maya illustrates a type of language in which no more than two structural arguments are possible; in a certain state of affairs a verb can either be transitivized or detransitivized. More precisely, causative (suffixation with -s) or applicative (suffixation with -t) applies to verbs in an intransitive state, whereas passive, antipassive or noun incorporation applies to verbs in a transitive state. These operations can easily be combined. (63a) shows the ordering V-CAUS-PASS, (63b) V-APPL-PASS, (63c) V-PASS-CAUS-PASS, and finally (63d) V-INCORP-APPL. The last line in each example indicates the semantic representation of the complex verb.

(63) Alternation of transitivization and intransitivization in Yucatec Maya  
(Krämer & Wunderlich 1999)

- |    |                                                                                            |        |           |
|----|--------------------------------------------------------------------------------------------|--------|-----------|
| a. | kíin-s-áab-en                                                                              | tumèen | leti      |
|    | die-CAUS-PASS.PERF-1                                                                       | PREP   | PRON.3.SG |
|    | ‘I was killed by him.’                                                                     |        |           |
|    | $\lambda y \lambda e \exists x \{ \text{ACT}(x) \ \&_{\text{CAUS}} \ \text{DIE}(y) \} (e)$ |        |           |



## (66) Chichewa CAUS-APPL representing both scopes (Hyman 2003)

- a. alenjé a-ku-líl-**its-il**-a waná ndodo.  
 hunters 3pl-PROG-CRY-CAUS-APPL-FV child sticks  
 ‘The hunters are making the child cry with sticks.’ (INST (CAUSE (CRY)))
- b. alenjé a-ku-tákás-**its-il**-a mkází mthíko.  
 hunters 3pl-PROG-STIR-CAUS-APPL-FV woman spoon  
 ‘The hunters are making the woman stir with a spoon.’ (CAUSE (INST (STIR)))

A similar ambiguity is caused by the second constraint: TIE-PASS-CAUS ‘u causes y to be tied’ and TIE-CAUS-PASS ‘x is caused to tie y’ clearly mean different things, that is, two different semantic compositions are mapped onto the same surface string *mang-its-idw-a*. Unless there is a strong contextual bias to the contrary, the compositional reading in which the order of suffixes reflects the order of semantic operations should be assumed to be the default option for the hearer.

Another type of mismatch found in Chichewa is semantically empty suffix repetition. In (67), the second occurrence of the reciprocal suffix *-an* has to be ignored because the semantic reciprocal operation cannot be repeated in the same domain.

## (67) Redundancy in Chichewa:

- A-tsikana a-na-mang-an-**its-idw**-ir-*an*-a m-nkhalango.  
 2-girl 2-PAST-tie-REC-CAUS-PASS-APPL-(REC)-FV LOC-forest  
 ‘The girls were caused to tie each other in the forest.’

Similarly, double or triple causative found in languages of India often only means emphasized causative, e.g., Kashmiri *khy-aav-inaav* ‘eat-CAUS-CAUS’ and *khy-aav-inaav-inaav* ‘eat-CAUS-CAUS-CAUS’ both mean ‘have someone feed someone’.

Several other studies (e.g., Muysken 1986 and van de Kerke 1996 on Quechua) have established the insight that the order of affixes reflects the order of semantic composition in most instances, though unfortunately not in all. Surface alignment constraints partially destroy the ideal picture. Hyman (2003) argues that Proto-Bantu started with a fixed template (verb-CAUS-APPL-REC-PASS) of which many residuals are still present; he also cites Abasheikh (1978), who found that Chimwiini (a Swahili dialect of Somalia) has a fixed affix ordering.

In order to see how constraints such as those in (65) work, parallel processing can be assumed: For each suffix (contributing a phonological form and a semantic operation), the phonological output PF and the semantic output SF are computed separately. Differences between the input and output in PF do not affect the output in SF. The derivation fails only if one of the parallel lines of processing yields a zero output.

- |             |                     |                                                                                                       |             |
|-------------|---------------------|-------------------------------------------------------------------------------------------------------|-------------|
| (68) Input: | PF                  | SF                                                                                                    |             |
| a           | mang                | $\lambda y \lambda x \lambda s \text{ TIE}(x,y)(s)$                                                   |             |
| b           | mang-idw            | $\lambda y \exists x \lambda s \text{ TIE}(x,x)(s)$                                                   | (passive)   |
| c           | mang-idw-its        | $\lambda y \exists x \lambda u \lambda s \{\text{ACT}(u) \ \& \ \exists s' \text{ TIE}(x,x)(s')\}(s)$ | (causative) |
|             | ↓                   |                                                                                                       |             |
| Output:     | <i>mang-its-idw</i> |                                                                                                       |             |

According to (65b), the PF arrived at in line c is forbidden, so the second-to-best position of *-its* is chosen, that is, *-its* is in fact infixal.

Stiebels (2003) distinguishes between transparent, restricted and opaque affix orders. If both affix orders (-A-B and -B-A) occur and transparently reflect the underlying scope relations they are called transparent. If due to a language-specific constraint only one affix order occurs and receives a surface-true, i.e. compositional, interpretation it is called restricted. If a given affix order has both the compositional and the non-compositional interpretation – the latter violating the revised mirror principle – it is called opaque.

(69) Mirror Principle

- a. Morphological derivations must directly reflect syntactic derivations (and vice versa). (Baker 1985: 375)
- b. Revised: The affix order must mirror semantic composition. (Stiebels 2003: 292)

The revised mirror principle claims a correspondence between morphology and semantics rather than between morphology and syntax. Crucial for this claim are scope relations.

As the reader will have observed, the argument shifting operations presented in this article are realized by suffixes on the verb, except for the resultative prefixes, which are special. Thus, the linear ordering from left to right indicates the actual path of computing argument structure. Everything that precedes a certain suffix (operation) is in its scope: the underlying predicate together with all of the arguments as well as the result of preceding operations. Different suffix orders such as -CAUS-REC vs. -REC-CAUS generate different readings because they manipulate argument *variables*, which are scope-internal and therefore independent of the position of DPs that realize the arguments, hence, independent of any DP movement. If, in contrast, argument changing operations were phrasal, they would operate on VPs (rather than Vs), so that some arguments would already be saturated, and DP movement could easily extract the DP from the relevant scope.

- (70) Morphologically determined scope relations are immune to DP movement, syntactically determined scope relations are not.

The following data from Wechsler (1989) show that only core arguments and not PPs are included in the scope of a bound morpheme. The participants of the repeated situation expressed in the Chichewa example (71a) include the writer and the essay, but not the instrument; in (71b), however, the instrument is included as well, because the (instrumental) applicative has applied.

(71) Chichewa repetitives (Wechsler 1989: 429)

- a. Mu-lembe=nso chimangirizo [ndi nthenga]<sub>pp</sub>  
 you-write=again essay with feather  
 ‘you write the essay again, with a quill (this time)’  
 AGAIN [ $\lambda y \lambda x \lambda e$  WRITE( $x,y$ )( $e$ )] & INSTR(feather, $e$ )
- b. Mu-lembe-*re*=nso nthenga chimangirizo.  
 you-write-APPL=again feather essay  
 ‘you write the essay with a quill again’  
 AGAIN [[ $\lambda y \lambda z \lambda x \lambda e$  WRITE( $x,y$ ) & INSTR( $z,y$ )]( $e$ )]

Conversely, the English examples in (72) show that the repetitive adverb can include the locative PP in its scope (72a), but the repetitive prefix cannot (72b). Only if the location is incorporated into the verb is it in the scope of the prefix *re-* (72c); recall that *enter* is in fact a locative applicative in English.

(72) English repetitives

- a. John ran to the forest again.  
     AGAIN (to the forest (run (John)))
- b.\* John reran to the forest.  
     § to the forest (AGAIN (run (John)))
- c. John reentered the forest. – This forest, John reentered several times.  
     AGAIN (entered (John, the forest))

Note that *rerun* with the only possible reading  $\lambda x \lambda e$  AGAIN(RUN( $x$ )( $e$ )) is semantically deviant because running is an unbounded event, but *re-* only applies to bounded events. However, *reenter* is possible because entering something is a bounded event.

These examples clearly show that morphology is in a way immune to syntax. A bound morpheme such as ‘again’ – be it an affix or a clitic – takes in its scope all core arguments of the simple or derived verb to which it is attached, but nothing from outside, e.g., an adjunct. In the syntax it is possible to move argument-realizing DPs, thereby shifting scopal properties, which, however, has no influence on the scope of *re-* (which only sees the argument variables). Conversely, a PP or an adverb (syntactic adjuncts) can take the verb and some or all of the syntactically realized arguments into its scope. Von Stechow’s (1996) idea was that ‘again’ can have scope over different parts of the lexical decomposition of a verb; in which sense that could be true is still a matter of dispute (Wunderlich 2001: 492ff).

In any way, there is strong evidence that morphology and syntax behave differently. Although both reflect semantic conditions, they are not derived from each other. Therefore, morphological theories that are couched in a syntactic framework, such as Distributed Morphology, seem to be on the wrong track. Similarly, when phase theory, a syntactic theory, is used to clarify the conditions that govern multiple applicatives in the Bantu languages (McGinnis 2005), primarily a morphological phenomenon, one has to assume either that phase theory is particularly semantically inspired or that it is the wrong tool for this subject matter.

## 7. Argument alternation through lexical marking

From the semantic point of view, lexical marking is a trivial operation on argument structure. In the history of the Germanic languages (English, German, Scandinavian, Icelandic), many verbs encoding dative-nominative (73a) shifted to nominative-accusative (73b) without any relevant semantic change.

(73) Lexical marking shift from Early New High German to Modern German

- a. Mir      ahnte      das.  
     I.DAT   anticipated   that (NOM)
- b. Ich      ahnte      das.  
     I.NOM   anticipated   that (ACC)

The case-pattern shown in (73b) represents canonical transitive verbs, while the pattern in (73a) is characteristic for a certain subclass, the experiencer verbs. In general, lexical marking serves to classify verbs according to their inherent meaning, nevertheless it is a pure surface operation, which only affects subcategorization and not the semantic core. These lexical features, whatever they are (Wunderlich 2003), are added or removed during historical development. Small meaning differences can only emerge if for a particular verb different states of lexical marking coexist. It is important to note that lexical marking on the highest argument usually excludes passivization – verbs of the type (73a) cannot be passivized. However, (73b) allows passivization, at least in principle; *das wurde von niemandem geahnt*, the passive of ‘nobody anticipated that’, is fine.

## 8. Argument alternation: dative shift, and others

Another type of argument alternation results from a choice between semantically similar core representations, and not from a particular operation. In the so-called dative shift of English a verb with a prepositional object (PO) is shifted to a verb with double object (DO).

(74) PO-DO alternation in English

- a. Anna gave a photo to Max. (PO)
- b. Anna gave Max a photo. (DO)

However, a more precise investigation, provides evidence that the two alternative constructions are connected with slightly different semantic representations, spelled out as ‘change of location’ vs. ‘change of possession’, so that there cannot be an operation between them (Pinker 1989, Krifka 2004).

(75) Semantic representation of the PO-DO alternation

- a. PO:  $\lambda y \lambda z \lambda x \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \ \text{BECOME LOC}(z, \text{ATy}) \}$
- b. DO:  $\lambda z \lambda y \lambda x \{ \text{ACT}(x) \ \&_{\text{CAUSE}} \ \text{BECOME POSS}(y, z) \}$

These two representations crucially differ with respect to argument hierarchy: the recipient (= goal) is the medial argument in (75b), but the lowest one in (75a). This fact allows us to make some important predictions.

In the DO construction, the recipient (y) should consistently behave as the higher object: it should be able to bind a reflexive theme, license a negative polarity item (such as *any*), be moved in multiple questions, etc., which is indeed the case according to the several tests applied by Larson (1988). In contrast, in the PO construction the recipient (y, construed as a goal) should behave consistently as the lower argument: it should not allow binding by a theme, movement in multiple questions, etc. One of the possible tests is that a quantifier in the higher argument can bind the possessor of a lower argument, but not vice versa, as exemplified in (76),

(76) Argument hierarchy in the PO vs. DO construction

- a. He gave every baby<sub>i</sub> to its<sub>i</sub> mother.  
\* He gave her<sub>i</sub> baby to every woman<sub>i</sub>.
- b. He gave every woman<sub>i</sub> her<sub>i</sub> baby.  
\* He gave its<sub>i</sub> mother every baby<sub>i</sub>.

Another prediction concerns harmonic alignment. In general, the construction in which the higher argument outranks the lower one in terms of saliency should be favored. It is thus expected that PO is preferred if the theme is more salient than the recipient, e.g., first or second person, animate, a pronoun, definite, specific, or the topic. Conversely, DO should be preferred if the recipient (rather than the theme) has one of these properties. This is indeed the case, as shown by Bresnan & Nikitina (2003). (77) illustrates the distribution of pronominal vs. NP arguments.

(77) Salience in the PO vs. DO construction

- a. They gave him to an old woman.  
? They gave a crying baby to him.
- b. They gave him a crying baby.  
\* They gave an old woman him.

Similar observations have been made regarding the alternation between the serial verb (SV) construction and the DO construction in West African languages. In Fongbe, a Kwa language of Benin, the SV construction in (78) shows the ranking theme > recipient, while the DO construction in (79) shows the reverse ranking recipient > theme, indicated by the possibility of a quantifier binding a possessive pronoun.

(78) Serial verb construction in Fongbe (Lefebvre & Brousseau 2001: 463)

- a. Ûn sɛ fɛ́tòò dòkpódòkpó xɔ́ fɛ́tòó'tɔ́! tɛ́n.  
1sg take picture every show picture.owner GEN  
'I showed every picture to its owner.'
- b. \* Ûn xɛ́! fɛ́tòò tɛ́n xɔ́ mɔ́ dòkpódòkpó  
1sg take picture GEN give person every  
\* 'I showed his picture to every person.'

(79) Double object construction in Fongbe (Lefebvre & Brousseau 2001: 455)

- a. Ûn xɛ́! mɔ́ dòkpódòkpó fɛ́tòò tɛ́n. (or: ... fɛ́tòò tɛ́n mɔ́ dòkpódòkpó)  
1sg show person every picture GEN  
'I showed every person his picture.'
- b. \* Ûn xɛ́! fɛ́tòò dòkpódòkpó fɛ́tòó'tɔ́ tɛ́n  
1sg show picture every picture.owner GEN  
\* 'I showed its owner every picture.'

In Akan, a related Kwa-language of Ghana, pronominal or definite themes, which are high in salience, require the SV-construction.

(80) SV and DO construction in Akan (Campbell 1996: 101)

- a. Me-tOnn nwoma no maa Kofi.  
1sg-sold book that gave Kofi  
'I sold the book to Kofi.'
- b. Me-maa Kofi nwoma (\*no).  
1sg-gave Kofi book (that)  
'I gave Kofi a/\*the book.'



It has been argued that  $\text{poss}(y, z)$  and  $\text{LOC}(z, \text{AT } y)$  are weakly equivalent because usually if one of them is true, the other is true as well. If  $z$  is located at  $y$ , then  $y$  is able to exert some ownership on  $z$ . Conversely, if  $y$  has possession of  $z$ , then  $z$  must be located in the vicinity of  $y$  for  $y$  to be able to exert his possessorship (Wunderlich 2006: 151). For that reason possession is often expressed by means of a locative construction (e.g., Russian *u menja kniga* 'at me.GEN book' means 'I have a book'). Note that  $\text{poss}(y, z)$  and  $\text{LOC}(z, \text{AT } y)$  are not exactly converse to each other because  $\text{AT } y$  refers to some neighboring region of  $y$  rather than to  $y$  itself. However, this fact doesn't seem to have any influence on the capability of (80a,b) to represent alternative readings of one and the same verb; what counts here is the difference in argument hierarchy.

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*Dieter Wunderlich, Berlin (Germany)*

## 85. Type shifting

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### Abstract

*Since the seminal paper of Barbara Partee in 1987, type shifting principles, which allow syntactic categories to correspond to more than one semantic type and to shift between them, have been proven invaluable for the analysis of crosslinguistic data at the syntax-semantics interface, involving various types of nominal denotations. This article reviews some of these analyses that make use of type shifting principles, in particular for the denotation of object noun phrases in transitivity, case, and word order alternations.*

### 1. Introduction

In semantic type theory the two basic semantic types are *e* (for ‘entity’) and *t* (for ‘truth value’) and if *a* is a type and *b* is a type, then  $\langle a, b \rangle$  is a type as well. The type  $\langle a, b \rangle$  is a function that takes an argument of type *a* and yields an expression of type *b*. Montague (1974) assumed a homomorphism from syntactic categories to semantic types. Thus, an element belonging to a certain syntactic category is assigned the semantic type associated with that category. For example, a noun is always assigned the type of a predicate,  $\langle e, t \rangle$ , and each noun phrase is assigned the type of a generalized quantifier, type  $\langle \langle e, t \rangle, t \rangle$ . Many linguists afterwards have argued that such a one-to-one mapping between syntax and semantics is not feasible and that several syntactic categories in fact correspond to a variety of semantic types. Type shifting refers to the shifting of one semantic type to another. A type shifting operation can for example map an expression of type *a* to the more complex type  $\langle \langle a, b \rangle, b \rangle$ . Partee (1987) distinguishes between very general type shifting principles and others which are not of any formal generality but which are commonly employed because of their cognitive naturalness. As an example, she provides the rule which turns proper names into common nouns denoting one characteristic property, as in ‘He’s a real Einstein’. Partee & Rooth (1983) propose that each basic expression is lexically assigned the simplest (basic) type needed to capture its meaning, while other types can be used when they are required in order to combine meanings by available compositional rules (see also Hendriks 1993, Steedman 1996, as well as article 25 (de Swart) *Mismatches and coercion*). While Partee & Rooth (1983) mainly focus on type assignments to

verbs, Partee (1987) extends this idea to account for the different semantic types of noun phrases proposed in the literature. General type shifting principles are responsible for going from one interpretation to the other in a certain context, thus allowing for more flexibility in relating syntax and semantics than Montague's (1974) strict correspondence between syntactic category and semantic type. Partee (1987) provides some evidence for the claim that there are noun phrase interpretations of at least three types: the referential type  $e$ , the predicative type  $\langle e, t \rangle$ , and the quantificational type  $\langle \langle e, t \rangle, t \rangle$ . The three types are related via type shifting devices, some of which are more 'natural' than others. For example, an operation of existential closure turns a predicate (type  $\langle e, t \rangle$ ) into an existential generalized quantifier. This operation can be conceived of as the meaning of an indefinite article, such as *a* in English. Chierchia (1998) argues that in some languages, a determiner is obligatory in order for such a type shift to occur (hence, a bare noun cannot be used in an argument position), whereas other languages, such as Chinese, nouns refer to arguments and can therefore occur freely without a determiner in argument position. Chierchia (1998) assumes that non-lexicalized (free) type shifting in a certain language is only allowed if there is no lexical counterpart of the relevant type shifter available in that language, a principle that he dubs "Type Shifting as Last Resort". The reverse type shifter (from a referential or generalized quantifier type to the type of a predicate), called *BE*, is attested in natural language in the form of a copular verb, such as *be* in English. Again, languages differ in whether they have a lexicalized type shifter of this kind, i.e., a copular verb, or not.

In addition to the three types Partee (1987) proposes for noun phrase interpretations, de Hoop (1996) argues in favour of the predicate modifier type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  for certain noun phrase interpretations, in particular for objects that bear partitive case in Finnish. Her idea is that syntactic case-marking alternations reflect the type shifting operations as proposed by Partee (1987). According to Partee, natural languages may show considerable diversity in the use of type shifting principles, encoding them via lexical items, syntactic rules, or not encoding them at all (cf. Chierchia 1998, see also article 13 (Matthewson) *Methods in cross-linguistic semantics*). Matthewson (2001), like Chierchia (1998), argues that type shifting is highly restricted. She shows that in St'át'imcets (Salish, Canada), determiners are unable to take arguments of the predicative type  $\langle e, t \rangle$ ; instead they take arguments of type  $e$ , the referential type. Another approach along these lines is found in de Hoop (1997), who argues that some 'upstairs' determiners in a partitive construction select type  $e$  noun phrases, while others select type  $\langle e, t \rangle$ , and only a few are ambiguous in this respect and can take either type of noun phrase.

Also, Partee (1987) discusses several 'sort-shifting' operations within a single type, for converting count to mass reference and vice versa, or within the domain of entities, to be able allow for events as entities, or for plural individuals (Link 1983). One recent approach that proposes further additional structure within the domain of entities is de Swart, Winter & Zwarts (2007) who argue that bare nominals referring to capacities, e.g., *teacher* or *president*, denote in the domain of type  $e$  expressions, as a subtype  $e_c$  which is similar but sortally distinct from kind referring expressions, that are assumed to denote in subtype  $e_k$ . Although Partee does not say much about constraints on the mapping of syntax to semantics, her paper has opened up a new perspective on type shifting principles that seems very promising for the study of semantic universals and language typology. In this article I focus on type shifting and the correspondence between the syntax and semantics of noun phrases from a cross-linguistic perspective. In section 2 I will discuss

different ways of how a transitive verb is combined with an object noun phrase, dependent among other things on the strength of the object. Section 3 explains a difference between definite and indefinite objects and their scrambling behaviour in Dutch, giving a new twist to the strategy of Partee & Rooth (1983) to assign noun phrases a preferred type – usually the simplest type possible – by using these preferences to phrase soft constraints. Thus it becomes possible to judge whether type shifting is optimal and the output accordingly grammatical in a certain context.

## 2. Transitivity and case alternations

As Keenan (1989) points out, in principle transitive sentences are underdetermined as to which noun phrase is interpreted as the subject and which as the object. Keenan provides a way of specifying this information without commitment as to how any particular language structures transitive sentences, or what case system is used, if any. He does so by expressing the argument structure of a sentence in terms of case extensions: ‘nominative’ (subject) and ‘accusative’ (object) case extensions are added to the basic denotations of the constituents. Given the denotation of a basic noun phrase, for instance *Robert*, and a binary relation *kiss*, the nominative extension of *Robert* sends the binary relation *kiss* to the set of entities which Robert kissed. Similarly, the accusative extension of *Robert* sends *kiss* to the set of entities which kissed Robert:

- (1) For  $F$  basic,  $F_{\text{nom}}$  or the *nominative case extension* of  $F$  is that extension of  $F$  which sends each binary relation  $R$  to  $\{b: F(R^b) = 1\}$  with  $R^b =_{\text{df}} \{a: (a,b) \in R\}$
- (2) For  $F$  basic,  $F_{\text{acc}}$  or the *accusative case extension* of  $F$  is that extension of  $F$  which sends each binary relation  $R$  to  $\{b: F(R^b) = 1\}$  with  $R^b =_{\text{df}} \{a: (b,a) \in R\}$

Keenan (1989) argues that in English, word order determines that the first noun phrase is interpreted ‘nominatively’ and the second one ‘accusatively’. In Japanese, if there is a noun phrase with suffix *-o*, it must be interpreted accusatively, otherwise a *-ga* suffixed one is interpreted accusatively. This constraint accounts for the fact that (3) is not ambiguous, while (4) is (Japanese, Japan; Keenan 1989).

- (3) Taroo-ga Hanako-o nagutta.  
Taroo Hanako hit  
‘Taroo hits Hanako.’
- (4) Taroo-ga Hanako-ga suki da.  
Taroo Hanako likes  
‘Taro likes Hanako.’ or ‘Hanako likes Taro.’

In Warlpiri (Australian, Australia), according to Keenan (1989), if there is an NP marked with (the ergative case-marker) *-ngku*, it is interpreted nominatively, and otherwise a zero marked NP is interpreted nominatively. Note that the only difference between Keenan’s ‘nominative’ and ‘accusative’ case is the difference between the denotation of the first and the second NP argument of a transitive verb (normally the subject and the object).

In Keenan’s approach, transitive verbs denote in type  $\langle e, \langle e, t \rangle \rangle$ , and they combine with deictic NPs (type  $e$ ) or basic NPs (type  $\langle \langle e, t \rangle, t \rangle$ ). The latter type is also called

‘quantificational’ but it is the type that is in principle available for all NPs, whence Keenan’s term ‘basic’. Since Keenan interprets transitive verbs (binary relations) invariably as functions from the set of individuals to functions from the set of individuals to the set of truth values (type  $\langle e, \langle e, t \rangle \rangle$ ), the basic semantic types of ‘nominative’ and ‘accusative’ NPs do not change (both are either  $e$  or  $\langle \langle e, t \rangle, t \rangle$ ); only their extension (being interpreted as the subject or the object) differs. However, in order to deal with case and voice alternations in a variety of languages, several semanticists have abandoned this strict view, and propose more flexibility in the semantic composition of transitive sentences.

Partee (1987) suggests that  $e$  is the unmarked type for subjects and for arguments of extensional verbs generally. Semantically, a transitive verb denotes a relation between two entities. Syntactically, however, such transitive 2-place relations are not always expressed as transitive constructions. Compare for example the following two sentences. The Mandarin Chinese example in (5) consists of a transitive verb *chi* ‘eat’ and two arguments, the subject *Zhang San* and the object *pingguo* ‘apple’ (Mandarin, Sino-Tibetan, China; Yang 2008).

- (5) Zhang San    chi    pingguo    le.  
       Zhang San    eat    apple     PARTICLE  
       ‘Zhang San ate an apple/apples.’

However, in West Greenlandic (Eskimo-Aleut, Greenland; Van Geenhoven 1996), the same event is expressed by an intransitive construction in which the bare noun is morphologically incorporated in the verb which functions as a 1-place predicate:

- (6) Arnajaraq    ipili-tur-p-u-q.  
       Arnajaraq    apple-ate-IND-[-TR]-3SG  
       ‘Arnajaraq ate an apple/apples.’

Other examples of syntactically intransitive constructions that express semantically transitive relations between two participants are easily found. One well-known case is the use of a passive construction in English, as in (7):

- (7) The apple was eaten (by Peter).

Likewise, not all syntactically transitive sentences in natural language correspond to 2-place relations between two equal arguments. As pointed out in Bary & de Swart (2005) and de Swart (2007), the object in a cognate object construction behaves semantically as a predicate modifier rather than as a full-fledged argument.

- (8) Peter smiled an angelic smile.

In English, clearly, the cognate object is realized as any other direct object in a transitive construction, that is, it does not show its deviant semantic status. Yet, in a relatively rich case marking language like Russian (Indo-European, Russia), the different semantic type of the cognate object is mirrored by the use of a different type of case, i.e., instrumental case in (10) (Bary & de Swart 2005; Pereltsvaig 1999).

- (9) On ulybnulsja ulybkoi angela.  
 he.NOM smiled smile.INSTR angel.GEN  
 'He smiled an angelic smile.'

For an extensive discussion of different types and degrees of mismatches between syntactic and semantic transitivity, see de Swart (2007).

Thus, transitive verb phrases can be semantically composed in at least two different ways. Firstly, the verb can be straightforwardly transitive (type  $\langle e, \langle e, t \rangle \rangle$ ), as in Keenan's (1989) approach, in the sense that it denotes a relation between two semantically equal or equally prominent arguments of either type  $e$  or type  $\langle \langle e, t \rangle, t \rangle$ . Secondly, the verb can be formally intransitive (type  $\langle e, t \rangle$ ) with its object functioning as a predicate modifier (type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$ ), as argued in de Hoop (1996), and Bary & de Swart (2005).

Cross-linguistically, the semantic type of an object can influence its case-marking. Let me illustrate this with an example of differential object marking. In Finnish (Uralic, Finland), depending on the reading associated with it, the object of certain transitive verbs can be marked either with accusative or with partitive case:

- (10) Ostin leipää.  
 I.bought bread.PART  
 'I bought (some) bread.'

- (11) Ostin leivän  
 I.bought bread.ACC  
 'I bought the bread.'

The partitive case in (10) goes with a non-specific reading of the object, while the accusative case in (11) goes with a specific reading of the object. In traditional grammars (cf. Karlsson 1983), the alternation between a partitive object and an accusative object is not only attributed to the definiteness or specificity of the object, as exemplified in (10)–(11), but also and even more so to the resultativity of the verb phrase. The latter phenomenon is illustrated by the alternation in (12)–(13):

- (12) Presidentti ampui lintua.  
 President shot bird.PART  
 'The president shot at a/the bird.'

- (13) Presidentti ampui linnun.  
 President shot bird.ACC  
 'The president shot a/the bird.'

In (13) we get the resultative reading and the result of the shooting is clear (the bird was shot), but in (12) the result is not known. That is, (12) is about the shooting rather than about the bird.

De Hoop (1996) proposes to unify these two semantic distinctions (object related and verb phrase related) by the notion of 'predicate modification'. Her basic idea is that the object that bears partitive case can syntactically still be a 'full-fledged' argument, but



semantically it functions as a predicate modifier of type  $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$ , both in a context such as in (10)–(11) above where the noun phrase differs in specificity or definiteness, as well as in the other type of context, illustrated by (12)–(13) above, where the verb phrase differs in resultativity. Note that even a quantificational object bearing partitive case would be interpreted as a predicate modifier of type  $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$ , as in the following example (de Hoop 1996):

- (14) Presidentti ampui kaikkia lintuja.  
 president shot all.PART birds.PART  
 ‘The president shot at all birds.’

There is yet a third option of composing a transitive verb phrase. The third option is that the verb functions as a predicate modifier (type  $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$ ) which semantically incorporates a weak (predicative) object of type  $\langle e,t\rangle$ , as proposed by Van Geenhoven (1996). In West-Greenlandic, the incorporating verb is intransitive from a morpho-syntactic perspective. The Greenlandic example in (6) above clearly shows *syntactic* incorporation of the indefinite noun phrase into the predicate. Consider another example of object incorporation in West Greenlandic (Eskimo-Aleut, Greenland; Van Geenhoven 1996):

- (15) Esta nutaa-mik aalisagar-si-v-u-q.  
 Ester fresh-INSTR.SG fish-get-IND-[-TR]-3SG  
 ‘Ester got (a) fresh fish.’

The object is incorporated in the verb and also receives its existential quantificational force from the verb (cf. Carlson 1977). Van Geenhoven (1996) assumes that in these cases the verb is of the ‘incorporating’ type  $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$ , looking for an indefinite noun phrase which is of the predicative type  $\langle e,t\rangle$ . Note that in (15) the incorporated noun is modified by means of an adjective that bears instrumental case. In Van Geenhoven’s approach, the full object is semantically incorporated, i.e. including the independently case-marked adjective (see also article 44 (Dayal) *Bare noun phrases*). Van Geenhoven (1996) assumes that whereas certain verbs are inherently incorporating and others can never semantically incorporate their object, there are also verbs that can type shift, from one semantic type to the other. Clearly, a type shift from a transitive verb type  $\langle e,\langle e,t\rangle\rangle$  to the incorporating type of verb  $\langle\langle e,t\rangle,\langle e,t\rangle\rangle$  requires a concomitant shift from  $e$  to  $\langle e,t\rangle$  in the type of the object.

In fact, Van Geenhoven argues that not only the indefinite object in a West Greenlandic noun incorporation construction is of this predicative type, but so are the indefinite objects in the following Dutch, German and English transitive sentences. She claims that these indefinite noun phrases are of the predicative type  $\langle e,t\rangle$  too, and they are *semantically* though apparently not syntactically incorporated into the predicate:

- (16) dat Peter gisteren een televisie heeft gekocht.  
 (17) daß Peter gestern einen Fernseher gekauft hat.  
 (18) that Peter bought a TV yesterday

According to Van Geenhoven (1996), the transitive sentences in (16)–(18) are semantically similar to the syntactically intransitive sentences in (6) and (15) above. That is, Van Geenhoven assumes that also in these examples the verb functions as a predicate

modifier (type  $\langle\langle e, t \rangle, \langle e, t \rangle\rangle$ ) which incorporates a predicative object (type  $\langle e, t \rangle$ ) to build a verb phrase of type  $\langle e, t \rangle$ .

Note that although the components of the derived transitive verb phrases may differ in their type complexity, the result of the semantic composition in all cases discussed above is a verb phrase of type  $\langle e, t \rangle$ . That is, a regular transitive verb of type  $\langle e, \langle e, t \rangle \rangle$  combines with an object of type  $e$  or  $\langle\langle e, t \rangle, t \rangle$  to form a verb phrase of type  $\langle e, t \rangle$ . An incorporating verb of type  $\langle\langle e, t \rangle, \langle e, t \rangle\rangle$  that combines with a predicative object of type  $\langle e, t \rangle$  forms a verb phrase of type  $\langle e, t \rangle$  as well, and so does an intransitive verb of type  $\langle e, t \rangle$  that combines with a predicate modifier object of type  $\langle\langle e, t \rangle, \langle e, t \rangle\rangle$ . So, in the end the semantic result of the composition is the same.

If we now turn to syntactic composition, we find that cross-linguistically the variation in semantic composition in many languages is reflected in the syntax through a variety of voice and/or case alternations. A nominative-accusative or ergative-absolutive case frame most often corresponds to the standard transitive relation, that is, a verb of type  $\langle e, \langle e, t \rangle \rangle$  taking two arguments of type  $e$  or  $\langle\langle e, t \rangle, t \rangle$ .

Deviations from this transitive case frame, e.g. when the object is in an oblique case instead of in the accusative, as in the Finnish examples discussed above, correspond to changes in semantic structure. In languages with differential object marking on the basis of definiteness or specificity, for instance, it has been argued that noun phrases that are ‘strong’ (type  $e$  or  $\langle\langle e, t \rangle, t \rangle$ ) are likely to be overtly case marked with accusative case, while ‘weak’ (indefinite or non-specific) objects either show up in a different case or they do not show overt case marking at all (cf. de Hoop 1996). Also, weak objects are typically the ones that can occur in antipassive and noun incorporation structures, as illustrated in the West-Greenlandic examples (20) and (21) respectively (West Greenlandic, Eskimo-Aleut, Greenland; Fortescue 1984).

- (19) Tuttu taku-aa.  
caribou see-3SG.3SG  
‘He saw the caribou.’
- (20) Tuttu-mik taku-*nnip*-puq.  
caribou-INSTR see-ANTIP-IND.3SG  
‘He saw a caribou.’
- (21) Tuttu-si-vuq.  
caribou-see-IND.3SG  
‘He saw a caribou.’

Clearly, some languages closely mirror the differences in semantic composition whereas others do not (cf. de Swart 2007).

So far, I only discussed the different types of objects of extensional verbal predicates (such as *eat* and *see*). Van Geenhoven (1996) shows that an incorporated object of an intensional predicate (such as *look for*) only allows for a non-specific reading (also called a *de dicto* reading in intensional contexts), as illustrated by the following example (West Greenlandic, Eskimo-Aleut, Greenland; Van Geenhoven 1996):

- (22) Vittu cykili-ssar-siur-p-u-q.  
Vittu bike-fut-*seek*-IND-[TR]-3SG

- a. 'Vittus is looking for an (arbitrary) bike.'
- b. \* 'There is a specific bike that Vittus is looking for'.

Van Geenhoven argues that the property introduced by the noun *bike* is the object of the intensional predicate *look for* in the above example. Thus, "an intensional verb is semantically incorporating par excellence: it absorbs a property as its argument" (Van Geenhoven 1996: 202). Thus, the object of an intensional verb is of the predicative type  $\langle e, t \rangle$ . Note that this not only holds for lexically intensional verbal predicates such as *look for* but also for predicates that are intensional because they are in the scope of a modal affix. Van Geenhoven claims that in the following sentence the instrumental partitive noun phrase is also interpreted as a predicative noun phrase of type  $\langle e, t \rangle$ , denoting a property even though this is the property of being a member of a specific set of students:

- (23) Atuartu-t      ila-an-nik      ikiu-i-sariaqar-p-u-nga.  
 Student-ERG.PL PART-3PL.SG-INST.PL help-AP-must-IND-[-TR]-1SG  
 'I must help one of the students (any one will do).'

Van Geenhoven (1996) claims that the basic denotation of intensional predicates are semantically incorporating, which means that they preferably combine with a property-denoting, i.e., predicative type of object.

Similarly, Partee & Borschev (2004) hypothesize that where we see nominative/genitive and accusative/genitive alternations in Russian (both under negation and under intensional verbs), the nominative or accusative object represents an ordinary  $e$  or  $\langle \langle e, t \rangle, t \rangle$  type, whereas a genitive noun phrase is always interpreted as a property of type  $\langle e, t \rangle$ . In the case of intensional verbs like *ždat* 'expect, wait for' they argue that there is a shift in verb sense correlated with the shift in the interpretation of the object (Russian, Indo-European, Russia; Neidle 1988):

- (24) On    ždet    podругu.  
 he    waits    girlfriend.ACC  
 'He's waiting for his girlfriend.'
- (25) On    ždet    otveta      na vopros.  
 he    waits    answer.GEN    to question  
 'He's waiting for an answer to the question.'

The object in (24) is specific, but the intensional variant of the verb *wait for* in (25) selects a non-specific NP. This would be a semantically incorporating type of verb in Van Geenhoven's approach, and the genitive object gets the concomitant predicative or property-denoting type. Partee & Borschev put forward the hypothesis that genitive subjects are of type  $\langle e, t \rangle$  as well.

### 3. Word order variation

Not only case and transitivity alternations may result in different types of noun phrases, also variation in word order may yield a shift in meaning. An important question with respect to type shifting is whether 'anything goes' or not? Clearly, if we allow arbitrary type shifting from one type to another, this would make the theory much too powerful (cf.

Hendriks 1993, Chierchia 1998, Matthewson 2001 for relevant discussion). Chierchia (1998) assumes that type shifting is constrained by his principle “Type Shifting as a Last Resort”, and notes that this principle, which blocks free type shifting when there is a lexical type shifter present in a language, might interact with a general principle of economy in language. In the recently developed framework of Optimality Theoretic semantics (Hendriks & de Hoop 2001), type shifts would only occur as the optimal result of the interaction of potentially conflicting violable constraints. A principle such as Chierchia’s “Type Shifting as a Last Resort” is then simply translated in terms of the interaction between a faithfulness constraint that requires a syntactic category to be assigned its basic semantic type, and a markedness constraint (economy) that prohibits the use of a lexical type shifter. Van der Does & de Hoop (1998) account for the word order variation called ‘scrambling’ in terms of such an Optimality Theoretic type shifting perspective. They show how the interpretive tendencies that arise with different word orders (see also article 73 (Ward & Birner) *Discourse and word order*) can be modelled using a notion of optimal derivations, phrased in terms of the preferred semantic types of different types of noun phrases and verbs. They argue that referential definites have a natural interpretation in type *e*, while the predicative meaning of an indefinite noun phrase is the denotation of its noun, i.e. type  $\langle e, t \rangle$  (see also article 41 (Heim) *Definiteness and indefiniteness* and article 44 (Dayal) *Bare noun phrases*). However, certain definite noun phrases look very similar to predicative indefinites, forming a semantic unity with a ‘light’ verb, verbs which do not have much semantic content of their own. Compare the pair of sentences below, which only differ in the (in)definiteness of the object. The meaning of these two sentences is basically the same, and in both sentences the object does not get a referential meaning:

- (26) dat ik ook mazelen heb.  
       that I also measles have  
       ‘that I also have the measles.’

- (27) dat ik ook de mazelen heb.  
       that I also the measles have  
       ‘that I also have the measles.’

But even though there does not seem to be a difference between the sentence with a bare plural object in (26) and the one with a definite plural in (27), when the word order is changed, there is. That is, the definite object in (27) can scramble to the left of the adverb, but the indefinite one cannot:

- (28) dat ik \*(de) mazelen ook heb.  
       that I the measles also have  
       ‘that I also have the measles.’

Van der Does & de Hoop (1998) argue that indefinites can scramble to a marked position to the left of the adverb, but only when they type shift from their basic predicative type to a generalized quantifier type  $\langle \langle e, t \rangle, t \rangle$ . However, when the indefinite noun phrase scrambles and shifts to an  $\langle \langle e, t \rangle, t \rangle$  reading, then the verb with which it combines must be of the transitive type  $\langle e, \langle e, t \rangle \rangle$ . Light verbs, however, such as *hebben* ‘have’ in the examples above, have the incorporating verb type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  as their preferred type. That

means that scrambling the indefinite object would induce type shifting of the object as well as of the light verb. This leads to a suboptimal derivation, yielding an ill-formed output. By contrast, definite noun phrases preferably denote in type  $e$ . Thus, when the definite object is semantically incorporated in the light verb, it has to shift to the predicative type  $\langle e, t \rangle$  in order to combine with the type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  light verb. Alternatively, when the definite object does not type shift to a predicative type, the light verb has to shift to the transitive verb type  $\langle e, \langle e, t \rangle \rangle$ . Van der Does & de Hoop (1998) leave both options open: either the definite object in (27) and (28) type shifts to the predicative type, or the light verb type shifts to the transitive type. Either way, one type shift has to take place in a construction like this, and both derivations are optimal, and the meanings are equivalent. To sum up, van der Does & de Hoop argue that whereas the predicative use of indefinites prefers to live in type  $\langle e, t \rangle$ , definites have their basic denotation in type  $e$ . In the case of a light verb, with the preferred type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  interpretation of incorporating verbs, a predicative indefinite object gives one optimal derivation. Definite objects allow for two optimal derivations when combined with light verbs: either the definite or the verb denotes in its preferred type. This explains the free scrambling behaviour of definite objects as compared to indefinite objects. Merging an incorporating light verb and a predicative type of definite is synonymous with merging a shifted light verb and a referential type of definite. The result is the same, in the sense that both derivations are equally costly as they require one type shift each.

The different derivations for indefinite and definite objects can be illustrated by two Optimality Theoretic tableaux (van der Does & de Hoop 1998):

Tab. 85.1: OT semantic tableau of a light verb combined with an indefinite object (Dutch)

| <i>Light verb + indefinite object</i>                                                                                                                                        | <i>Indefinite in type <math>\langle e, t \rangle</math></i> | <i>Light verb in type <math>\langle \langle e, t \rangle, \langle e, t \rangle \rangle</math></i> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------|
| ☞ $\langle \langle e, t \rangle, \langle e, t \rangle \rangle + \langle e, t \rangle$<br>$\langle e, \langle e, t \rangle \rangle + \langle \langle e, t \rangle, t \rangle$ | *                                                           | *                                                                                                 |

In Tab. 85.1, an OT semantic tableau is given that illustrates the process of optimization of a sentence that contains a light verb and an indefinite object. The first candidate output, which combines a light transitive verb of type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  (an incorporating type of verb) with an indefinite object of basic type  $\langle e, t \rangle$  is optimal as it does not violate either constraint. By contrast, the second candidate output combines a regular transitive verb type with a generalized quantifier type of object. This output violates both the constraint that requires a light verb to denote in type  $\langle \langle e, t \rangle, \langle e, t \rangle \rangle$  and the constraint that requires an indefinite noun phrase to denote in type  $\langle e, t \rangle$ . Hence, the first candidate comes out as the winner of the competition, i.e., as the optimal candidate. For a definite object in combination, on the other hand, the two candidate outputs both violate one of the constraints, as shown in Tab. 85.2. Therefore, dependent on the ranking of the constraints (for Dutch, van der Does & de Hoop argue that they are not ranked with respect to each other, but of course this can be different for other languages), each candidate can win the competition. If we relate this to the position with respect to an adverbial in Dutch, we can account for the fact that definite objects of light verbs in Dutch scramble freely, while indefinite objects of light verbs have to stay in situ, adjacent to the verb (cf. van der Does & de Hoop 1998).

Tab. 85.2: OT semantic tableau of a light verb combined with an definite object (Dutch)

| <i>Light verb + definite object</i> | <i>Definite in type e</i> | <i>Light verb in type &lt;&lt;e,t&gt;,&lt;e,t&gt;&gt;</i> |
|-------------------------------------|---------------------------|-----------------------------------------------------------|
| $\varphi$ <<e,t>,<e,t>> + <e,t>     | *                         |                                                           |
| $\varphi$ <e,<e,t>> + e             |                           | *                                                         |

Yang (2008) argues that in Chinese the semantic type of a noun phrase interacts with the interpretive characteristics of its word order position as well. The preverbal position in Chinese is typically associated with ‘strong’ (referential or quantificational) types of noun phrases. Therefore, an indefinite object in preverbal position as in (29) is subject to two conflicting constraints. Because the object is indefinite its preferred type is <e,t> but because it is in scrambled (preverbal) position, its preferred meaning is a (specific) type *e* reading.

- (29) Ta ba yi-ge pingguo chi le.  
he ACC one-CL apple eat PRT  
‘He ate an apple.’

The question is how this conflict is resolved. Which type comes out as optimal, that is, is the resulting meaning non-specific (predicative) or specific (referential) for *yi-ge pingguo* ‘one apple’? Yang (2008) argues that the non-specific predicative reading of the indefinite object comes out as the winner of the competition. Hence, the constraint that favours a predicative reading for an indefinite noun phrase is claimed to outrank the one that penalizes a non-specific reading in preverbal position (Mandarin Chinese, Sino-Tibetan, China; Yang 2008). This is illustrated by the following tableau:

Tab. 85.3: OT semantic tableau of an indefinite object in preverbal position (Mandarin Chinese)

| <i>Ta ba yi-ge pingguo chi le</i> | <i>Indefinite in type &lt;e,t&gt;</i> | <i>Avoid &lt;e,t&gt; in preverbal position</i> |
|-----------------------------------|---------------------------------------|------------------------------------------------|
| $\varphi$ <e,t> (He ate an apple) |                                       | *                                              |
| e (He ate a specific apple)       | *                                     |                                                |

However, when the predicate is changed to a predicate that denotes a bounded event, the specific reading comes out as optimal:

- (30) Ta ba yi-ge pingguo chi-wan le.  
he ACC one-CL apple eat-finish PRT  
‘He finished a (particular) apple.’

Unlike in (29), in (30) the specific reading becomes optimal and according to Yang (2008) this is due to the semantic type of the bounded predicate, which apparently does not shift to an incorporating type. The constraint that penalizes the combination of a non-specific indefinite object and a bounded predicate outranks the constraint that favours a type <e,t> reading of an indefinite object. However, this constraint itself is in competition with a constraint that favours the <e,t> reading of an object in an intensional context (Zimmermann 1993). The indefinite object in (31) is interpreted as either specific (type *e*) or

non-specific (type  $\langle e, t \rangle$ ), according to Yang (2008), which means that the two highest ranked constraints are tied constraints, i.e., they are not ranked with respect to each other.

- (31) Ta neng ba yi-ge pingguo chi-wan le.  
 he can ACC one-CL apple eat-finish PRT  
 'He can finish a (particular) apple.'

Yang's (2008) Optimality Theoretic account of different violable constraints that influence the preferred types of indefinite objects thus nicely accounts for the possible semantic types of preverbal objects in Mandarin Chinese.

#### 4. Conclusion

This article examined some of the syntactic factors that appear to influence type shifting of object noun phrases, namely case and transitivity alternations and word order. I hope to have shown that type shifting principles which allow for different denotations of noun phrases offer a nice approach to cross-linguistic phenomena where different readings occur in similar contexts.

*I am grateful to my colleagues from the research group Optimal Communication, in particular Peter de Swart, for helpful discussions on semantic type shifting possibilities in natural language.*

#### 5. References

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*Helen de Hoop, Nijmegen (The Netherlands)*

## 86. Constructional meaning and compositionality

1. Constructions and compositionality
2. Continuum of idiomaticity
3. Kinds of constructional meanings
4. Model-theoretic and truth-conditional meaning
5. Argument structure
6. Conventional implicature, or pragmatic presupposition
7. Less commonly recognized illocutionary forces
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### Abstract

*One of the major motivations for constructional approaches to grammar is that a given rule of syntactic formation can sometimes, in fact often, be associated with more than one semantic specification. For example, a pair of expressions like purple plum and alleged thief call on different rules of semantic combination. The first involves something closely related to intersection of sets: a purple plum is a member of the set of purple things and a member*



*of the set of plums. But an alleged thief is not a member of the intersection of the set of thieves and the set of alleged things. Indeed, that intersection is empty, since only a proposition can be alleged and a thief, whether by deed or attribution, is never a proposition. This chapter describes the various ways meanings may be assembled in a construction-based grammar.*

## 1. Constructions and compositionality

It is sometimes supposed that constructional approaches are opposed to compositional semantics. This happens to be an incorrect supposition, but it is instructive to consider why it exists. A foundation of construction-based syntax is the idea that rules of syntactic combination (descriptions of local trees) are directly associated with interpretive and use conditions, in the form of semantic and pragmatic features that attach to the mother or daughter nodes in these descriptions (Kay 2002; Sag 2010). This amounts to the claim that syntactic rules mean things. Meaning, of course, is generally viewed as the exclusive purview of words, and in the prevailing view of meaning composition, syntactic rules do no more than determine what symbol sequences function as units for syntactic purposes. So while syntactic rules assemble words and their dependent elements into phrases, and the phrases denote complex concepts like predicates and propositions, the rules cannot add conceptual content to that contributed by the words; nor can they alter the combinatoric properties of the words. On this view, which Jackendoff (1997: 48) describes as the “doctrine of syntactically transparent composition”, “[a]ll elements of content in the meaning of a sentence are found in the lexical conceptual structures [...] of the lexical items composing the sentence” and “pragmatics plays no role in determining how [lexical conceptual structures] are combined”. To embrace a construction-based model of semantic composition is not to reject the existence of syntactically transparent composition but instead to treat it, as per Jackendoff (1997: 49), as a “default in a wider array of options”. That is, whenever a class of expressions can be viewed as licensed by a context-free phrase structure rule accompanied by a rule composing the semantics of the mother from the semantics of the daughter, a construction-based approach would propose a construction that is functionally equivalent to such a rule-to-rule pair. But constructional approaches also provide a revealing way to represent linguistic structures in which semantics of the mother does not follow entirely from the semantics of the daughters. A case in point is the pattern exemplified by the attested sentences in (1), retrieved from Google. We will call such sentences pseudo-conditionals, and we will refer to the *if*-clause and main clause as the pseudo-protasis and pseudo-apodosis, respectively.

- (1) a. If you're 3Com right now, you're considering buying add space in next week's issue.
- b. If you're George Bush, you're now allowed to lie in the faces of trusting young voters.
- c. [I]f you're Betty Ford right now, you're probably thinking, you know, I hope everybody's OK.
- d. [More than one able program director thinks commercials, promos and features is not an all-news station,] but if you're new CBS President Dan Mason right now you're going to leave well enough alone.

Example (2) shows that the pseudo-apodosis, like a true apodosis, can be extended beyond the bounds of the initial sentence.

- (2) If you are George W. Bush and this vending machine represents Iraq, you keep putting money into the machine. When you have none left and it is obvious to all rational persons that trying again is not going to result in a different outcome, you borrow more and keep going.

Syntactically the sentences in (1) and the first sentence in (2) appear to be ordinary conditional sentences like (3).

- (3) If you're pleased with the outcome, you may feel like celebrating.

But the sincere speaker of the protasis of an ordinary conditional sentence does not hypothesize a patently impossible state of affairs, while the *if*-clauses of (1)–(2) appear to pose the manifest impossibility that the addressee is identical to Peter Angelos/Betty Ford/George Bush/Dan Mason/etc. Of course that is not what is being said in (1)–(2). Exactly what is being said is difficult to pin down with certitude. The syntactic form is roughly given by (4).

- (4) If you are  $x, p(x)$ .

The semantics seems to assert the proposition expressed by  $p(x)$ , qualified in different examples by a number of different illocutionary forces or speaker attitudes. In any case, no hypothetical situation is posed; it appears that a categorical judgment is expressed (possibly hedged or epistemically qualified in some way) and the subject of that judgment is not the addressee but the person identified as  $x$ ; e.g., example (2) is clearly about George Bush, not about the consequences of a hypothetical identity between George Bush and the addressee. Pseudo-conditionals have the same form as (one type of) familiar conditional but entirely distinct semantics.

If the grammar accords to a sentence a different interpretation from what could be built up piece by piece from its words and constituent phrases, syntactically transparent compositionality scores this as an instance of non-compositionality. As such, the pseudo-conditional pattern could appropriately be called an idiom, but, as numerous proponents of construction-based approaches have observed, idiomaticity is not the same thing as inflexibility (Fillmore, Kay & O'Connor 1988; Michaelis & Lambrecht 1996; Culicover 1997). The pseudo-conditional pattern is evidently a productive one, and an adequate grammar must describe the interpretive and combinatoric constraints that define it. In a construction-based grammar, the pseudo-conditional sits on a continuum of idiomaticity (or generality) of expressions, somewhere between tightly bound idioms and fully productive processes (cf. article 20 (Fellbaum) *Idioms and collocations*). A construction grammar models this continuum with an array of constructions of correspondingly graded generality (Kay & Fillmore 1999; Sag 2010). Doing so obviously requires many more rules of composition than are countenanced in most non-constructional approaches – roughly as many as there are constructions listed in an (ideal) traditional grammar. A construction-based grammar sees nothing special about any part of the syntactic structure of sentences like (1)–(2); the syntax of (1)–(2) is the same as the syntax of (3) – that of a common, garden-variety conditional sentence. But the meaning is different, and not obviously derivable by conversational implicature. So one posits a special construction with the syntax of a vanilla conditional, constrained as in (4), but with a semantic form unlike that of an ordinary conditional: a hedged categorical judgment is expressed – one whose subject is not denoted in the pseudo-protasis.

The pseudo-conditional is important for our purposes because the existence of this interpretive affordance appears to undermine one of the foundational assumptions of syntactically transparent composition, as expressed by the following quote (from the online *Stanford Encyclopedia of Philosophy*):

- (5) “If a language is compositional, it cannot contain a pair of non-synonymous complex expressions with identical structure and pairwise synonymous constituents.”  
(Szabó 2007)

If we use Szabó’s diagnostic, the existence of pseudo-conditionals entails either that English is not compositional or that pseudo-conditionals are syntactically distinct from ordinary present-tense conditionals. A view of compositionality this narrow also presumably necessitates different syntactic analyses for any pair of readings attached to sentences in the large class illustrated by (6)–(7). Each such sentence yields both an idiomatic and a composed interpretation:

- (6) My yoga instructor sometimes pulls my leg.  
(7) I’m afraid he’s going to spill the beans.

A constructional approach welcomes a single syntactic analysis in all of these cases and posits constructions in the case of the idiomatic readings that attach semantic interpretations directly to certain relatively complex syntactic objects. In short, constructional approaches recognize as instances of compositionality cases in which two different meanings for the same syntactic form are licensed by two different collections of form-meaning licensors, i.e., by two different collections of constructions. Construction-based grammars are nevertheless compositional in a quite usual sense: if you know the meanings of the words and you know *all* the rules that combine words and phrases into larger formal units, while simultaneously combining the meanings of the smaller units into the meanings of the larger ones, then you know the forms and meanings of all the larger units, including all the sentences. The ‘bottom-up’ procedural language used here is intended only heuristically: most constructional approaches are explicitly or implicitly declarative and constraint based, notwithstanding the tempting metaphorical interpretation of *construction* as denoting the building of big things out of little things.

Constructional approaches tend to pay special attention to the fact that there are many such rules, and especially to the rules that assign meanings to complex structures. And such approaches do not draw a theoretical distinction between those rules thought to be of the ‘core’ and those considered ‘peripheral’. Proponents of construction-based syntax assume that accounting for *all* the facts of a language as precisely as possible is a major goal, if not the major goal, of scientific linguistics. One can in fact view construction-based theories of syntax as upholding standards of grammar coverage that the original proponents of generative grammar abandoned, as they sought to reduce the theory’s dependence on linguistic facts. Chomsky (1995: 435) describes this shift in the goals of grammarians as follows: “A look at the earliest work from the mid-1950s will show that many phenomena that fell within the rich descriptive apparatus then postulated, often with accounts of no little interest and insight, lack any serious analysis within the much narrower theories motivated by the search for explanatory adequacy, and remain among

the huge mass of constructions for which no principled explanation exists – again, not an unusual concomitant of progress”. It seems safe to say that most proponents of construction-based syntax would not consider the loss of insightful and interesting accounts a mark of progress, and find the search for putatively narrower theories of explanatory adequacy unrequited. Whether *narrower* properly describes a relation between the Minimalist Program, for example, and, say, the construction-based version of Head Driven Phrase Structure Grammar of Ginzburg & Sag (2000) is itself open to question. It can be plausibly argued that a formal theory, such as that of Ginzburg & Sag, is *ipso facto* “narrower” than an informal one, such as the Minimalist Program, by virtue of the fact that formalism imposes a limit on potential predictions.

In the remainder of this article, we will examine how and what constructions mean. Section 2 focuses on the continuum of idiomaticity alluded to above. Section 3 surveys the range of constructional meanings. Section 4 outlines the constructional approach to model-theoretic and truth-conditional meaning. In section 5, we focus on argument-structure constructions of the kind proposed by Goldberg (1995, 2006). In section 6, we describe the relationship between constructional meaning and conventional implicature. Less commonly recognized illocutionary forces expressed by constructions are discussed in section 7. Section 8 discusses the relationship between constructions and metalinguistic operators, as discussed by Kay (1997), among others. In section 9 we will discuss constructional accounts of the discourse-syntax interface, with particular attention to the assignment of prosodic peaks. Section 10 contains brief concluding remarks.

## 2. Continuum of idiomaticity

Related to the less restrictive view of compositionality is the recognition that there exists a gradient of idiomaticity-to-productivity stretching from frozen idioms, like *the salt of the earth*, *in the doghouse*, and *under the weather* on the one hand to fully productive rules on the other, e.g., the rules licensing *Kim blinked* (the Subject-Predicate Construction) or *ate oranges*, *ready to leave*, and *in the kitchen* (the Head-Complement Construction). Several examples discussed below occupy intermediate points on this scale.

At one end of the scale we find expressions like *right away*, *as of* [requiring a date or time expression as complement], *by and large*, *cheek by jowl*, which are not only entirely fixed as regards their lexical makeup but also exhibit idiosyncratic syntax. Somewhat less idiosyncratic are expressions with fixed lexical makeup that exhibit syntax found elsewhere in the language, such as *a red herring*, *carrying coals to Newcastle*, and *water under the bridge*. Fillmore, Kay & O'Connor (1988: 504) follow Makkai (1972) in pointing out that many idiomatic expressions are no less idiomatic for being merely ‘encoding’ idioms. That is, someone who knows everything about the language except a particular encoding idiom may be able to decode that idiom on a first hearing, while still not knowing that the expression is a standard way of expressing that meaning. Examples of encoding idioms that are not decoding idioms are expressions like *twist NP’s arm*, *as for* [when preceding a topic-resuming NP], *rock the boat* or the French *de vive voix* (‘orally in person’, as against in writing; lit. ‘of living voice’). In other words, idioms are defined not only as those expressions that are not interpretable by a naïve speaker but also as those expressions that a naïve speaker would not know to use in a given context. Close behind these come idioms that allow morphological inflection or minor syntactic alteration such as *kick/kicks/*

*kicked/kicking the bucket*. More productive than these are idioms with partially fixed lexical membership. Examples include the [*Watch* NP[ACC] VP[bare-stem-infinitive]] pattern that occurs in a sentence like “I’ve taught you well, now *watch you/\*yourself beat me*.” Many subtypes of idioms fit in this category: among others, VP idioms with fixed verb and controlled or uncontrolled pronominal argument (8), VP idioms with variable object (9), the rare subject idioms (10). Note in the case of (10c) that the idiom (construction) specifies interrogative form but does not specify main-clause syntax versus that of embedded question.

- (8) a. blow one’s nose  
b. blow someone’s mind
- (9) a. slip someone a Mickey  
b. give someone the slip
- (10) a. The world has passed someone by.  
b. Someone’s time is up.  
c. Where does someone get off?/I wonder where someone gets off.

Nunberg, Sag & Wasow (1994) demonstrate that VP idioms behave in ways that are explicable only if they have compositional properties – that is, if their parts map in a one-to-one way to the parts of their paraphrases. In particular, they argue, the rarity of subject idioms, exemplified in (10), follows from the fact that the arguments of verb-headed idioms, even when lexically animate, denote inanimate entities, as evidenced by the second arguments of the expressions *let the cat out of the bag*, *throw the baby out with the bath water*, *take the bull by the horns*. Since subject arguments tend to be interpreted as agents, and therefore as animates, it stands to reason that so few idiomatic expressions constrain the subject role. In addition, they argue, differences in the degree of syntactic flexibility exhibited by VP idioms can be attributed to differing degrees of (sometimes metaphorically based) semantic compositionality, where flexibility includes the availability of a passive paraphrase (e.g., *The beans were spilled*, as against *\*The bucket was kicked*) and the felicity of nominal modification, as in the attested example *Clinton and McCain both have much larger, more repugnant skeletons in their closet* (retrieved from Google), as against, e.g., *\*He blew some ludicrous smoke*. Crucially, the type of semantic transparency that Nunberg, Sag & Wasow (1994) see as driving syntactic flexibility cannot be equated with the existence of a general semantic motivation for the VP idiom, e.g., one involving metaphor or metonymy. For example, the expression *chew the fat* describes the jaw motions associated with talking, while the expression *drop the ball* presumably evokes the metaphor LIFE IS A GAME. Neither expression, however, maps in a one-to-one fashion to its literal paraphrase (which we presume to be ‘converse’ and ‘fail’, respectively). Accordingly, neither expression exhibits syntactic flexibility: *\*The fat was chewed*, *\*He dropped the important ball*. Because semantically transparent VP idioms must combine with constructions like passive and modification, they require a compositional representation, as verbs with partially lexically filled valence lists.

An example of an idiom, or construction, which is both defined largely syntactically and also contains a significant amount of specified lexical material is Nominal

Extraposition, an exclamatory construction studied by Michaelis & Lambrecht (1996) and exemplified by attested cases in (11):

- (11) a. It's amazing the people you see here. (Michaelis & Lambrecht 1996: 215, (1a))  
 b. It was terrible, really, the joy I took at the notion of skunking Pigeys.  
 (Michaelis & Lambrecht 1996: 215, (1e))  
 c. It's staggering the number of books that can pile up. (Michaelis & Lambrecht 1996: 215, (1g))

The syntax of the construction is roughly as summarized in (12):

- (12) *It* <sub>BE</sub> AP [<sub>NP</sub> *the* CN].

Michaelis & Lambrecht argue that Nominal Extraposition, in contrast to the superficially similar pattern right-dislocation pattern, has a nonreferential subject (invariantly *it*) and a focal rather than topical post-predicate NP. The pattern qualifies as an idiomatic pattern on the basis of its syntax (adjectives do not otherwise license non-oblique complements) and its semantics: the post-predicate NP is metonymically construed as referring to a scalar parameter, e.g., the number or variety of people seen in (11a).

Moving onward toward purely formal idioms, we encounter the much discussed Correlative Conditional (or, equivalently, Comparative Correlative), exemplified in (13):

- (13) The more I drink the better you look.

The only lexically specified elements in the Correlative Conditional are the two tokens of *the*, which only coincidentally have the form of the definite article: these forms are in fact reflexes of Old English instrumental-case demonstratives (Michaelis 1994a). With the exception of idiomatic comparative expressions like *the better to see you with* and *all the more reason to*, the word *the* serves as a degree marker only in the Correlative Conditional (Borsley 2004; Culicover & Jackendoff 1999; Fillmore, Kay & O'Connor 1988; Fillmore 1986). Finally, when no lexical material is encountered in an idiom, we have entered the realm of minor syntactic patterns. Well-known examples include the Incredulity Construction (Akmajian 1984; Lambrecht 1990), as exemplified in (14), and the conjunctive conditional. The latter construction, exemplified in (15), expresses a range of commissive speech acts (Culicover 1970; Cornulier 1986):

- (14) Him get first prize?!  
 (15) a. One more beer and I'm leaving.  
 b. Bouges pas ou je tire! ('Don't move or I'll shoot!')

The step from these relatively special-purpose syntactic patterns to those that license canonical statements, imperatives, questions of many different types (Ginzburg & Sag 2000), ordinary noun phrases, head-complement phrases, etc. is a small one. A close look at the variety of constructions in English – and presumably in many, if not all, other languages – reveals, not a dichotomy between core and peripheral constructions, but a gradient of fully fixed to fully productive patterns of phrase construction. The semantics of constructions is the semantics to be discovered along the full length of this gamut.

### 3. Kinds of constructional meanings

Probably any kind of meaning that occurs can be the semantic contribution of a construction. The classification implied in the following list is intended to be neither definitive nor exhaustive.

- (i) Literal meaning in general, especially that concerned with the truth conditions of statements and the straightforward interpretations of questions and imperatives: the kind of meaning that formal semantics has traditionally been primarily concerned with.
- (ii) Argument structure in particular.
- (iii) Conventional implicatures, or pragmatic presuppositions.
- (iv) Less commonly recognized illocutionary forces, as in the incredulity construction (14) or the construction that announces an observed incongruity and requests an explanation for it (as in, e.g., *What are you doing smoking?*)
- (v) Metalinguistic comments, as in metalinguistic negation (e.g., *It's not good, it's great!*) or the metalinguistic comparative (e.g., *He's more annoying than dangerous.*)

### 4. Model-theoretic and truth-conditional meaning

Normally, a construction specifies a syntactic configuration, usually (in some constructional approaches, always) a local tree, consisting of a mother node and one or more daughter nodes. Sign-Based Construction Grammar (Sag 2010) distinguishes between lexical constructions, which describe lexeme classes, and combinatoric constructions, which describe phrasal types. (For recent precursors to this approach, see the constructional HPSG of Ginzburg & Sag 2000, and the constructional approaches of Kay & Fillmore 1999; Kay 2002, 2005; Michaelis & Lambrecht 1996 and Michaelis 2004.) The construction also specifies how the semantics of the daughters are combined to produce the semantics of the mother, and what additional semantics, if any, is contributed by the construction itself. Current Sign-Based Construction Grammar (Sag 2010) uses a modified form of Minimal Recursion Semantics (Copestake et al. 2005), but constructional approaches in general are not constrained to any particular semantic theory, formal or informal. A fully developed formal analysis of the semantics and syntax of a very wide range of English interrogative clauses is given in Ginzburg & Sag 2000. That work represents perhaps the most extended formal fragment of any grammar that deals in full detail with both the syntactic and semantic phenomena of a large domain, as well as the exact specifics of their interrelations. As such it presents arguably the fullest available concrete demonstration of the principle of compositionality. Ginzburg & Sag implement the notion of construction in the formal device of typed feature structures (briefly 'types') organized as a multiple inheritance hierarchy. This enables them to build a hierarchy of types, with initially separate syntactic and semantic branches, which however are mixed and matched by virtue of multiple inheritance into hybrid syntactico-semantic types that pair structure and meaning. These hybrid types are intended as fully explicit implementations of the traditional notion of a construction as a conventional (specifically, grammatical) association of form and meaning. This expansive, tightly-written treatise contains too much material to be summarized here, but some idea of the coverage – if not the novel

semantic theory of interrogatives – can be given by the leaves (maximal subtypes) of the hierarchy of interrogative clauses, which present fully explicit constructions specifying the syntax and semantic of the six major types of interrogative clauses given in (16), plus the thirteen subtypes suggested by multiple examples.

- (16) a. polar interrogative clause: *Did Kim leave?*  
 b. non-subject *wh* interrogative clause: *What did Kim see? [I wonder] what Kim saw*  
 c. subject *wh* interrogative clause: *Who left? [I wonder] who left*  
 d. reprise [i.e., echo] interrogative clause: *You saw WHO? Did I see WHO? Go WHERE? You're leaving?*  
 e. direct in-situ interrogative clause: *You saw WHO? Kim saw Sandy?*  
 f. sluiced interrogative clause: *Who? I wonder who.*

Ginzburg & Sag (2000) present separate constructions specifying the full syntax and semantics of each of these thirteen interrogative-clause types, as well as the complex inter-relations of the various syntactic and semantic types they inherit. Sag (2010) generalizes the Ginzburg & Sag analysis by analyzing the interrogative patterns in (16) as subtypes of the head-filler construction, along with other constructions that license long-distance dependencies, including topicalization, *wh*-exclamatives, relative clauses and the clauses of the biclausal correlative conditional discussed in section 2 above. Sag observes that while each of these clause types exhibits an extraction dependency between a clause-initial filler phrase and a gap in the clausal head daughter, there are several parameters of variation that distinguish these types from one another, including: the type of the filler (i.e., whether it contains a *wh*-element and, if so, of what kind), the possible syntactic categories of the filler daughter, the semantics and/or syntactic category of the mother and the semantics and/or syntactic category of the head daughter. He shows that each of the five subtypes of the filler-gap construction imposes a distinct condition: the filler daughter of a topicalized clause must contain no distinguished element (*wh*-phrase or *the*-phrase), *wh*-interrogative, *wh*-relative, and *wh*-exclamative clauses each require the filler daughter to contain a distinct type of *wh*-element and the filler of a *the*-clause must contain the definite degree marker *the*. Paralleling these syntactic differences are semantic and discourse-pragmatic differences; for example, while interrogative clauses denote propositional functions, exclamatory clauses like *What a nice person Sandy is* denote 'facts' (presupposed propositions). Because the type descriptions that define constructions in this system can involve any combination of syntactic, semantic and use conditions, the model can incorporate types that have even more specific formal, interpretive and pragmatic constraints than those just discussed. These types include the interrogative construction illustrated in (17), which Kay & Fillmore (1999) refer to as the WXDY construction:

- (17) a. What's this fly doing in my soup?  
 b. What's this scratch doing on the table?  
 c. Can you tell me what this scratch is doing on my favorite table?

What makes the construction undeniably idiomatic is that it is a *why* question that takes the form of a *what* question. At the same time, as Kay & Fillmore (1999) demonstrate, the



pattern interacts with many semantic regularities. First, the predication expressed by Y is applied to x in the standard way that any (one-place) predicate is applied to its argument, resulting in the proposition  $\|Y(x)\|$ ; it is this proposition, *e.g.*, ‘There’s a fly in my soup’, that is subject to the special, explanation-seeking illocutionary force. Second, within the Y constituent, the semantics is assembled according to the familiar rules for assembling the semantics of prepositional phrases (17), adjective phrases (18a), gerundial clauses (18b), predication noun phrases (18c):

- (18) a. What are you doing stark naked?  
 b. What was he doing running for office?  
 c. What’s she doing only the runner up?

So sentences exemplifying the WXDY construction seamlessly interweave the semantic structures of the familiar constructions involved, *e.g.*, those that license the Y predicate, non-subject *wh* interrogatives (main clause with inverted head daughter or embedded and canonical), with a special illocutionary force to compose their meaning. Constructional approaches recognize the responsibility to account in a compositional way for the meanings of wholes in terms of the meanings of their parts and the rules of combination, that is, the constructions.

## 5. Argument structure

The principal contribution of constructional approaches to the semantics of argument structure has been the thesis that patterns of argument structure (argument-structure constructions) exist independently of lexical argument-taking predicates. Adele Goldberg has been the leading exponent of this view (see, *e.g.*, Goldberg 1995, 2006; Kay 2005 and Michaelis 2004). Among the argument-structure constructions proposed by Goldberg are the Caused Motion Construction, the *Way* Construction and the Ditransitive Construction. The Caused Motion Construction is motivated by examples like (19)–(22):

- (19) a. They laughed him off the stage.  
 b. \*They laughed him.
- (20) a. Frank sneezed the tissue off the table.  
 b. \*Frank sneezed the tissue.
- (21) a. She let the water \*(out of the bathtub).  
 b. \*She let.
- (22) a. Frank squeezed the ball through the crack.  
 b. Frank squeezed the ball.

In (19)–(20) the verb can be used intransitively (not illustrated above) but cannot be used transitively without the path expression (as shown in the b versions). In (21) the verb also cannot be used transitively without the path expression and cannot be used intransitively either. In (22) the verb can be used transitively but does not have a motion-causing meaning when so employed. Clearly, the verb itself does not license the path PPs

in (19)–(22), so something else must. Goldberg posits a Caused Motion Construction, an independent argument-structure construction, as the licenser. This construction adds the notion of caused motion to the semantics of the verb and the preposition. Gawron (1985, 1986) and others had argued that pragmatic inference is sufficient to complete the picture in the interpretation of, e.g., (20) by adding to the explicitly expressed propositions that (1) Frank sneezed and (2) the tissue found itself off the table and (3) the pragmatic inference that Frank's sneezing must have caused the tissue to find itself off the table.

Goldberg's counterarguments include the observation that many languages do not permit this kind of construction, owing to the prohibition against the manner and fact-of-motion event components in verb-framed languages (Goldberg 1995: 155, citing Talmy 1985) and the observation that some of the criticism is based on the confusion of merely decoding idioms with true encoding idioms – the latter requiring representation in the grammar because they are not deducible from anything else in the grammar. Kay (2005) acknowledges Goldberg's main point: that something has to be added to the grammar to license the path expressions, but suggests that both agentive transitivity constructions and path adjunct constructions are independently required to derive (23b) and (23c), respectively, from (23a). He argues that if an independent Caused Motion Construction is posited, the analysis attributes to (23d) a spurious ambiguity.

- (23) a. The top was spinning.  
       b. Kim was spinning the top.  
       c. The top was spinning off the table.  
       d. Kim was spinning the top off the table.

Kay also argues that the proposed Caused Motion Construction overgenerates, presenting examples like those in (24):

- (24) a. \*He bragged her to sleep. (cf. *He bored her to sleep.*)  
       b. \*The storm raged the roof off the house. (cf. *The storm tore the roof off the house.*)

While this argument provides an alternative analysis for examples like (22), it does not provide an account for examples like (19)–(21), in which there is no independent active transitive version of the verb, or, if there is, it lacks the appropriate second argument. The argument against the Caused Motion Construction becomes somewhat fractionated at this point, different authors taking different views on the troublesome examples. Example (19) can be seen as semi-lexicalized; compare ??*They snored him off the stage*. According to this argument, (19) participates in a pattern of coinage that is not productive synchronically, like the pattern exemplified by the metaphorical comparatives *heavy as lead*, *light as a feather*, *old as the hills/Methuselah*, *happy as a lark* and *easy as pie*. But there are those who argue that such patterns of coinage, although not productive synchronically, should nevertheless be considered constructions of the language and included in the grammar. The argument against the Caused Motion Construction holds that tokens like (19)–(22) are analogical, nonce creations, not licensed by the grammar. Again, there does not seem to exist convincing evidence either for or against the nonce-creation view. Examples of this kind occur relatively rarely (an observation that supports the nonce-creation view) but with a relatively wide variety of verbs (an observation that undermines it); they sound

strained or poetic to proponents of the nonce-creation view but (apparently) less so to advocates of the Caused Motion Construction. Whether or not it is decided that English contains a Caused Motion Construction, Goldberg's larger claim that caused-motion phenomena motivate the existence of argument-structure constructions that expand the semantic and syntactic valences of verbs appears sound.

The *Way* construction, exemplified in (25) provides a straightforward (although not necessarily simply analyzed) example of an argument-structure construction (Goldberg 1995: 202ff; Levin & Rapoport 1988; Jackendoff 1990):

- (25) a. She was hacking her way through the brush, when . . .  
 b. He whistled his way home.  
 c. \*He whistled her way home.

The construction requires an intransitive verb (or a transitive verb used intransitively, such as *eat* or *drink*) and adds to its valence a NP that occurs in what is normally object position – but which does not passivize to subject – and an additional phrase of any syntactic category denoting a path or destination. The pseudo-object NP is determined by a possessive pronoun that is co-construed with the subject. One is inclined to dub this NP a pseudo-object because it cannot co-occur with an object, as illustrated in (26):

- (26) a. She entertained her way into café society.  
 b. \*She gave parties her way into café society.

In all cases the path or destination predicate is interpreted as predicated of the denotatum of the subject. Hence the denotatum of the subject is understood as moving either to a destination or along a path (or both). Thus in (25a) 'she' was traveling through the brush and in (25b) 'he' got home. In examples like (25a) the type of eventuality denoted by the verb is interpreted as providing a means that enables the movement (along the path or to the destination), overcoming some presupposed obstacle or other difficulty. The presumption of difficulty explains the sort of contrast exemplified in (27), according to which ordinary verbs of locomotion require a special context that provides an image of difficulty to sound acceptable in such sentences.

- (27) a. ??She walked her way home.  
 b. ??She swam her way across the pool.  
 c. Exhausted by the struggle, she barely managed to swim her way to safety.

In examples like (25b), the type of eventuality denoted by the verb is interpreted as an accompaniment or a manner of the movement. Goldberg (1995: 210ff) sees the availability of both means and manner readings as evidence of constructional polysemy, pointing to precedents in the lexicon.

- (28) a. Bob cut the bread with a knife. (means) [Goldberg 1995: 211, (37)]  
 b. Bob cut the bread with care. (manner) [Goldberg 1995: 211, (38)]
- (29) a. Pat found a way to solve the problem. (means) [Goldberg 1995: 211, (40)]  
 b. He had a pleasant way about him. (manner) [Goldberg 1995: 211, (41)]

More formal, constraint based approaches, such as SBCG, would analyze the relations between examples like (25a) and (25b) as illustrating inheritance of identical syntax and largely overlapping semantics by two distinct constructions, leaving discussion of the extension of means to manner semantics as belonging to the history of the language rather than the synchronic grammar.

Most constructional approaches to argument structure have considered either additions to the argument structure of verbs or alternate syntactic valences with possible semantic consequences as in the dative alternation. Goldberg (1995: 141–151) and Kay (2005: 71–98) have provided analyses of the ‘Dative Movement’ alternation in somewhat differing constructional frameworks, Goldberg’s relying on the notion of constructional polysemy, radial categories of argument-structure constructions, and various types of links among senses of a construction. This approach is close in spirit to much of the work in cognitive linguistics. Kay’s approach is more similar to SBCG and the more formal constraint-based approaches to grammar. Both approaches agree that one or more argument-structure constructions are necessary to provide the special syntax of sentences like (30):

(30) Kim sent Sandy a letter.

and to account for the well known contrast of acceptability illustrated in (31).

- (31) a. Kim forwarded the letter to Sandy.  
 b. Kim forwarded Sandy the letter.  
 c. Kim forwarded the letter to Oshkosh General Delivery.  
 d. \*Kim forwarded Oshkosh General Delivery the letter.

Whereas the destination of the transfer in (31a) and (31c) is not constrained to be a recipient, it is so constrained in (31b) and (31d). Before leaving the topic of argument structure constructions, we should note that argument-structure constructions do not always add arguments or shuffle them around arguments furnished by the lexical predicator. Argument-structure constructions may also delete arguments, as is the case of certain French reflexives, which inchoativize inherent transitives. Some French reflexives are presumably derived from transitive counterparts by removing an agentive subject valent both semantically and syntactically, rather than indicating that the subject’s denotatum is performing a reflexive action. For example *démocratiser* is necessarily transitive and means ‘to make [something] democratic’; similarly *améliorer* is necessarily transitive and means ‘to improve [something]’, but the reflexive versions *se démocratiser* and *s’améliorer* do not mean ‘to democratize itself/oneself’ or ‘to improve itself/oneself’, but merely ‘to become democratic’ and ‘to improve’.

## 6. Conventional implicature, or pragmatic presupposition

One of the areas in which constructional approaches have contributed to semantics is that of conventional implicature or pragmatic presupposition. It seems appropriate to allow the notion of compositionality to comprise these ‘pragmatic’ instructions embedded in the grammar that provide the addressee with a certain semantic structure and instruct him or her to find content in the context that satisfies that structure. Consider utterance of a sentence like (32):

(32) Kim won't (even) get question eight right let alone Sandy get question nine.

Sentence (32) asserts that Kim and Sandy won't get the correct answers to questions eight and nine, respectively. But there is rich content to (32) beyond these truth conditions (Fillmore, Kay & O'Connor 1988). The use of *let alone* to connect the two clauses signals that the first unilaterally entails the second, and thus suggests the paraphrase in (33).

(33) Kim won't get problem eight right; *a fortiori* Sandy won't get problem nine right.

And this entailment takes a particular form. In this example, we have to think that the problems can be arranged on a scale (presumably of difficulty) and students arranged on a scale (presumably of ability) where the scales are interrelated in such a way that a more able student will answer correctly any problem that a less able one will and a less able student will miss any problem that a more able one misses. A network of propositions connected by entailments of this kind has been called a scalar model (Kay 2004: 684). Scalar models have several interesting general properties. Two of these properties are that the form of a scalar model can be made mathematically precise (for the formal details, see Kay 1990), and that its content is left entirely open to retrieval from context, including background knowledge (Fillmore, Kay & O'Connor 1988; Kay 1997). The latter property is perhaps more readily appreciated with an example like (34).

(34) SANDY doesn't eat CHICKEN let alone KIM eat DUCK.

An utterance of (34) could be readily interpreted in a context in which duck is viewed as more expensive than chicken and Kim as more frugal than Sandy – or in a context in which duck is viewed as meatier than chicken and Kim is viewed as a stricter vegetarian than Sandy – or in a context in which duck is viewed as more exotic than chicken and Kim as more squeamish than Sandy. The *let alone* operator instructs the addressee to find in the context a scalar model that is induced by two unidimensional scales, here of eaters  $\langle x_1, x_2, \dots, x_n \rangle$  and foods  $\langle y_1, y_2, \dots, y_m \rangle$ , and a propositional function (here:  $x_i$  doesn't eat  $y_j$ ), such that whatever Kim will eat Sandy will eat and whoever doesn't eat chicken necessarily doesn't eat duck. In the *let alone* construction the content of the scalar model is left for the addressee to extract from the context although the form of the model is strictly fixed. It is this property of directing the addressee to extract information of a prescribed form from the context that motivates the appellation 'contextual operator'.

An additional component of the meaning of the *let alone* is discussed further in section 9: the negation of the proposition denoted by the second clause is taken to be in the context. For example, a successful utterance of (34) requires a conversational context in which the proposition that Kim will eat duck is on the floor although not necessarily taken for granted: for instance, the context proposition might have been introduced in a question: *I wonder if Kim eats duck*. The construction seems designed for use in a circumstance in which the demands of Gricean Quantity conflict with those of Relevance (Relation). For example, an utterance of (34) would be most appropriate in a context where the proposition that Sandy eats chicken has been asserted or questioned, and the speaker feels that rather than respond directly with a denial it would be more informative to reply that Kim does not eat duck, since the latter entails the correct answer to the former and provides additional, presumably relevant, information.

Contextual operators can be parasitic upon one another, by which we mean that when two occur in the same utterance the conceptual output of one can serve as input to the other. Consider *respective* and *vice versa*. First we establish that each of these expressions is a contextual operator. *Respective* (and *respectively* in a somewhat different fashion) presuppose a mapping (usually bijective) relating two sets, but in effect instruct the addressee to discover in the context the rule establishing the mapping (Kay 1989). Consider a sentence like (35):

(35) The teachers called their respective mothers.

An utterance of this sentence could of course be used in a context where the teachers' female parents were the intended receivers of calls but it could also be used in a context of a parent-teacher association function where each teacher has been assigned one (or more) mother to call. Figuring out from context the mapping relation that yields the codomain is the responsibility of the addressee.

Interpreting a sentence containing *vice versa* can likewise be shown to depend crucially on the addressee's finding needed information in the context. This can be seen by first considering a sentence that presents an ambiguity that can only be resolved by context. In (36) only context can decide the ambiguity between the referential (*John*) and bound variable (*Every boy*) reading of the pronoun.

(36) John<sub>i</sub> thinks [every boy]<sub>j</sub> loves his<sub>i,j</sub> mother.

If we embed a sentence with this kind of ambiguity under the *vice versa* contextual operator, we see that the ambiguity is maintained.

(37) John thinks that every boy loves his mother and vice versa.

Sentence (37) will convey John's conviction of mutual love between himself and every boy's mother only if the referential interpretation is dictated by the context in which the sentence is heard. By the same token, only if the context dictates the bound variable interpretation, will the sentence convey John's conviction that all mother-son pairs are mutually loving. An ambiguity comparable to but distinct from that created by the referential versus bound variable reading of the pronouns in (36) can be created by *respective*.

(38) The secretaries called their respective senators.

In (38), the relation pairing secretaries and senators must be recovered from context. The senators may be the employers of the secretaries, pen pals, and so on. If we put both contextual operators into the same sentence, as in (39), the one with wider scope will take the conceptual output of the one with narrower scope as its input.

(39) The secretaries called their respective senators and vice versa.

Whatever relation is contextually recovered as pairing secretaries  $\langle x_1, x_2, \dots, x_n \rangle$  with senators  $\langle y_1, y_2, \dots, y_n \rangle$  will establish the relation  $\{\langle x, y \rangle \mid x \text{ called } y\}$  as the meaning that is fed into the *vice versa* operator, which in turn will yield the meaning  $\{\langle x, y \rangle \mid x \text{ called}$

y & y called x}. (For further discussion of these and other examples of contextual operators, see Kay 1997; Michaelis 1994b on Vietnamese markers of expectation violation and Michaelis 1996 on the aspectual adverb *already*.)

A view closely related to that of contextual operator is that of Fillmorean frames, which provide an alternative explanation for many of the phenomena that go under the heading of presupposition in the formal semantic literature. Gawron (cf. article 29 *Frame Semantics*) discusses Fillmore's well-known example of *on the ground* versus *on land* (Fillmore 1985). An utterance employing the former expression is likely to presuppose a context including an air voyage while the latter is likely to presuppose a sea voyage. The striking aspect of the example is that these expressions appear to denote the same thing and differ only in the background frame they rely on and therefore evoke when uttered. Somewhat similarly, Fillmore has discussed at length the "commercial-event frame", which seems to provide background for and be evoked by a rather long list of words, including *buy, sell, cost, price, goods, etc.* Frame semantics provides a persuasive semantic theory at the lexical level; the mechanism that combines the meanings of words and elementary constructions into the meanings of sentences has received less attention in this tradition. (For further discussion see article 29 (Gawron) *Frame Semantics* and the Fillmore references cited therein.)

## 7. Less commonly recognized illocutionary forces

A number of constructions appearing in recent constructionist writings have involved special illocutionary forces, beyond the familiar ones of imperatives, questions, and a handful of others. Perhaps the most familiar such special illocutionary force is that associated with the "Mad Magazine" sentence type (Akmajian 1984; Lambrecht 1990); it is illustrated by (14), repeated below:

(14) Him get first prize?!

The force of this sort of sentence appears to be an expression of incredulity, but perhaps a particular nuance of that attitude expressible only in this or a small number of other forms.

Somewhat similarly perhaps, it is difficult to gloss the force of the construction illustrated in (7), repeated below:

(7) Watch me get wet.

The particular attitude conveyed by using this form has been described as "conjuring fate", but capturing the exact signification of this sentence form is not easy. Again, it is possible that this particular illocutionary meaning is expressible in English only in this form.

Another special illocutionary force displayed by a construction discussed above is that of examples (17a,b) repeated.

- (17) a. What's this fly doing in my soup?  
b. What's this scratch doing on the table?

The illocutionary force conveyed by this construction seems roughly to be that of pointing out an anomaly and expressing a desire for an explanation of it.

The special force or forces of the pseudo-conditional construction, exemplified in (1–2) above and in (40) below, seem especially hard to pin down. The examples in (40) present the first five relevant Google hits that matched the pattern “If you’re *x* \* you . . .”. After viewing quite a few attested examples we confess to failure in isolating what the choice of the pseudo-conditional construction adds to or subtracts from a simple assertion of the proposition (or posing the question or imperative) formed from the pseudo-apodosis by substituting the person the (pseudo-) addressee is identified with in the pseudo-protasis substituted for “you”. We leave figuring out the illocutionary function of this construction as an entertainment for the reader.

- (40) a. We make a living by what we get, Churchill said, but we make a life by what we give. And to save a life? If you’re Bill Gates, the richest man in the world, you give fantastic sums of money [ . . . ]. If you’re a rock star like Bono, you give money. [ . . . ] If you’re Bill Clinton and George H.W. Bush, you raise money – but you also give the symbols of power and the power of symbols[ . . . ].
- b. Look, Davis is the boss and can sign and cut whoever he wants. It’s just that communication is not one of his strengths. If you’re the coach of the Raiders, you deal with it.
- c. [I]f you’re Britney Spears’ publicist you might as well go ahead and kill yourself. Unless you have a time machine, there’s no way to fix this.
- d. The Firearms Waiting Period: No, that’s not the waiting period to *buy* a gun. If you’re Dick Cheney, that’s the time you take until you get around to reporting you’ve shot somebody.
- e. If You’re Barack Obama, How Much Do You Trust Howard Dean?

## 8. Metalinguistic constructions

Metalinguistic constructions convey a comment on the form or meaning (or both) of the utterance in which they occur. The best-known example is Horn’s (1985) analysis of metalinguistic negation (see also Horn 1989: Chapter 6), which relies on works by Grice (1967/1989, 1975), Wilson (1975) and Ducrot (1972, 1973), the last of whom was, to our knowledge, the first to use the term metalinguistic negation (*négation métalinguistique*). Horn showed that a sentence like (40) could not be analyzed by positing either a very general kind of propositional negation or two separate propositional negation operators in English (or languages with a similar phenomenon), primarily based on examples like those in (41).

(40) The King of France is not bald, because there is no King of France.

- (41) a. Her name isn’t [æ’n’drijə]; it’s [andrej’ə].
- b. It’s not pretty; it’s gorgeous.
- c. It’s not the unique criteria; it’s the unique criterion.
- d. The cow isn’t pissing, son, she’s urinating.

None of the examples in (41) expresses negation of a proposition: (41a) involves correction of pronunciation; (41b) expresses cancellation of a Quantity implicature; (41c) concerns a grammatical correction; (41d) involves a correction of register. The point is that metalinguistic negation can object to any aspect of an utterance, not just the propositional content.



The metalinguistic negation phenomenon is of particular interest to constructional approaches because, along with the special semantic behavior just described, it possesses special morphosyntactic properties, so that it is appropriate to speak of the metalinguistic negation construction. First, metalinguistic negation does not act as a negative polarity trigger, not surprisingly since semantically it does not negate a proposition.

- (42) a. John didn't manage to solve \*any/some of the problems, he managed to solve all of them. (Horn 1985: 135)  
 b. I wouldn't rather walk, but I'm willing to. (Kay 2004: 688)

In (42a) the negative polarity item *any* is rejected and in (42b) the positive polarity item *rather* is welcomed.

Secondly, metalinguistic negation does not allow morphologically or lexically incorporated negation.

- (43) a. A bad outcome is \*improbable/not probable; it's certain.  
 b. I \*doubt/don't believe he'll come; I'm sure of it.

Finally, a rectification clause, which is almost always present and always understood, cannot be introduced by *but*.

- (44) a. He's not happy; (\*but) he's delirious.  
 b. Her name isn't [dʒæ'kwəlɪn]; (\*but) it's [ʒaklɪn].

The metalinguistic comparative construction was discussed briefly in section 3, as was metalinguistic negation. Again, we see evidence of a grammatical construction, as against an implicature or trope, in observing special constraints on the syntax.

- (45) a. This cat is more stupid than malicious.  
 b. \*This cat is stupider than malicious.  
 c. This cat is more stupid than he is malicious.  
 d. This cat's stupidity exceeds his malice.

The metalinguistic comparative in version (45a) is read as proposing that *stupid* is a more apt description of the cat than *malicious*; it does not mean the same as (45d). The metalinguistic comparative also resists morphological incorporation, as shown in (45b). Example (45c), with a non-ellipted *than*-clause, does not yield a metalinguistic interpretation, but rather means roughly the same as (45d).

The class of metalinguistic operators includes the expressions dubbed *hedges* by Lakoff (1973). English hedges include the expressions *strictly speaking*, *loosely speaking*, *technically (speaking)*, *kinda* (equivalently *kind of*, *sorta*, *sort of*). According to Kay (1984), a hedged sentence, when uttered, contains a comment on itself, its utterance or some part thereof. For example, in uttering the statement *Loosely speaking France is hexagonal*, a speaker has made a certain kind of comment on the locution *France is hexagonal*. "In this sort of metalinguistic comment, the words that are the subject of the comment occur both in their familiar role as part of the linguistic stream and in a theoretically unfamiliar role as part of the world the utterance is about" (Kay 1984: 129). That is,

in saying *Loosely speaking France is hexagonal* a speaker at once claims that France is hexagonal and signals that there is something 'loose' about the claim being made, or the way it's being made.

The attested sentence (46) similarly makes a claim, and the same time makes a comment on the making of that claim:

(46) Chomsky has a very *sorta* classical theory of syntax.

The adverb *very* intensifies the adjective *classical*, but the metalinguistic hedge *sorta* signals that the speaker is unsure that *classical* is the *mot juste*. If *sorta* were simply an attenuator, like *slightly* for example, sentence (46) would mean something close to (47) but it clearly does not.

(47) Chomsky has a very slightly classical theory of syntax.

Rather, the intensification of *very* is heard as part of the interpretation of (46) and *sorta* is heard as a comment on the aptness of the word *classical* as a name for the property (of Chomsky's theory of syntax) the speaker has in mind.

*Kinda* and *sorta* also have a syntax that distinguishes them from ordinary deintensifiers, like *slightly*. Briefly, *kinda/sorta* can modify any projection of any major category. Kay (2004: 699) gives the following examples distinguishing the syntactic behavior of *kinda/sorta* from that of deintensifying adverbs.

- (48) a. a very slightly but unevenly worn tire  
b. \*a very *sorta* but surprisingly classical theory
- (49) a. That tire is worn very slightly.  
b. \*That tire is worn very *sorta*.
- (50) a. That tire is worn, but only very slightly.  
b. \*That tire is worn, but only very *sorta*.
- (51) a. That [very slightly]<sub>i</sub> worn tire is proportionately<sub>i</sub> discounted.  
b. \*That [very *sorta*]<sub>i</sub> classical theory is correspondingly<sub>i</sub> admired.

Metalinguistic constructions often mimic fairly closely the syntax of non-metalinguistic constructions, although usually with some variation.

## 9. Information flow

The central question addressed by theories of information structure is: why do grammars provide so many different ways of expressing the same proposition? The answer given is that the construction space of English and other languages is shaped by level-mapping constraints involving the three-termed relationship among syntactic roles, semantic roles and pragmatic roles, in particular topic and focus (Lambrecht 1995). The examples in (52) illustrate the range of syntactic and prosodic means available for expressing the proposition 'The dog ate the leftovers' in English (points of prosodic prominence are marked by small caps):

- (52) a. The dog ate the LEFTOVERS.  
 b. The DOG ate the LEFTOVERS.  
 c. The LEFTOVERS, the DOG ate.  
 d. It's the DOG that ate the leftovers.

Lambrecht (1994) and Lambrecht & Michaelis (1998) propose that the prosodic and syntactic permutations in (52) amount to differences in the presuppositional content of the constructions that license them. The relevance of presupposition to the pattern in (52e) is no doubt relatively obvious: as a cleft sentence, (52d) presupposes the propositional function 'The dog ate x', and the prosodic peak marks the focus, or 'new information': the identity of the variable (Jackendoff 1972: chapter 6). It is less obvious how presupposition comes into play in the other sentences: (52a), for example, can, but need not, presuppose the propositional function evoked by (52d); (52a) could answer the question (53a) as readily as it could (53b):

- (53) a. What did the dog do NOW?  
 b. What did the dog eat?

In the context of (53a), (52a) represents a predicate-focus sentence, and as such it is interpreted according to Lambrecht & Michaelis's (1998: 498ff) Principle of Accent Projection: an accented argument expression (in this case, *the leftovers*) can extend its semantic value to an unaccented predicate (in this case, *ate*), in which case the predicate and argument form a single information unit. In the case of (52a), this unit is a focal unit.

But what of (52b)? If the two peaks of (52b) were each presumed to represent foci, we could not easily explain why it, just like its single-peak analog (52a), can serve as an answer to the 'broad' question (53a). Lambrecht (1994: chapter 4) and Lambrecht & Michaelis (1998) propose that both the single- and double-peak prosodic patterns are the products of focus constructions, which affect the presuppositional properties of predicate-argument combinations. Lambrecht (1994: chapter 5) proposes three focus constructions, which are listed and exemplified in (54), along with the communicative function associated with each pattern:

- (54) a. Argument focus, e.g., *SOCIETY's to blame*. Function: identifying a variable in a presupposed open proposition.  
 b. Predicate focus, e.g., *She speaks several LANGUAGES*. Function: predicating a property of a given topic.  
 c. Sentence focus, e.g., *Your SHOE's untied*. Function: introducing a new discourse referent or reporting an event or state involving such a referent.

Focus constructions behave much like argument-structure constructions, in that they impose interpretive and formal constraints on predicates and their valence members. In English, such constructions assign prosodic peaks to one or more arguments and potentially to the verb itself. According to Lambrecht & Michaelis (1998), the assignment of prosodic peaks is constrained by general principles governing the prosodic expression of the topic and focus roles in a predication. In contrast to theories of sentence prosody based on the Nuclear Stress Rule of Chomsky & Halle (1968) (see, e.g., Neeleman &

Reinhart 1998), the accent-placement principles proposed by Lambrecht & Michaelis (1998) make no reference to either linear order of constituents or hierarchical structure. Such accent-placement principles are analogous to case-marking principles based on semantic role ordering (rather than syntactic position), and they are equally critical to the functioning of a declarative, nonprocedural model of grammar: no movement transformations are required to model focus marking in flexible word-order languages and only one set of principles is needed for both local and nonlocal argument instantiation, as in (55):

- (55) a. It's called Republic PLAZA.  
b. Republic PLAZA it's called.

Both (55a) and (55b) illustrate the argument-focus pattern, whose accentual properties are described by a principle referred to by Lambrecht & Michaelis (1998: 498) as the Discourse Function of Sentence Accents, viz., "A sentence accent indicates an instruction from the speaker to the hearer to establish a pragmatic relation between a denotatum and a proposition". Sentence (55a) has a locally instantiated second argument while (55b) is an instance of focus fronting (Prince 1981), but the establishment of the focus relation relative to the open proposition 'It's called x' proceeds identically in the two cases. Similarly, predicates may fall under the pragmatic scope of their accented arguments whether they precede or follow them. The Principle of Accent Projection mentioned above accounts for the 'spreading' of an accented argument's focal value to its predicate – not only within the VP, as in (52a), but also in the sentence-focus pattern exemplified in (54c), in which the accented argument precedes the verb that licenses it. In both cases, predicate and argument are integrated into a single focal unit.

According to Accent Projection, while a focal predicate need not be accented, a focal argument is always accented. Is an accented argument necessarily a focus? The answer given by this model is no: an accented argument may also be a topic. Sentence (52b), repeated below as (56), illustrates this point:

- (56) The DOG ate the LEFTOVERS.

The two prosodic peaks in (56) have distinct discourse-pragmatic significances. Removing the peak on *leftovers* changes (56) from a predicate-focus to an argument-focus sentence, but removing the peak on *dog* has no effect on the sentence's focus articulation: it remains a predicate-focus sentence. If the subject accent in (56) is not a focus accent, what is it? According to the principle referred to above as the Discourse Function of Sentence Accents, sentence accents establish a pragmatic relation, whether it is a focus-relation or a topic relation. This means that the referent of an accented argument expression can be either focal or topical. Lambrecht & Michaelis (1998: 499) use the term *topic accent* to refer to a sentence accent that marks a discourse-new or 'unratified' topic argument rather than a focus. In declarative sentences, a topic accent is necessarily accompanied by a focus accent elsewhere in the clause. (The one exception to this principle, discussed by Lambrecht & Michaelis (1998), is found in *wh*-questions, in which the focal constituent, the *wh*-word, is typically unaccented and accents in the gapped portion of the clause represent topic accents, as in, e.g., *Where did the POPE stay when he was in*

NEW YORK?) While that focus accent falls within the VP in subject-predicate sentences like (56), it may also fall within the gapped clause of a filler-gap construction like topicalization, as in (52c): *The LEFTOVERS the DOG ate*. While (52c) and (56) feature identical accented words, these accents reverse their roles in (52c): the topicalized NP *the leftovers* bears a (contrastively interpreted) topic accent, while the subject of the gapped clause (*the dog*) bears a focus accent (see Prince 1981, 1986 for discussion of the presuppositional properties of topicalization). The principle that governs the discourse function of sentence accents treats both patterns under a single umbrella, but the two patterns create a potential paradox for a movement-based account: how does the accented object NP change its pragmatic construal (from focus to topic) after its focus accent has been assigned *in situ*?

Let us now return to the question with which we began this section: what is presupposed by predicate-focus sentences like (56) and (52a)? Sentence (52a) is repeated below as (57):

(57) The dog ate the LEFTOVERS.

The answer given by Lambrecht & Michaelis (1998) relies on the distinction between *knowledge* presuppositions and *topicality* presuppositions. Knowledge presuppositions concern the assumed knowledge state of an addressee at the time of an utterance. Knowledge presuppositions correspond to those described in linguistic philosophy as the propositions evoked by factive verbs, definite descriptions, sentential subjects, aspectual verbs and argument-focus constructions of various kinds (Prince 1986). Topicality presuppositions concern the assumed statuses of referents as topics of current interest in a conversation. Sentence-focus sentences like *Your SHOE'S untied*, *My CAR broke down* and *Your PHONE'S ringing* illustrate the difference between the two types of presupposition: while all of the foregoing sentences, by virtue of their definite subjects, could be said to trigger the existential presupposition (a knowledge presupposition), all lack the topicality presupposition: their subject-referents are not presumed to be topics of current interest in the conversation. But the assumption that the subject referent is a topic (or predictable argument) in the predication is precisely what predicate-focus utterances convey. Put differently, the predicate-focus construction triggers the topicality presupposition. It does so, according to Lambrecht (1994), because of a communicative constraint originating from the Gricean lower bound on informativeness: the Principle of Separation of Reference and Role (PSRR). He describes this constraint by means of a maxim: "Do not introduce a referent and talk about it in the same clause" (Lambrecht 1994: 185). Michaelis & Francis (2007) observe the operation of this constraint in the distribution of lexical versus pronominal subject NPs in the Switchboard conversational corpus (Marcus, Santorini & Marcinkiewicz 1993). Of approximately 31,000 subjects of declarative sentences, they find that only 9 percent are lexical NPs, while 91 percent are pronouns. (By contrast, about 66 percent of the approximately 7500 objects of transitive verbs are lexical.) The subject-coding trends indicate that conversants tend to adhere to the PSRR: they do not typically predicate properties of discourse-new entities. Conversely, and as suggested by the relative frequency of lexical object-expression in the corpus, speakers tend to introduce new referents in postverbal position and then resume them as pronominal subjects in subsequent predications. This strategy is exemplified in the following excerpt from the Fisher corpus of conversational speech:

- (58) I have a friend of mine who used to be really involved in the beach volleyball circuit but uh he's not anymore but he still watches it. He coaches his daughter and all kinds of stuff.

At the same time, the presence of some 3,000 lexical-subject predications in the Switchboard corpus indicates that the PSRR is a violable constraint. The passage in (59), also from the Fisher corpus, exemplifies the use of a lexical subject (shown in boldface):

- (59) [In a conversation about the Red Lobster restaurant] **My friend** used to work at Red Lobster actually, and she used to be so fed up with people coming in and being like oh it's mostly seafood.

Michaelis & Francis (2007) argue that the use of a lexical subject represents a short-circuited form of referent introduction that privileges speaker-based effort conservation at the expense of hearer-based explicitness. The lexical-subject strategy subserves effort conservation because it allows the speaker to accomplish something in a single clause that otherwise requires two clauses: introducing a referent and saying something about it. Michaelis & Francis argue that if one assumes the presuppositional analysis of predicate-focus sentences described above, the lexical-subject strategy can be seen as a brand of presupposition manipulation akin to those described by Lewis's (1979) rule for accommodation of presupposition: "If at time *t* something is said that requires presupposition *p* to be acceptable, and if *P* is not presupposed just before *t*, then – ceteris paribus and within certain limits – presupposition *P* comes into existence at *t*" (Lewis 1979: 172). Applied to the case at hand, this means that if a speaker uses a predicate-focus predication when the topicality presupposition is not satisfied, the hearer is capable of supplying it, insofar as the associated existential presupposition is banal (Kay 1992): the speaker has a friend, sister, etc. Accommodation of the topicality presupposition is also potentially facilitated by the linguistic mark carried by most new topics: the topic-establishing accent found in double-peak sentences like (56).

Presuppositional properties of focus constructions are relevant not only for the description of prosody and conversational referring behavior, but also for the establishment of inheritance relations among pragmatically specialized constructions, as shown by Birner, Kaplan & Ward (2007) in their study of the family of argument-structure constructions comprising *th*-clefts (e.g., *That's John who wrote the book*), equatives with epistemic *would* and a demonstrative subject (e.g., *That would be John*) and simple equatives with demonstrative subjects (e.g., *That's John*). The latter two constructions, they argue, should not be analyzed as truncated clefts (pace Hedberg 2003). Instead, as they demonstrate, all three constructions inherit formal, semantic and information-structure properties from an argument-focus construction used for equative assertions. The construction contains a copular verb, requires a demonstrative subject and presupposes an open proposition whose variable is referred to by the demonstrative subject. (The post-copular focal expression identifies this variable, as in other argument-focus constructions.) Thus, for example, in the sentence *That will be John*, the demonstrative subject refers to the variable in a presupposed open proposition (e.g., 'x is at the door'). They argue that the family of equative constructions exhibits functional compositionality, as cases which "the discourse-functional properties of a complex structure are determined

by the functional and semantic properties of its component parts” (Birner, Kaplan & Ward 2007: 319, fn. 1). Birner, Kaplan & Ward’s analysis is elegant and intuitively appealing, and further supports the claim that constructional and compositional modes of analysis are compatible.

## 10. Conclusion

In asking what constructions mean we must also ask how constructions mean. Constructions invoke formal properties ranging from syntactic categories to prosodic features to fixed lexical forms. All such patterns must interact in the licensing of utterances. The recursive nature of a language comes from the fact that we can use in one construction a sign that is an instance of another construction. While no current syntactic theory has failed to acknowledge that verbal idioms and their ilk can be embedded as the terminal nodes of regularly constructed phrases, non-constructionists have been less apt to acknowledge another fact about embedding: regular patterns can be embedded in idiomatic ones. Examples include the WXDY interrogative construction analyzed by Kay & Fillmore (1999), the subjectless tag sentences analyzed by Kay (2002) and the double-copula construction analyzed by Brenier & Michaelis (2005). We believe that the seamless integration of relatively idiomatic constructions with more productive ones in actual sentences provides an additional challenge to the notion of a privileged ‘core’ grammar.

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Paul Kay, Berkeley, CA (USA)

Laura A. Michaelis, Boulder, CO (USA)

## 87. Scalar implicature as a grammatical phenomenon

1. Introduction
2. Embedded implicatures: a first crack in the Gricean picture
3. A new argument for embedded implicatures in UE contexts: Hurford's constraint
4. Further cracks in the Gricean picture
5. Concluding remarks
6. References

### Abstract

*This article develops various arguments for the view that scalar implicatures should be derived within grammar and not by a theory of language use (pragmatics). We focus primarily on arguments that scalar implicatures can be computed in embedded positions, a conclusion incompatible with existing pragmatic accounts. We also briefly review additional observations that come from a variety of empirical domains, all incompatible with pragmatic accounts, yet predicted by the grammatical alternative.*

### 1. Introduction

Since the late 1990's there has been a lively revival of interest in implicatures, particularly scalar implicatures (SIs for short). Building on the resulting literature, our main goal in the present article is to present several arguments for the claim that SIs can occur systematically and freely in arbitrarily embedded positions. We are not so much concerned with the question of whether drawing implicatures is a costly option (in terms of semantic processing, or of some other markedness measure). Nor are we specifically concerned with how implicatures come about (even though, to get going, we will have to make some specific assumptions on this matter). The focus of our discussion is testing the claim of the pervasive embeddability of SIs in just about any context, a claim that remains so far controversial. While our main goal is the establishment of an empirical generalization, if we succeed, a predominant view on the division of labor between semantics and pragmatics will have to be revised. A secondary goal of this article is to hint at evidence that a revision is needed on independent grounds. But let us first present, in a rather impressionistic way, the reasons why a revision would be required if our main generalization on embedded SIs turns out to be correct.

In the tradition stemming from Grice (1989), implicatures are considered a wholly pragmatic phenomenon (cf. article 92 (Simons) *Implicature*, article 5 (Green) *Meaning in language use*, and also Davis 2005) and SIs are often used as paramount examples. Within such a tradition, semantics is taken to deal with the compositional construction of sentence meaning (a term which we are using for now in a loose, non technical way), while pragmatics deals with how sentence meaning is actually put to use (i.e. enriched and possibly modified through reasoning about speakers' intentions, contextually relevant information, etc.). Simply put, on this view pragmatics takes place at the level of complete utterances and pragmatic enrichments are a root phenomenon (something that happens globally to sentences) rather than a compositional one. So if SIs can be systematically generated in embedded contexts, something in this view has got to go. Minimally, one is

forced to conclude that SIs are computed compositionally on a par with other aspects of sentence meaning. But more radical task reallocations are also conceivable. While we may not be able to reach firm conclusions on this score, we think it is important to arrive at a consensus on what are the factual generalizations at stake, how they can be established, and what range of consequences they may have.

Let us rephrase our point more precisely. The semantics/pragmatics divide can usefully be lined up with compositional vs. postcompositional interpretive processes. In the compositional part, basic meanings are assigned to lexical entries, which are then composed bottom up using a restricted range of semantic operations on the basis of how lexical entries are put together into phrases. These operations apply in an automatic fashion, blind to external considerations, e.g., speaker intentions and relevant contextual knowledge. Sentence meaning is, thus, constructed through the recursive application of semantic rules – typically, functional application. But what is sentence meaning? Such a notion is often identified with truth conditions. While semantics, as we understand it, falls within this tradition, we would like to keep our options open on the exact nature of sentence meaning. For the notions of sentence content that have emerged from much recent work are way more elaborate than plain truth conditions (cf. article 71 (Hinterwimmer) *Information structure* and 94 (Potts) *Conventional implicature*). For example, sentence meaning has been argued to involve the computation of alternative meanings and hence to be a multidimensional phenomenon (cf. the semantics of questions, focus, etc); or sometimes sentence meaning has been assimilated to context change potentials (cf. dynamic approaches to presuppositions and anaphora). We remain neutral here on these various options, and we do so by simply taking sentence meaning as equivalent to the output of the compositional process of interpretation as determined by UG, whatever that turns out to be.

In understanding the compositional/postcompositional divide, one further preliminary *caveat* must be underscored. Sentence meaning is blind to context, but not independent of it. Virtually every word or phrase in Natural Language is dependent on the context in some way or other. In particular, the meaning of sentences will contain variables and indexicals whose actual denotation will require access to factual information accessible through the context. To illustrate, consider the following standard analysis of *only* and focus association, along the lines of Rooth (1985, 1992) and Krifka (1993) (an example that will turn out to be very useful for our approach to SIs). According to Rooth a sentence like (1a) is analyzed along lines explicated in (1b-d):

- (1) a. Joe only upset [<sub>F</sub>Paul and Sue]  
(where [<sub>F</sub>] indicates the constituent bearing focal stress)
- b. **LF:** only [Joe upset [<sub>F</sub>Paul and Sue]]
- c. **Interpretation:**  
[[Only]<sub>ALT(D)</sub> Joe upset [<sub>F</sub>Paul and Sue]]<sup>w<sub>0</sub></sup> = 1 iff  
UPSET(JOHN, PAUL + SUE) (*w<sub>0</sub>*) = 1  $\wedge \forall p \in \text{ALT}(D)$  [ $\lambda w$ .UPSET(JOHN, PAUL + SUE) (*w*)  $\not\subseteq p \rightarrow p(w_0) = 0$ ]
- d.  $\text{ALT}(D) = \{\lambda w$ .UPSET(JOHN, *u*) (*w*) : *u*  $\in D\}$  =  
{The proposition that Joe upset Lee, the proposition that Joe upset Sue, the proposition that Joe upset Kim, the proposition that Joe upset Lee and Sue, ... }

Something like (1a) has the Logical Form in (1b), where *only* is construed as a sentential operator, and is interpreted as in (1c). Such an interpretation, informally stated, says that

Joe upset Paul and Sue and that every member of the contextually restricted set of alternatives ALT not entailed by the assertion must be false. Thus, in particular, *Joe upset Paul* is entailed by the assertion, and hence has to be true, but *Joe upset Kim* is not, and hence must be false. The set ALT is specified as in (1d). Such a set is generated by UG-driven principles through a separate recursive computation (and this is part of what makes sentence meaning multidimensional). In (1c), there is one variable whose value has to be picked up by pragmatic means: D, the quantificational domain. The determination of D's value is a pragmatic, 'postcompositional' process.

So, pragmatics, as understood here, is the process whereby speakers converge on reasonable candidates as to what the quantificational domain may be; it is also the process whereby a sentence like (1a) may wind up conveying that the meeting was a success (because, say, Joe managed to keep the number of upset people to a minimum), or the process whereby (1a) may result in an ironical comment on Joe's diplomatic skills, etc. Such processes are arguably postcompositional, in the sense that they presuppose a grasp of sentence meaning, plus an understanding of the speaker's intentions, etc. We have no doubt that such processes exist (and, thus, that aspects of the Gricean picture are sound and effective). The question is whether SIs are phenomena of the latter post-compositional sort or are UG-driven like, say, the principles of focus association sketched in (1).

## 1.1. Background

In his seminal work, Grice (1989) argues that the main source of pragmatic enrichment is a small set of maxims (Quality, Quantity, Relation, Manner) that govern, as overridable defaults, cooperative conversational exchanges (Oswald Ducrot developed related ideas independently, e.g. Ducrot 1973. Another approach, broadly inspired by Grice but which departs more radically from the original formulations, can be found within the tradition of Relevance Theory – see, e.g., Sperber & Wilson 1986, Carston 1988).

In discussing the various ways in which these maxims may be used to enrich basic meanings, Grice considers the case of how *or* might strengthen its classical Boolean inclusive value (according to which 'p or q' is true if at least one of the two disjuncts is true) to its exclusive construal ('p or q' is true if one and only one of the two disjuncts is). In what follows, we offer a reconstruction of the relevant steps of this enrichment process, as is commonly found in the literature (cf., e.g., Gamut 1991). The basic idea is that, upon hearing something like (3a), a hearer considers the alternative in (3b) and subconsciously goes through the reasoning steps in (3i-vi)

- (3)
  - a. Joe or Bill will show up
  - b. Joe and Bill will show up
  - i. The speaker said (3a) and not (3b), which, presumably, would have been also relevant [Relevance]
  - ii. (3b) asymmetrically entails (3a), hence is more informative
  - iii. If the speaker believed (3b), she would have said so [Quantity]
  - iv. It is not the case that the speaker believes that (3b) holds
  - v. It is likely that the speaker has an opinion as to whether (3b) holds.  
Therefore:
  - vi. It is likely that the speaker takes (3b) to be false.

This example illustrates how one might go from (3a) to (3vi) by using Grice's maxims and logic alone. The conclusion in (3vi) is close to the desired implicature but not quite. What we actually want to draw is that the speaker is positively trying to convey that Joe and Bill will not both come. Moreover, we need to be a bit more precise about the role of relevance throughout this reasoning, for that is a rather sticky point. We will do this in turn in the next three subsections.

## 1.2. SIs as exhaustifications

To understand in what sense the conclusion in (3vi) should and could be strengthened, it is convenient to note that the reasoning in (3) can be viewed as a form of *exhaustification* of the assertion, i.e., tantamount to inserting a silent *only*. Using  $B_s$  as a short form for 'the speaker believes that', the assertion in (3a) would convey to the reader the information in (4a), while the alternative assertion in (3b) would convey (4b).

- (4) a.  $B_s(\text{show up}(j) \vee \text{show up}(b))$   
 b.  $B_s(\text{show up}(j) \wedge \text{show up}(b))$

If you now imagine adding a silent *only* (henceforth,  $O$ ) to (4a) (and evaluating it with respect to the alternative in (4b)), we get:

- (5)  $O_{ALT}(B_s(\text{show up}(j) \vee \text{show up}(b)))$   
 $= B_s(\text{show up}(j) \vee \text{show up}(b)) \wedge \neg B_s(\text{show up}(j) \wedge \text{show up}(b))$

The result in (5) is the same as (3iv) and entitles the hearer only to the weak conclusion in (3vi) (and for the time being, we might view this use of  $O$  as a compact way of expressing the reasoning in (3)). Now, the conclusion we would want instead is:

- (6)  $B_s(O_{ALT}(\text{show up}(j) \vee \text{show up}(b)))$   
 $= B_s(\text{show up}(j) \vee \text{show up}(b)) \wedge \neg (\text{show up}(j) \wedge \text{show up}(b))$

The speaker, in other words, by uttering (3a), is taken to commit herself to the negation of (3b). The reading in (6) can be derived if we are allowed to go from something like *it is not the case that  $x$  believes that  $p$  to  $x$  believes that not  $p$* . Sauerland (2004) calls this 'the epistemic step'. What is relevant in the present connection is that in the computation of SIs such a step does not follow from Gricean maxims and logic alone. It is something that needs to be stipulated. This seems to be a gap in the Gricean account of SIs (see for instance Soames 1982, Groenendijk & Stokhof 1984). And this problem interacts with another, even more serious one, having to do with seemingly innocent assumption that in uttering (3a), something like (3b) is likely to be relevant. Let us discuss it briefly.

## 1.3. Relevance

Let us grant that in uttering (3a), (3b) is also indeed relevant, whatever 'relevant' may mean. Now, a natural assumption is that the property of 'being relevant' is closed under negation, i.e., if a proposition  $\phi$  is relevant, then  $\neg \phi$  is relevant as well. To say that  $\phi$  is relevant must

be to say that it matters whether  $\phi$  is true or false (this follows from several formal definitions of relevance proposed in the literature, e.g., Carnap 1950; Groenendijk & Stokhof 1984, 1990). If this is so, the negation of (3b) will also be relevant. But then the set of relevant alternatives changes. Assuming that relevance is also closed under conjunction (if  $A$  and  $B$  are both relevant, then so is  $A$  and  $B$ ), it now includes:

- (7) a. show up(j)  $\vee$  show up(b)
- b. show up(j)  $\wedge$  show up(b)
- c.  $\neg(\text{show up(j)} \wedge \text{show up(b)})$
- d.  $(\text{show up(j)} \vee \text{show up(b)}) \wedge \neg(\text{show up(j)} \wedge \text{show up(b)})$

Now, note that both (7d) and (7b) a-symmetrically entails (7a) (i.e., (3a)). So if we run the Gricean reasoning in (3) over this expanded set of alternatives or, equivalently, if we exhaustify the assertion along the lines discussed in (4), we must conclude that the speaker's only relevant belief is (7a), and, in particular, that he does not have the belief that (7b) is true, nor than (7d) is true. In other words, we conclude that a) the speaker believes that John or Bill will show up, b) that she does not have the belief that both will show up and c) that she does not have the belief that only one of the two will show up. Notice that in this case, the epistemic step would lead to a contradiction. In other words, we have to conclude that if the speaker utters  $p$  or  $q$ , he must not have an opinion as to whether  $p$  and  $q$  is the case, which blocks the possibility that he believes  $p$  and  $q$  to be false (a precursor of this argument, which was made explicit by von Stechow & Heim in their 1997 pragmatics class notes, can be found in Kroch 1972 – see also Davis 1998). This problem is a general one: the assumption that relevance is closed under negation (which is hard to avoid) has the effect of blocking any potential SI.

So we see that on the one hand, by logic alone, we are not able to derive SIs in their full strengths from the Gricean maxims. And, if we are minimally explicit about relevance, we are able to derive no implicature at all (except for 'ignorance' implicatures). Something seems to be going very wrong in our attempt to follow Grice's ideas. However, post-Gricean scholars, and in particular Horn (1972, 1989), have addressed some of these problems and it is important to grasp the reach of such proposals.

#### 1.4. Scales

Horn's important point is that if we want to make headway in understanding how SIs come about, then the set of relevant alternatives needs to be constrained. In the most typical cases, they will be *lexically* constrained by items of the same category whose entailments line them up in a scale of increasing informativeness. Examples of Horn's scales are the following:

- (8) a. The positive quantifiers: *some, many, most, all*
- b. The negative quantifiers: *not all, few, none*
- c. Numerals: *one, two, three, . . .*
- d. Modals: *can, must*
- e. Sentential connectives: *or, and*
- f. Gradable adjectives: *warm, hot, boiling / chilly, cold, freezing, etc.*

These series are characterized by the fact that the items on the right are stronger than the items on their left. For example, if all of the students did well, then most of them did and surely some of them did. Similarly for the other scales. Horn's proposal is that if you use *some*, other members of the scale may be activated and provide the alternatives against which the assertion is evaluated. Not all have to be activated; perhaps none of them will. But if they are activated, they must look like in (8). What is crucial about these scales is that one cannot mix elements with different monotonicity/polarity properties (see Fauconnier 1975b and Matsumoto 1995). Thus for example, one cannot have positive and negative quantifiers as part of the same scale. This is the way the problem considered in section 1.3. is circumvented.

Horn's suggestions can be extended to other seemingly more volatile/ephemeral scales. Consider the following example, modeled after Hirschberg (1985):

- (9) A: Did John mail his check?  
B: He wrote it.

This dialogue suggests that B's intention is to convey that John didn't mail the check. The 'scale' being considered here must be something like {write the check, mail the check}. What is crucial is that we do not consider mailing vs. not mailing, or mailing vs. stealing, for otherwise we would only derive ignorance implicatures (on the role played by questions for determining alternatives, see also van Kuppevelt 1996 and Spector 2006).

The main moral is that the notion of 'relevance' to be used in implicature calculation is, yes, context dependent but constrained in at least two ways: through the lexicon (certain classes of words form lexical scales) and through a monotonicity constraint: all scales, even scales that are not lexically specified, such as those needed for (9), cannot simultaneously include upward and downward entailing elements.

## 1.5. Monotonicity and scale reversal

There is a further important point to make. Let us consider an example like (10).

- (10) A: Who will come to the party?  
B: I doubt that Joe or Sue will come.

Here no implicature comes about, even though the conjunctive statement *Joe and Sue will come to the party* must be relevant on the background of the question in A. The reason is the following. The active alternative to B is *I doubt that Joe and Sue will come to the party*. Since B's utterance *entails* this alternative, the latter cannot be excluded and no implicature comes about (operators which, like negation and the verb *doubt*, reverse the direction of entailment are called downward entailing, or monotone decreasing; operators which *preserve* entailment patterns are called upward entailing, or monotone increasing). In our terms, use of covert *only* in cases like these is simply vacuous. It is useful to compare (10) with:

- (11) A: Who will come to the party?  
B: I doubt that all of the students will  
B-ALT: I doubt that (some of the) students will come to the party

If B's answer is as indicated, its alternative would presumably be something like B-ALT. (B-ALT might be somewhat less than felicitous because *some* is a positive polarity item – whence the parentheses.) So, exhaustifying B's utterance will bring about the negation of B-ALT, namely:

- (12) It is not true that I doubt that (some of the) students will come to the party  
       = I believe that some of the students will come to the party.

This appears to be the right result: B's response to A does seem to implicate (12). This effect of scale reversal under negation and other downward-entailing operators, emphasized by several authors (cf., among others, Fauconnier 1975a, 1975b; Atlas & Levinson 1981, Horn 1989) is a welcome result.

## 2. Embedded Implicatures: a first crack in the Gricean picture

As mentioned, the goal of this article is to challenge the 'neo-Gricean' approach to SIs. We use the term "neo-Gricean" to characterize theories that attempt to derive SIs from Grice's maxims of conversation, generally supplemented with the notion of *scale*, and view SIs as resulting from a reasoning process about speakers' intentions (as in Horn 1972, 1989; Fauconnier 1975a, 1975b, and Levinson 1983, but also, more recently, Spector 2003, 2006, 2007b; Sauerland 2004; van Rooij & Schulz 2004, 2006). Chierchia (2004), in an article which began circulating in 2000, partly building on ideas by Landman (1998), challenged this neo-Gricean approach on the basis of embedded scalar implicatures, and concluded that SIs are derived by means of compositional rules which apply recursively to the constituents of a given sentence (see also Récanati 2003 for a version of this position). Chierchia (2004) thus argues for a *grammatical approach* to scalar implicatures. Several works reacted to this proposal by refining the neo-Gricean approach so as to enable it to account for some of Chierchia's empirical observations. (See for instance Spector 2003, 2006, 2007b; Sauerland 2004; van Rooij & Schulz 2004, 2006; Russell 2006. Horn 2006 is a recent assessment of several aspects of this dispute, from the neo-Gricean standpoint. See also Geurts 2009 for a nuanced defense of the globalist view.)

We are not going to review this literature in details; our goal here is to present what seem to us to be some of the most compelling arguments for a grammatical approach to scalar implicatures. The arguments (some of which are new) will be based on the existence of embedded SIs, and on a variety of additional considerations

We will begin in section 2 with an illustration of what a grammatical approach to SIs might look like, followed by a preliminary argument in favor of such an approach, based on a sub-case of the generalization mentioned in the introduction, namely that embedded implicatures are possible in downward entailing and non-monotonic contexts (non-monotonic operators are operators which are neither upward- nor downward-entailing). Section 3 will provide a detailed new argument for the existence of embedded implicatures in upward entailing contexts. Finally, section 4 will review other arguments that have been recently given for a grammatical approach to SIs.

### 2.1. Exhaustification as a grammatical device

Does Grice's approach, emended as proposed by Horn, provide us with a framework in which SIs may be properly understood? Horn's move helps us get around the problem



raised by the appeal to relevance; but the epistemic step remains unaccounted for: reasoning via the maxims about the speaker's intentions gets us at best from something like (13a) to (13b):

- (13) a. John or Bill will show up  
 b. The speaker has no evidence that they both will show up

For the time being, let us simply stipulate that the epistemic step can take place and that an utterance of (13a) could be understood as conveying something such as (14a), which we represent as (14b):

- (14) a. John or Bill and not both will show up  
 b.  $O_{ALT}(\text{John or Bill will show up})$

For concreteness, we may assume that if the alternatives are active (and hence the set ALT is non empty), such alternatives are obligatorily factored into meaning via O. Otherwise, if the alternatives are not active, the plain unenriched meaning is used, and no SI comes about. (see also section 4.1.)

So far, we have regarded our silent *only* as way to express, in compact form, Gricean reasoning of the type exemplified in (3). However, a different interpretation of O is possible. One might imagine that a silent *only* can be present in the sentence's logical form, and that the scalar implicatures of a given sentence S are in fact *logical entailments* of S when construed as corresponding to an LF in which a silent *only* occurs and takes maximal scope. In this case, exhaustification would be more than just a way of expressing Gricean reasoning compactly. It would become a grammatical device. What lends preliminary plausibility to this interpretation is the observation, stemming from Horn's work, that grammar seems to constrain (via a specification of lexical scales) the set of alternatives.

Before further elaboration, we should state explicitly how our operator O is interpreted. Given a sentence S and a set of alternatives,  $O_{ALT}(S)$  expresses the conjunction of S and of the negations of all the members of ALT that are not entailed by S. Equivalently, it states that the only members of ALT that are true are those entailed by S:

- (15)  $\|O_{ALT}(S)\|^w = 1$  iff  $\|S\|^w = 1$  and  $\forall \phi \in ALT (\phi(w) = 1 \rightarrow \|S\| \subseteq \phi)$

In section 3.4.2., we will need to modify this definition, but for the time being (15) is sufficient. Quite often in this article, we'll omit the subscript *ALT* (we make the simplifying assumption that ALT is fully determined by the scalar items that occur in the scope of O). A word of caution is in order: O, so defined, is not exactly equivalent to *only*, for *only* is usually assumed to trigger various presuppositions which O, according to the above entry, does not. Note also that the above definition does not encode any direct relationship between O and focus marking (see Fox & Katzir 2009).

We can now properly address the main issue of the present article. So far, we have been discussing implicatures that occur in unembedded contexts (like our original case in (3)). And even when we consider cases where implicature triggers (Horn Scale members, a.k.a. scalar items) occur in an embedded position, as in (11) and (12), the relevant implicatures appear to be computed at the root level. This is in keeping with Grice's insight that

implicatures arise by reasoning on speakers intention given a particular speech act (i.e. a whole utterance).

The question we would like to investigate now is whether SIs are *always* computed at the root level. If Grice is right, it should indeed be so. In this respect, the view we are developing that implicatures arise via something like a covert use of *only*, suggests that a different answer to the question might be right. For there is no *a priori* reason for thinking that covert uses of *only* are restricted to the root. If such an operator exists, it is unclear what should prevent its deployment at embedded scope sites. However, whether we are right or wrong on how SIs come about, the issue of whether they can systematically arise in embedded positions clearly deserves close inspection.

Summing up, the Gricean view, emended *à la* Horn with grammatically based constraints on scales, and with the extra assumption of an epistemic step, is able to derive basic SIs. However, such an approach seems to clearly predict that SIs are a root, post-compositional phenomenon. This prediction seems to be confirmed in cases of ‘scale reversal’ such as those in (11)–(12). The question is whether it withstands further scrutiny.

The rest of this section argues that it does not, based on the existence of so-called ‘intrusive’ implicatures (see Levinson 2000), i.e., cases where a scalar item retains its ‘strengthened’ meaning under the scope of a downward entailing (DE) or non-monotonic (NM) operator. In section 3, we’ll turn to SIs embedded in UE contexts. As we will see, they are expected to be harder to detect. Nonetheless, we will present various tools that will allow us to see very clear consequences of the presence of such implicatures.

## 2.2. Implicatures embedded in DE and NM contexts

Sometimes scalar items receive an enriched interpretation under the scope of negation. Examples that seem to force such an enrichment are the following.

- (16) a. Joe didn’t see Mary or Sue; he saw both.
- b. It is not that you *can* write a reply. You must.
- c. I don’t expect that some students will do well, I expect that all students will.

The first example in (16a) receives a coherent interpretation only if the embedded *or* is interpreted exclusively. Similarly, the modal in (16b) has to be interpreted as *can though need not*, and the quantifier *some* in (16c) as *some though not all*. For all the sentences in (16), in other words, it looks as if the implicature gets embedded under the negative operator. In our notation, the LF of, e.g., (16a) could be represented as:

- (17) not  $O_{ALT}$ (John saw Mary or Sue)

Examples of this sort have been widely discussed in the literature (especially in Horn 1985, 1989); they seem to require either focal stress on the implicature trigger and/or a strong contextual bias. Horn argues that cases of this sort constitute metalinguistic uses of negation, i.e., ways of expressing an objection not to a propositional content but to some other aspect of a previous speech act. The range of possible speaker’s objection can be very broad and concern even the choice of words or the phonology.

- (18) You don't want to go to [leisister] square, you want to go to [lester] square

In particular, with sentences like (16), the speaker objects to the choice of words of his interlocutor, presumably for the implicatures they might trigger.

While the phenomenon of metalinguistic negation might well be real (if poorly understood) there are other examples of DE contexts not involving negation that seem to require embedded implicatures, as noted by Horn himself (Horn 1989). In what follows, we will consider several such cases, modelled mostly after Levinson (2000). To begin with, consider the contrast in (19).

- (19) a. If you take salad or dessert, you'll be really full.  
 b. If you take salad or dessert, you pay \$ 20; but if you take both there is a surcharge.

The most natural reading of (19a) involves no implicature (*or* is construed inclusively); on the other hand, on the inclusive reading, (19b) would be contradictory. If an indicative conditional sentence is analyzed as a material or a strict conditional, a coherent interpretation, which is clearly possible in the case of (19b), requires an embedded implicature. Let us go through the reasons why this is so. Suppose that in the context where (19b) is uttered, the alternative with *and* is active. Then, there may be in principle two sites at which the implicature is computed. Using our notation, they can be represented as follows:

- (20) a.  $O_{ALT}(\text{if you take salad or dessert, you pay \$ 20})$   
 b.  $\text{if } O_{ALT}(\text{you take salad or dessert}), \text{ you pay \$ 20}$

If the option in (20a) is taken, the relevant alternative set would be as in (21b):

- (21) a. If you take salad or dessert, you pay \$ 20  
 b.  $ALT = \{\text{If you take salad or dessert, you pay \$ 20, If you take salad and dessert, you pay \$ 20}\}$   
 c.  $O_{ALT}(\text{if you take salad or dessert, you pay \$ 20}) = 1$  iff  
 If you take salad or dessert, you pay \$ 20  $\wedge \forall p \in ALT$  such that  $p$  is not entailed by 'if you take salad or dessert, you pay \$ 20',  $p$  is false.

Since the assertion (21a) entails all its alternatives, the truth conditions of (20a) wind up being the same as those of (21a) (i.e., no implicature comes about – cf. the computation in (21c)). And as already noted, this reading is too strong to be compatible with the continuation in (19b). So the LF in (20a) cannot account for the coherent interpretation of (19b). On the other hand, if the implicature is computed at the level of the antecedent, as in (20b), we get the equivalent of:

- (22) If you take salad or dessert and not both, you pay \$ 20

The truth conditions of (22) are weaker than those of (20a), and this makes them compatible with the continuation in (19b). Thus, the fact that sentences such as (19b) are

acceptable seems to constitute *prima facie* evidence in favor of the possibility of embedding SIs.

One might wonder whether an alternative, non-monotonic analysis of conditionals, e.g., that of Stalnaker (1968) or Lewis (1973) could provide an account which would not rely on embedded implicatures. Although space limitations do not allow us to discuss this in any detail, we would like to point out that any such account would also have to explain the different behavior of conditional sentences in which the antecedent does not license a scalar implicature in isolation. (*#If you take salad or dessert or both, you pay exactly \$ 20; but if you take both there is a surcharge.*).

This phenomenon seems to be quite general. Here are a few more examples involving the antecedents of conditionals, as well as further DE contexts like the left argument of the determiner *every*.

- (23) a. If most of the students do well, I am happy; if all of them do well, I am even happier  
 b. If you can fire Joe, it is your call; but if you must, then there is no choice  
 c. Every professor who fails most of the students will receive no raise; every professor who fails all of the students will be fired. (M. Romero p.c.)

It should be noted that these examples can be embedded even further.

- (24) John is firmly convinced that if most of his students do well, he is going to be happy and that if all of them will do well, he'll be even happier.  
 (25) Every candidate thought that presenting together his unpublished papers and his students evaluation was preferable to presenting the one or the other.

Without adding implicatures at a deeply embedded level, all of these examples would be contradictory. For instance, in (24) the implicature is embedded within the antecedent of a conditional, which is in turn embedded under an attitude verb. In (25), a coherent interpretation is possible only if *or* (in *the one or the other*) is interpreted as exclusive; note indeed that structures of the form *A is preferable to B* are perceived as contradictory when A entails B, as evidenced by the oddness of, e.g., *Having a cat is preferable to having a pet*. Thus if disjunction were inclusive in (25), it should sound odd as well.

A similar argument can be replicated for non-monotonic contexts. Consider for instance:

- (26) Exactly two students wrote a paper or ran an experiment

It seems relatively easy to interpret *or* in (26) exclusively. As a first step towards seeing that this is the case, it is useful to note that the truth conditions associated with the exclusive and inclusive construals of *or* under the scope of a non-monotonic quantifier as in (26) are logically independent. For example, in a situation in which one student writes a paper and another writes a paper and also runs an experiment (and nobody else does either), the sentence is true on the inclusive construal of *or*, but false on the exclusive construal. On the other hand, in a situation in which one student only writes a paper, another only runs an experiment and other students do both, the inclusive interpretation of *or* in

(26) is falsified; in such a scenario, (26) is only true on the (embedded) exclusive construal. Now the exclusive reading can be easily observed when we consider environments in which it forced:

- (27) Exactly two students wrote a paper or ran an experiment. The others either did both or made a class presentation.

For (27) to be coherent, the implicature must be computed under the scope of *exactly two*. Cases of this sort are pretty general and can be reproduced for all scalar items: sentence (28) below must be interpreted as ‘exactly three students did most though not all of the exercises’

- (28) Exactly three students did most of the exercises; the rest did them all.

Taking stock, we have discussed a number of example sentences involving a variety of DE and NM contexts. Such sentences appear to have coherent interpretations that can only be derived if an implicature is computed at an embedded level (i.e., within the scope of a higher verb or operator). It should be noted that focal stress on the scalar item often helps the relevant interpretation. From our point of view, this is not surprising. The mechanism we have sketched for implicature calculation is, in essence, covert exhaustification, one of the phenomena triggered by focus. More generally, for the time being, we make no claim as to the frequency or marked status of embedded implicatures (but see our discussion in section 4.6 below). Our point is simply that they can and do naturally occur and that there are ways in which embedded implicatures can be systematically induced. This fact seems to be incompatible with the claim that SIs are a postcompositional semantic process, as the Gricean or Neo-Gricean view would have it. Of course, to establish our claim fully, we would like to be able to show that SIs can also be embedded in UE contexts, which, as we will see shortly, calls for more sophisticated methods.

### 3. A new argument for embedded implicatures in UE contexts: Hurford’s constraint

If embedded implicatures exist, we expect many sentences to be multiply ambiguous, depending on whether an SI is computed in a given embedded position or not. Furthermore, in UE contexts, the various readings that are predicted are all stronger than the ‘literal’ reading, and in many cases, the presence of an embedded implicature yields a reading which is stronger than both the literal reading and the reading that results from applying the standard Gricean reasoning to the sentence as a whole (in our terms, the reading that results from applying *O* to the whole sentence). So, it may prove hard to establish the possibility of embedded implicatures by mere inspection of truth-conditions (since if a certain reading R1 entails another reading R2, there can be no situation where R1 is accepted as true and R2 is not; see, e.g., Meier & Sauerland 2008 for a related methodological discussion).

In order to circumvent this difficulty, it would be useful to have constructions in which only one of the potentially available readings is licensed. In this section, we are going to

argue that such constructions exist: we'll show that some sentences will *have* to contain a local exhaustivity operator in a UE context for a certain constraint (Hurford's constraint) to be met. The general line of argumentation is presented in a more detailed way in Chierchia, Fox & Spector (2009).

### 3.1. Hurford's constraint

Hurford (1974) points to the following generalization:

- (29) Hurford's constraint (HC): A sentence that contains a disjunctive phrase of the form *S or S'* is infelicitous if *S* entails *S'* or *S'* entails *S*.

This constraint is illustrated by the infelicity of the following sentences:

- (30) a. # Mary saw an animal or a dog.  
b. # Every girl who saw an animal or a dog talked to Jack.

However (31) below, which is felicitous, seems to be a counterexample to HC:

- (31) Mary solved the first or the second problem or both

If *or* is interpreted inclusively, then clearly (31) violates HC, since 'Mary solved both problems' entails 'Mary solved the first problem or the second problem'. On the basis of such examples, Hurford reasoned that *or* has to be ambiguous, and that one of its readings is the exclusive reading. On an exclusive construal of the first disjunction in (31), the sentence no longer violates HC. Gazdar (1979) noticed other cases where HC appears to be obviated, such as (32):

- (32) Mary read some or all of the books

By analogy with Hurford's reasoning about disjunction, one might conclude that *some* is ambiguous as well, and means *some but not all* on one of its readings. But Gazdar argued that multiplying lexical ambiguities in order to maintain HC misses an obvious generalization. Gazdar, thus, proposed to weaken Hurford's generalization in the following way:

Gazdar's generalization: A sentence containing a disjunctive phrase *S or S'* is infelicitous if *S* entails *S'* or if *S'* entails *S*, unless *S'* contradicts the conjunction of *S* and the implicatures of *S*. (Note that Gazdar's generalization is asymmetric, i.e., allows for cases where *S'* entails *S* but not for cases where *S* entails *S'*. We do not address this point here. See also Singh 2008)

In both (31) and (32), the SI associated with the first disjunct (*Mary did not solve both problems*, *Mary did not read all of the books*) contradicts the second disjunct, and so both sentences are predicted to be felicitous by Gazdar's generalization. Gazdar himself did not offer an account of his generalization. We will provide such an account, along the following lines:

- HC is correct as originally stated
- All apparent violations of HC involve the presence of an implicature-computing operator within the first disjunct, ensuring that HC is met – hence the presence of a ‘local implicatures’

In a sense, we extend Hurford’s original account based on ambiguity to all scalar items, even though we do not assume a *lexical* ambiguity, and instead derive the various readings with our implicature-computing operator. It should be clear that we derive something close to Gazdar’s generalization: suppose S2 entails S1; then ‘S1 or S2’ violates HC; yet ‘O<sub>ALT</sub>(S1) or S2’ may happen to satisfy HC; this will be so if S1 together with its implicatures is no longer entailed by S2, which will be the case, in particular, if S2 contradicts S1 together with its implicatures

However, as we will show in the next subsections, our proposal turns out to make very precise and new predictions in a number of cases – predictions that do not fall out from anything that Gazdar has said.

### 3.2. Forcing embedded implicatures

Gazdar’s generalization, as such, does not make any particular prediction regarding the *reading* that obtains when there is an apparent violation of HC. But consider now the following sentence (in a context where it has been asked which of a given set of problems Peter solved):

(33) Peter either solved both the first and the second problem or all of the problems.

In the absence of an exhaustivity operator, (33) would violate HC, since solving all of the problems entails solving the first one and the second one. And (33) would then be equivalent to (34):

(34) Peter solved the first problem and the second problem.

Therefore, we predict that an exhaustivity operator has to be present, with the effect that (33)’s logical form is the following:

(35) O<sub>ALT</sub>(Peter solved the first problem and the second problem) or he solved all of the problems

Recall that the meaning of our operator is supposed to be – as a first approximation – the same as that of *only*. If we are right, the meaning of (33) could be given by the following paraphrases (which are themselves equivalent):

- (36) a. Peter only solved the first problem and the second problem, or he solved all of the problems  
 b. Either Peter solved the first problem and the second problem and no other problem, or he solved all the problems

It turns out that this is indeed the only possible reading of (33). In other words, (33) is clearly judged *false* in a situation in which Peter solved, say, the first three problems and

no other problem (out of a larger set). So (33) seems to be a clear case of an embedded implicature. What distinguishes (33) from cases like (31) and (32) is that exhaustifying the first disjunct has a semantic effect in this case.

In Chierchia, Fox & Spector (2009), we discuss more complex cases in which exactly the same logic is at play. But the general form of the argument should be clear: if HC is correct as originally formulated, then, in some cases, the only way to satisfy HC is to insert O locally at an embedded level, and this gives rise to readings which turn out to be the only possible ones. The next section develops a similar, though more complex, argument.

### 3.3. HC and recursive exhaustification

In this section, we are going to show that even in cases where the obligatory presence of embedded O does not have any direct effect on the literal truth-conditions of a sentence, it nevertheless has consequences that can be detected by investigating the *implicatures* of the sentence in question (or lack thereof). In our terms, the presence of the embedded implicature-computing operator turns out to have a truth-conditional effect when the sentence is itself embedded under another implicature-computing operator. First, we'll look at the interpretation of disjunctions of the form 'A or B or both' in the scope of necessity modals (3.3.1). Then we'll offer an account of the 'cancellation effect' triggered by *or both* in non-embedded contexts (3.3.2).

#### 3.3.1. *Or both* in the scope of necessity modals

Consider the following two sentences:

(37) We are required to either read *Ulysses* or *Madame Bovary*

(38) We are required to either read *Ulysses* or *Madame Bovary* or both

Both these sentences implicate that we are not required to read both *Ulysses* and *Madame Bovary*. At first sight, they do not seem to trigger different implicatures. But upon further reflection, they, in fact, do. Suppose that we are actually required to read *Ulysses* or *Madame Bovary* and that we are *not* allowed to read both of them. Then (37) would be an appropriate statement, while (38) would not. Sentence (37), on its most natural reading, is silent as to whether or not we are allowed to read both novels. But (38) strongly suggests that we are allowed to read both novels. So (38) seems to trigger an implicature that (37) does not.

This is further confirmed by looking at the following dialogues:

(39) A: We are required to either read *Ulysses* or *Madame Bovary*  
B: No! we have to read both

(40) A: We are required to either read *Ulysses* or *Madame Bovary*  
B: ## No! We are not allowed to read both

(41) A: We are required to either read *Ulysses* or *Madame Bovary* or both  
B: No! We are not allowed to read both



(39) serves to set the stage. It shows what we've already seen in section 2, namely that an implicature can be embedded below negation: Speaker B, in (39), is objecting, not to the literal meaning of A's utterance but to an implicature of this utterance, namely, that we are not required to read both novels. In section 2 we've argued that phenomena of this sort argue for embedded implicatures, but this is not important in the current context. What is important here is that the relevant phenomena could be used to investigate the implicatures of various utterances, and as such they distinguish between (37) and (38). In (40), B's reply is clearly deviant. This shows that A's utterance in (40) (= (37)) does *not* implicate that we are allowed to read both novels; indeed, if A's sentence did trigger this implicature, then B's objection would be perfectly felicitous, since it would count as an objection to an implicature of A's utterance. But now notice the contrast with (41). B's objection in (41) is completely natural, and hence confirms our claim that in (41), A's sentence (= (38)) does implicate that we are allowed to read both novels.

How are these facts to be explained? Why does (38) have an implicature that (37) doesn't? Note that (modulo the effects of matrix *O*) (37) and (38) have the same truth-conditions. Yet they trigger different implicatures. We are going to show that this phenomenon is in fact entirely expected from our perspective. The implicatures associated with (37) and (38) are, in fact, instances of the following generalization:

- (42) A sentence of the form  $\Box(A \text{ or } B)$  triggers the following implicatures (where  $\Box$  stand for any modal operator with universal force):  $\neg\Box A, \neg\Box B$

To illustrate this generalization let us begin with (37), repeated here as (43), which implicates that we have a choice as to how to satisfy our obligations.

- (43) We are required to either read *Ulysses* or *Madame Bovary*

The reading of (43), 'pragmatically strengthened' on the basis of the generalization in (42), is given in (44a), which is equivalent to (44b) (because 'being not required to do X' is equivalent to 'being allowed not to do X') and then to (44c).

- (44) a. We are required to either read *Ulysses* or *Madame Bovary* and we are not required to read *Ulysses* and we are not required to read *Madame Bovary*.  
 b. We are required to either read *Ulysses* or *Madame Bovary*, we are allowed not to read *Ulysses* and we are allowed not to read *Madame Bovary*.  
 c. We are required to either read *Ulysses* or *Madame Bovary*, and we are allowed to read either one without reading the other

Now, let's see the consequences of this generalization for the case of (38) ("We are required to read *Ulysses* or *Madame Bovary* or both"), schematized as follows:

- (45)  $\Box [O_{ALT}(A \text{ or } B) \text{ or } (A \text{ and } B)]$

(45) is predicted to implicate the following:

- (46) a.  $\neg\Box(O_{ALT}(A \text{ or } B))$   
 b.  $\neg\Box(A \text{ and } B)$

The end-result is the following proposition, which indeed corresponds to the most natural reading of (38):

- (47) We are required to read *Ulysses* or *Madame Bovary*, we are not required to read only one of the two novels, we are not required to read both novels.

From (47) it follows that we are allowed to read both novels, which was the desired result. So far we have shown that given the generalization in (42), the observed interpretation of (38) follows directly from the assumption that O is present in the first disjunct. Of course, it is also desirable to understand why generalization (42) should hold. It turns out that the exhaustivity operator as we have defined it so far (adding the negations of all non-weaker alternatives) can derive all the inferences that we observed, provided we now assume that the scalar alternatives of a disjunctive phrase *X or Y* include not only the phrase *X and Y* but also each disjunct *X* and *Y* independently. If so, then (43) has the following alternatives (using now the sign ‘ $\Box$ ’ to abbreviate ‘we are required to’, ‘U’ to abbreviate ‘read *Ulysses*’, and ‘MB’ to stand for ‘read *Madame Bovary*’):

- (48)  $\text{ALT}((43)) = \{\Box(U \text{ or } MB), \Box U, \Box MB, \Box(U \text{ and } MB)\}$

To get the ‘strengthened meaning’ of (43), we simply assume that (43) gets exhaustified yielding the Logical Form in (49), which involves adding the negation of each of its alternatives that is not weaker than the assertion. The result is:

- (49)  $\text{O}_{\text{ALT}}((43)) = \text{O}_{\text{ALT}}\Box(U \text{ or } MB) = \Box(U \text{ or } MB) \wedge \neg\Box U \wedge \neg\Box MB$

Let us now go back to our original example (38) to see how this assumption plays out:

- (50) a. We are required to either read *Ulysses* or *Madame Bovary*, or both  
 b.  $\text{O}_{\text{ALT}}(\Box(\text{O}_{\text{ALT}}(U \text{ or } MB) \text{ or } (U \text{ and } MB)))$

The logical form of (50a) must be (50b), where the embedded exhaustivity operator is forced by HC and the matrix one exhaustifies the entire sentence. Given our new assumptions about the alternatives of a disjunctive phrase, (50)’s alternatives include, among others, ‘ $\Box(\text{O}_{\text{ALT}}(U \text{ or } MB))$ ’ (i.e., “we are required to read either *Ulysses* or *Madame Bovary* and we are forbidden to read both”) and ‘ $\Box(U \text{ and } MB)$ ’. Focussing (for simplicity) on just these two alternatives, (50b) tantamounts to

- (51) a.  $\Box(U \text{ or } MB) \wedge \neg\Box(\text{O}_{\text{ALT}}(U \text{ or } MB)) \wedge \neg\Box(U \text{ and } MB)$   
 b. We are required to either read *Ulysses* or *Madame Bovary*, and we are not required to read only one of them, and we are not required to read both  
 c. We are required to read *Ulysses* or *Madame Bovary* and we are allowed to read both of them and we are allowed to read only one of them

This is exactly what we wanted to derive. Let us sum up what has been shown. The obligatory presence of an exhaustivity operator applying to the first disjunct in sentences like (38), together with the assumption that each member of a disjunctive phrase contributes to the alternatives of the disjunctive phrase, immediately predicts that (38), though

equivalent to (37), has more alternatives. One of these alternatives, crucially, contains an exhaustivity operator. Due to this additional alternative, (38) triggers an inference that (37) does not (the inference that we are not required to read *only* one of the two novels), a prediction that appears to be correct.

### 3.3.2. Symmetric alternatives and Innocent Exclusion

In the next sub-section we will show that our perspective enables us to derive the fact that disjunctions of the form *A or B or both*, or *some or all*, do not trigger any SI if they are not embedded (a fact that is sometimes described as a ‘cancellation’ effect). But first we need to elaborate a bit on the idea that the disjuncts are alternatives of a disjunctive sentence. This idea, which seems to be needed for a variety of purposes in addition to the one mentioned above (see Sauerland 2004; Spector 2003, 2007b and Fox 2007), doesn’t follow from the Horn set for disjunction given in (9d). One way of modifying the Horn set for binary connectives along the lines we have discussed is suggested by Sauerland (2004), namely expanding such a set to include the abstract elements *L* and *R*, where *p L q* is equivalent to *p* and *p R q* is equivalent to *q*:

(52) **Sauerland’s alternatives for disjunction:** {*or*, *L*, *R*, *and*}

(For alternatives see Spector 2006, Katzir 2007, and Alonso-Ovalle 2005). The obvious problem with the proposal that the disjuncts are among the alternatives of a disjunctive statement is that our operator *O*, as we have defined it in section 2, now yields a contradiction when it applies to a simple disjunctive sentence: according to our definition, *O(p or q)* states that the disjunctive sentence is true and each of its alternatives (none of which it entails) is false. In particular, it would now follow that each of the disjuncts is false, but this of course contradicts (*p or q*). The problem arises whenever the set of alternatives has a property that we might call ‘symmetry’, i.e., whenever it contains two or more alternatives that can be excluded separately but not together (e.g., *p or q* is consistent with the exclusion of *p* or with the exclusion of *q*, but the moment both are excluded the result is contradictory).

In order to correct for this problem, we have to revisit the question of which alternatives get to be excluded. Our previous definition stated that entailed alternatives don’t get excluded. But, why? The reason seems rather obvious. Exclusion of weaker alternatives would lead to an automatic contradiction. But, as we’ve just seen, there are other exclusions that would lead to a contradiction, namely the simultaneous exclusion of two symmetric alternatives. We might therefore suggest that *O* be modified to avoid contradictions in situations of symmetry. In particular, given a sentence *S* and a set of alternatives *C*, we could define a set of innocently excludable alternatives, *I-E(S,C)*, as the set of sentences that can all be false while *S* is true. We take this definition from Fox (2007), who took his inspiration from Sauerland’s algorithm for the computation of SIs. (See also Spector 2003, 2007b and van Rooij & Schulz 2004, 2006 for related proposals.)

The definition of *I-E(S,C)* proceeds in two steps. First we look at the biggest subsets *C'* of *C* such that  $\{\neg S': S' \in C'\} \cup \{S\}$  is a consistent set of propositions. Each such set corresponds to a way of excluding as many alternatives as possible in a consistent manner (i.e., consistent with the basic assertion). For instance, if *S* is of the form *p or q* and *C* is  $\{p \text{ or } q, p, q, p \text{ and } q\}$ , there are two sets which meet this condition, namely  $C' = \{p, p \text{ and } q\}$  and

$C'' = \{q, p \text{ and } q\}$ . This is so because (a)  $\{p \text{ or } q, \neg p, \neg(p \text{ and } q)\}$  is consistent (every member of this set is true if  $q$  is true and  $p$  is false), and so is  $\{p \text{ or } q, \neg q, \neg(p \text{ and } q)\}$ , and (b)  $C'$  and  $C''$  are, furthermore, maximal such sets, since the only bigger subset of  $C$  that does not include  $S$  is  $\{p, q, (p \text{ and } q)\}$ , whose members cannot be consistently denied together if  $S$  itself ( $p \text{ or } q$ ) is asserted. The set of innocently excludable alternatives,  $I-E(S, C)$ , is then constructed by collecting the alternatives which belong to *every* such maximal set. These are the alternatives which we know can be excluded safely (i.e., consistently), irrespective of which other alternatives have been already excluded.  $O$  is then defined in terms of innocent exclusion: when applied to a sentence  $S$  relative to a set of alternatives  $C$ , it returns the conjunction of  $S$  and the negations of all the innocently excludable members of  $C$  (i.e., of all the members of  $I-E(S, C)$ ). This definition of  $O$  is summarized below:

- (53) a.  $O_C(S)$  is true iff  $S$  is true and for any  $S'$  in  $I-E(S, C)$ :  $S'$  is false  
 b.  $I-E(S, C)$  is the intersection of maximal excludable alternatives of  $C$  given  $S$ .  
 c.  $M \subseteq C$  is an excludable alternative of  $C$  given  $S$ , if the conjunction of  $S$  and the negation of all members of  $M$  is consistent.  
 d.  $M$  is a maximal excludable alternative of  $C$  given  $S$  if  $M$  is an excludable alternative of  $C$  given  $S$  and there is no superset of  $M$  included in  $C$  which is an excludable alternative of  $C$  given  $S$ .

The result of applying  $O$ , at times, could be rather difficult to compute, but the notion itself is rather simple. All stronger alternatives are excluded unless there is symmetry, in which case all alternatives that do not partake in symmetry are excluded. However, in most cases we do not need consider the definition in (53). Specifically, whenever using our initial definition of  $O$  does not result in a contradiction, we can continue to use it, and the reason is simple. If using our previous definition yields a non-contradictory result, then the set of innocently excludable alternatives is precisely the set of sentences in  $C$  not entailed by  $S$ . We will, thus, continue to use our initial definition of  $O$  whenever the result is consistent.

### 3.3.3. Cancellation

Consider the two following sentences:

- (54) a. John bought some of the furniture.  
 b. John bought some or all of the furniture.

Since the early days of theorizing on the nature of SIs, the fact that (54b) is not associated with the same SIs as the simple sentence in (54a) has been highly problematic. We will see that the problem is eliminated the moment the role of embedded exhaustification is understood.

The two sentences in (54) are equivalent. Under the Neo-Gricean Theory, as well as the grammatical alternative we are considering, the only way two equivalent sentences can be systematically associated with different SIs is if they have different scalar alternatives. The problem is that, without an embedded exhaustivity operator, (54a) and (54b) have equivalent scalar alternatives. Consider indeed the scalar items in (54b): *some*, *all*, and *or* with the following Horn Sets.

- (55) a. Connectives: {*or*, *L*, *R*, *and*}  
 b. Quantifiers: {*some*, *all*}

We thus get the following sentential alternatives:

- (56) a. Alternatives for (54a):  
 {John bought some of the furniture, John bought all of the furniture}  
 b. Alternatives for (54b):  
 {John bought some of the furniture, John bought some or all of the furniture,  
 John bought some or some of the furniture, John bought some and some of the  
 furniture,  
  
 John bought all of the furniture, John bought all or all of the furniture, John  
 bought some and all of the furniture, John bought all and all of the furniture}

Although there are more alternatives in (56b) than in (56a), they divide into two sets of equivalent alternatives (separated by a line). One set is equivalent to the *some* alternative in (56a) and the other to the *all* alternative. It follows that the same SI is predicted. The same holds if we use a more traditional Horn set, hence this recalcitrant problem in the Neo Gricean tradition is fairly independent of the particular perspective on alternatives we've been taking.

Interestingly the problem is obviated the moment *O* applies to the first disjunct. We now have another alternative, namely the first disjunct *O*(*John bought some of the furniture*), which states that John bought some but not all of the furniture. This alternative is symmetric relative to the alternative based on *all*. One cannot exclude both, and, hence neither is innocently excludable. There are thus no innocently excludable alternatives, and matrix application of *O* is vacuous, precisely the result we want. We now see clearly why the addition of *or both* in sentences such as (54) has the effect of canceling the exclusive implicature typically associated with *or*.

### 3.4. Conclusion

In this section, we have offered a theory of the interaction of SIs and Hurford's Constraint. HC provides us with a way of probing the existence of embedded implicatures. Sometimes *O* has to be embedded for HC to be satisfied. Moreover, once we allow for embeddings of *O*, as we sometimes have to, we make a host of complex predictions that we have painstakingly laid out and argued to be borne out. This further corroborates our main hypothesis, namely that scalar implicatures can be freely embedded.

## 4. Further cracks in the Gricean picture

As we mentioned at the very beginning, it is not clear how the availability of embedded scalar implicatures could be made consistent with a Gricean approach to SIs. More specifically, the facts suggest that SIs are not pragmatic in nature but arise, instead, as a consequence of semantic and syntactic mechanisms, which we have characterized in terms of the operator, *O*.

In this concluding section we would like to mention a few other observations that support this conclusion. Our discussion will be extremely sketchy given the limited space we have available. Nevertheless, we will try to introduce the pertinent issues and will refer the reader to relevant literature.

#### 4.1. Obligatory SIs

A property that is commonly attributed to SIs is their optionality, sometimes referred to as “cancelability”:

- (57) a. John did some of the homework. In fact, he did all of it.  
 b. John did the reading or the homework. He might have done both.

The first sentences in (57a) and (57b) would normally lead to SIs (*not all* and *not both*, respectively). But these SI are not obligatory, else the continuation would lead to a contradiction.

The optionality observed in (57) is a necessary attribute of SIs from the (neo-)Gricean perspective. According to the latter, SIs are not automatic but rather follow from two assumptions that don't always hold, namely the assumption that the speaker is opinionated about stronger alternatives (which justifies the epistemic step alluded to in section 1.2.), and the assumption that the stronger alternatives are contextually relevant. The fact that these assumptions are not necessarily made in every context explains optionality.

This optionality is also captured by our grammatical mechanism. Given what we've said up to now, there is nothing that forces the presence of the operator *O* in a sentence containing a scalar item. Optionality is thus predicted, and one can capture the correlation with various contextual considerations, under the standard assumption (discussed in the very beginning of this article) that such considerations enter into the choice between competing representations (those that contain the operator and those that do not). An alternative way of capturing optionality is to assume that there is an optional process that activates the alternatives of a scalar item, but that once alternatives are active, SIs are obligatory (see Chierchia 2006 for an implementation). Under the latter view, what is optional is the activation of alternatives; if alternatives are activated, they must be factored into meaning via *O*.

This second option has a consequence. If under certain circumstances scalar alternatives have to be activated, *obligatory* SIs are expected to arise. The claim that this is so is, in fact, implicitly present in Krifka (1995) and Spector (2007a), and has been explicitly defended in Chierchia (2004, 2006) and Magri (2009). We cannot go over all of the arguments and will narrow our attention to an argument made by Spector (2007a) in the domain of plural morphology.

Consider the contradictory status of the utterance in (58).

- (58) #John read (some) books; maybe he read only one book.

This contradiction suggests that the first sentence *John read (some) books* (on both its variants) is equivalent to the statement that there is more than one book that John read. However, assuming this as the basic meaning doesn't account for its behavior in downward entailing environments. Consider the sentences in (59). Their interpretation (at least the one that immediately springs to mind) is stronger than what would be predicted under the putative meaning for the first sentence in (58).

- (59) a. John didn't read books.  
 b. I don't think that John read (some) books.

To see this, focus on (59a). The sentence (under its most natural interpretation) is false if John read exactly one book. The same point can be made for (59b), and both points are illustrated by comparison with sentences in which *John read (some) books* is substituted by a sentence that clearly has the putative meaning, namely *John read more than one book*:

- (60) a. John didn't read more than one book.  
 b. I don't think that John read more than one book.

We seem to be facing something close to a paradox. In order to account for the meaning of (58), *John read (some) books* must have a strong meaning, namely that John read *more than one* book, and in order to account for the meaning of (59), it must have a weaker meaning, namely that John read *at least one* book.

Building on suggestions made by Sauerland (2003), Spector argues that the basic meaning is the *at least one* meaning, and that the stronger meaning (i.e., the *more than one* meaning) is a scalar implicature. Explaining how the strong meaning is derived is a rather complicated matter, which we will have to skip in this context. What is important, however, is that implicatures can easily disappear in downward entailing contexts, which accounts for the most natural readings of (59a) and (59b). As explained in section 2.1., the fact that scalar items need not retain their strengthened meaning in DE contexts is an automatic consequence of the neo-Gricean approach. It is also an automatic consequence of the grammatical perspective that we are advocating, since an exhaustivity operator (even if obligatorily present) need not be inserted below a DE operator. Let us see how things work in the case at hand.

If we assume that the plural morpheme *pl* makes it *obligatory* to insert the operator *O* in some syntactic position that c-commands *pl*, we expect the following: in a simple, non-embedded context, *O* can only be inserted just above the plural morpheme, which gives rise to an *at-least two* reading (as demonstrated in Spector's work); but if *pl* occurs in the scope of a DE-operator, more options are available; in particular, *O* may be inserted at the top-most level, i.e., above the DE-operator, in which case no implicature will arise (because inserting *O* at the top-most level always gives rise to the reading that is predicted by the pragmatic, neo-Gricean, approach). In the case of the plural morpheme, we therefore predict that the *at least two*-reading *can* disappear in DE-contexts, while it is obligatory in non-embedded UE contexts. This will generally be a property of *obligatory scalar implicatures*: the strengthened meaning of an item that *must* occur under the scope of *O* will be the only option in non-embedded UE contexts, but will appear to be optional in DE contexts. In the case of the plural morpheme, this seems to be just right. Notice that, as expected, the *at-least-two* reading actually *can* be maintained in DE-contexts, with the appropriate intonation pattern:

- (61) Jack may have read *one* book; but I don't think he has read books.

If all this is correct, it means that the implicature generated by plural morphology is obligatory (which is why (58) is contradictory in every context). As mentioned, this cannot be captured under neo-Gricean assumptions but can be made to follow from a grammatical theory that incorporates the operator *O*. Specifically, under the grammatical theory, one can maintain that for plural morphology, in contrast with standard scalar items,

alternatives are automatically activated. Once alternatives are active, they must be associated with the operator *O*. This operator yields the *more than one* interpretation for (58). However, once (58) is embedded under a downward entailing operator (e.g., ((59))), the stronger alternatives are now weaker, and the relevant implicatures can be eliminated.

While our discussion has been extremely sketchy (as promised), we hope that the nature of the argument is clear. Gricean implicatures must be optional/cancelable. But if implicatures are derived by a grammatical mechanism, they are optional only when the mechanism is optional, and that, in turn, may depend on various grammatical factors. A similar argument has been made in other domains. Most famously, Krifka (1995) has argued that negative polarity items are obligatorily associated with alternatives, and that these alternatives yield obligatory implicatures which account for their distributional properties. This argument has been developed by Chierchia (2004) to account for intervention effects (discussed in section 4.3 below) and has been extended to other polarity items in Chierchia (2006).

## 4.2. Encapsulation

Consider the oddness of the following:

(62) John has an even number of children. More specifically, he has 3 (children).

The source of the oddness is intuitively clear: the second sentence seems to contradict the first sentence. However, it is not trivial to account for the contradiction. The second sentence *John has 3 children* (henceforth just 3) has an interpretation which is consistent with the first sentence, e.g., an interpretation consistent with John having exactly 4 children, which is, of course, an even number. So, why should the two sentences feel contradictory? If in the context of (62), 3 was required to convey the information that John has exactly 3 children, the contradiction would be accounted for. But what could force this “exactly” interpretation on the sentence?

It is tempting to suggest that the theory of SIs should play a role in the account. If in (62) the implicature is obligatory, then the second sentence would contradict the first. And indeed, as we see in (63), and as we’ve already seen in the previous sub-section, there are some cases where implicatures are obligatory:

(63) Speaker A: Do you know how many children John has?

Speaker B: Yes, he has 4 children. #In fact, he has 5.

However, it turns out that the Gricean reasoning that has been proposed to account for SIs does not derive the attested contradiction. This is a point that was made in a different context by Heim (1991), and was discussed with reference to (62) and similar examples in Fox (2004) and most extensively in Magri (2009). To understand the argument, it is useful to try to derive the SI, along the lines outlined in section 1, and to see where things break down.

So, let’s try. Upon hearing the utterance of 3, the addressee (h, for hearer) considers the alternative sentences in (64), and wonders why the speaker, s, did not use them to come up with alternative utterances.



- (64) a. More specifically, he has 4 children.  
 b. More specifically, he has 5 children.  
 c. ...

Since all these (clearly relevant) alternatives are stronger than *s*'s actual utterance, *h* concludes based on (the assumption that *s* obeys) the Maxim of Quantity that *s* does not believe any of these alternatives. i.e., *s* derives the conclusions in (65), which together with the basic utterance, 3, can be summarized as (66).

- (65) a.  $\neg B_s(\text{John has 4 children})$ .  
 b.  $\neg B_s(\text{John has 5 children})$ .  
 c. ...

- (66)  $O_{ALT} [B_s(\text{John has 3 children})]$ .

Now, based on the assumption that *s* is opinionated with respect to the alternatives in (64), *h* might take 'the epistemic step' (tantamount to 'neg-raising'), which leads to the conclusions in (67), summarized in (68).

- (67) a.  $B_s \neg(\text{John has 4 children})$ .  
 b.  $B_s \neg(\text{John has 5 children})$ .  
 c. ...

- (68)  $B_s [O_{ALT} (\text{John has 3 children})]$ .

This conclusion clearly contradicts the first sentence in (62), thus, accounting for the observed phenomenon. We thus seem to have a purely neo-Gricean account of the deviance of (62). But this impression is mistaken, as the following illustrates.

The problem is that we were too quick to derive the conclusions in (65) based on the Maxim of Quantity. It is true that all of the utterances in (64) are *logically* stronger than 3, but are they all also *more informative*, given the special properties of the immediate context? To answer this question we have to understand what is taken to be true at the point at which 3 is uttered (i.e., after the first sentence in ((62))). If the first sentence in (62) is already taken to be true, i.e., if it is assumed that John has an even number of children, the proposition that John has at least 3 children (the relevant meaning of 3), and the proposition that John has at least 4 children (the relevant meaning of (64a)) provide *exactly the same information*, namely that John has an even number of children greater or equal to three, i.e., that he has 4 or more children.

So, the Maxim of Quantity does not require *s* to prefer (64a) to 3. Therefore, the inference in (65a) does *not* follow from the assumption that *s* obeys the maxim. Moreover, since (65a) and the second sentence in (62), which uses the number 3, convey exactly the same information, they are predicted to yield exactly the same SI, which together with the basic contextual meanings amounts to the proposition that John has an even number of children greater or equal to 3, but does not have an even number of children greater or equal to 5, which is, of course, tantamount to saying that John has exactly 4 children. So the only implicature we get by employing this purely Gricean reasoning fails to make (62) incoherent.

In other words, on closer scrutiny, it turns out that we fail to account for the contradictory nature of (62). The Gricean reasoning predicts that (62) will be just as appropriate as the following:

(69) John has an even number of children. More specifically, he has 4 children.

This is in sharp contrast with what happens if SIs are derived within the grammar, using the operator *O*. Under such a view, the contradiction is derived straightforwardly. The sentence 3 activates alternatives which are operated on by *O* ‘blindly’, as it were, and when this happens we obtain the proposition that John has exactly 3 children, and this proposition directly contradicts the earlier sentence which asserts that John has an even number of children.

To couch it differently, what (62) seems to teach us is that the notion of informativity relevant to SI computation is logical entailment, rather than entailment given contextual knowledge. This means that the module that computes SIs has to be encapsulated from contextual knowledge, which makes sense if the module is (part of) grammar but not if it is (part of) a “central system” used for general reasoning about the world, as Grice envisioned. For further arguments to this effect, see Fox & Hackl (2006) and in particular Magri (2009).

As various examples in Magri (2009) illustrate, our argument does not specifically rely on the use of numerals, which we selected here to simplify the exposition. The general point can be made with other scalar items, even though one has to construct more complicated discourses, such as the following:

(70) Every student, including Jack, solved either none of the problems or all of the problems. #Jack solved some of the problems.

In this case, the second sentence, under its non-strengthened, logical meaning, is compatible with the first (and contextually entails that Jack solved all of the problems). Yet it is felt as contradictory. So even if numerals only had an ‘exact’ meaning, as suggested by Breheny (2008), our general point would remain.

### 4.3. Negative polarity items and intervention effects

Negative Polarity Items (NPIs) (e.g., *any*) are generally licensed in downward entailing contexts (Ladusaw 1979, Fauconnier 1975a). However, as pointed out by Linebarger (1987), certain logical operators appear to disrupt this licensing:

- (71) a. John didn’t introduce Mary<sub>1</sub> to anyone she<sub>1</sub> knows  
 b. \*John didn’t introduce [every woman]<sub>1</sub> to anyone she<sub>1</sub> knows.

This intervention effect has been studied extensively in the literature. Among the important observations that have come out of this study is a typology of the logical operators that yield an intervention effects, henceforth intervening operators (cf., among others, Linebarger 1987; Guerzoni 2004, 2006). Compare (71b) to (72), and (73a) to (73b).

(72) John didn’t introduce [a single woman]<sub>1</sub> to anyone she<sub>1</sub> knows

- (73) a. John didn't talk either to Mary or to any other girl.  
 b. \*John didn't talk both to Mary and to any other girl.

This comparison leads to the conclusion that existential quantification and disjunction do not yield intervention effects, but universal quantification and conjunction do (Guerzoni 2004, 2006). Why should this be the case? Chierchia (2004) suggests that the answer follows from the theory of SIs. We cannot go over the details of the proposal but we can introduce the basic idea. Assume first that licensing of NPIs requires them to be in a DE context. Assume, furthermore, that SIs are obligatorily factored into the meaning of (71)–(73) (i.e., that we are here in presence of obligatory SIs, just like in the examples considered in section 4.1). It can be shown that SIs in (71)a, (72) and (73)a do not affect the DE character of the context, whereas they do in (71b) and (73b). Thus, in these latter cases, we no longer have DE contexts once SIs are factored in and hence the condition for the proper licensing of NPIs is not met.

To see how SIs could affect downward entailingness, consider the relationship between the sentences in (74).

- (74) a. John didn't talk both to students and professors  
 b. John didn't talk both to students and physics professors

(74a) entails (74b) as long as their potential scalar implicatures are not taken into account. But otherwise, this is no longer the case. The reason for this is that (74a) triggers the SI that the stronger alternative with disjunction – (75a) below – is false, namely the implicature that the speaker talked either to students or to professors. If we factor SIs into basic meanings (deriving *strengthened meanings*), (74a) no longer entails (74b): in a situation where John talked to two biology professors and to no one else, (74a) is true on its strengthened meaning but (74b), while true on its weak meaning, is false on its strengthened meaning. In other words, there is no entailment between the sentences in (74), if they receive the syntactic parse in (74)'.

- (74)' a.  $O_{ALT}$ [John didn't talk both to students and to professors].  
 b.  $O_{ALT}$ [John didn't talk both to students and to physics professors].

The situation in (75) is very different. (75a) has no SIs, because the alternative with conjunction – (74a) – is a weaker alternative and is therefore not excluded by any of the approaches to SIs.

- (75) a. John didn't talk to students or to professors.  
 b. John didn't talk to students or to physics professors.

So, even if (75) received a parse with *O*, parallel to (74)', this will not interfere with downward-entailingness:

- (75)' a.  $O_{ALT}$ [John didn't talk both to students or to professors].  
 b.  $O_{ALT}$ [John didn't talk both to students or to physics professors].

*O* is vacuous in (75)', and therefore does not affect the entailment between the (a) and the (b) sentence. In other words, if *O* is inserted above negation, the NPI in (73b) is no longer in a downward entailing environment, while in (73b) downward entailment is not affected.

The same applies, arguably, to all interveners. For example, we can make sense of the fact that universal quantifiers are interveners but existential quantifiers are not. Existential quantifiers, in contrast to universal quantifiers, are the lowest members of their scale. Existential quantifiers and universal quantifiers form a Horn scale in which the universal is the logically strong member. Since, strength is reversed under downward entailing operators, universal quantifiers lead to matrix implicatures when embedded under such operators and existential quantifiers do not. The relevant implicatures, in turn, destroy downward entailingness, thus yielding the intervention effect.

But of course, none of this can work if SI are computed outside grammar. Under such an architecture, there is no reason why they should affect the licensing of NPIs. Moreover, Chierchia shows that his account can work only under very specific assumptions about the effects of SIs on syntactic intervention effects. If there is something to the account, SIs clearly must be computed within grammar.

#### 4.4. Free choice

An utterance of the sentence in (76) is typically interpreted as a license to choose freely between two available options (the free choice inference, henceforth Free Choice).

- (76) You are allowed to eat cake or ice cream.  
*There is at least one allowed world where you eat cake or ice cream.*

More specifically, (76) licenses the two inferences in (77).

- (77) Free Choice (inference of ((76))  
 a. You are allowed to eat cake.  
*There is at least one allowed world where you eat cake.*  
 b. You are allowed to eat ice cream.  
*There is at least one allowed world where you eat ice cream.*

Free Choice, however, does not follow in any straightforward way from the basic meaning of the sentences. (76) – which contains two logical operators: the existential modal *allowed* and the disjunction *or* – should express the proposition that the disjunction holds in at least one of the allowed worlds [ $\Diamond(C \vee IC)$ ]. And, the truth of this proposition does not guarantee that for each disjunct there is an allowed world in which the disjunct is true. [ $\Diamond(C \vee IC) \not\Rightarrow \Diamond(C) \wedge \Diamond(IC)$ .]

Kamp (1973), who identified the puzzle, suggested that it be resolved by strengthening the basic semantics of the construction and a solution along such lines has been worked out also in Zimmermann (2000) and Geurts (2005) (see also Simons 2005). However, Kratzer & Shimoyama (2002) – henceforth K&S – and Alonso-Ovalle (2005) pointed out that such a revision would get the wrong result when the construction is embedded in a downward entailing environment:

(78) No one is allowed to eat cake or ice cream

If (76) – as part of its basic meaning – were to entail Free Choice, we would expect (78) to be true if one of the free choice inferences in (77) were false for every individual in the domain (e.g., if half the people were allowed to eat cake the other half were allowed to eat ice cream, but no one was free to choose between the two desserts). But (78) seems to express a much stronger proposition, namely that no one is allowed to eat cake and that no one is allowed to eat ice cream.

We've already seen this pattern in section 4.1, namely an inference that appears when a sentence is uttered in isolation, but is not incorporated into its meaning when the sentence is further embedded in a downward entailing environment. We've also seen that this otherwise puzzling pattern would follow straightforwardly if the inference could be derived as an SI. In the case of Free Choice, K&S suggest that the inference should follow from a reasoning process about the belief state of the speaker that one might call meta-implicature (see also, e.g., Schulz (2005), Klinedinst (2006), Chemla (2008), for related proposals).

Specifically, K&S suggest that the sentences in (76) has the alternatives given in (79) below, for which we've argued on independent grounds in section 3.

(79) Alternatives for (76) proposed by K&S/Alonso-Ovalle:

- a. You are allowed to eat the cake.
- b. You are allowed to eat the ice cream.

Furthermore, they suggest that when a hearer *h* interprets *s*'s utterance of (76), *h* needs to understand why *s* preferred (76) to the two alternatives. K&S, furthermore, suggest that it is reasonable for *h* to conclude that *s* did not choose the alternative because she was not happy with their strong meaning (basic meaning + implicatures) – hence our term meta-implicature. Specifically, K&S suggest that *h* would attribute *s*'s choice to the belief that the strong meanings of (79a) and (79b) (stated in (80)) are both false.

(80) Strong meaning of the alternatives for (76)

- a. You are allowed to eat the cake and you are not allowed to eat the ice cream.
- b. You are allowed to eat the ice cream and you are allowed to eat the cake.

And, as the reader can verify, if (76) is true and the strengthened alternatives in (80) are both false, then the Free Choice inferences in (77) have to be true.

We believe this logic is basically correct, but we don't see a way to derive it from basic principles of communication (Maxims). In fact, if *s* believed that the Free Choice inferences hold, the Maxim of Quantity would have forced *s* to prefer the sentences in (79) and to avoid an utterance of (76) altogether. The fact that *s* did not avoid (76) should, therefore, lead *h* to the conclusion that *s* does not believe that the sentences in (79) are true (see our discussion in section 1.1.).

This has led Chierchia (2006) and Fox (2007) to provide a formal/grammatical alternative to K&S. We cannot go over the details of the proposals, but would like to point out Fox's observation, namely that K&S's results follow from a representation in which two instances of the operator, *O*, are appended to (76):

- (81) Alternatives for A logical form for (76) that derives Free Choice:  
 O[O(You are allowed to eat cake or ice cream)].  
*There is at least one allowed world where you eat cake or ice cream.*  
*And (80)a,b, are both false.*

So while there are reasons to believe that free choice effects can be explained in a principled way as meta- (or higher order) implicatures (Spector 2007a, which we briefly discussed in subsection 4.1, also makes use of higher-order implicatures) and while the basic idea might seem at first compatible with a Gricean system, working it out turns out to be in conflict with the basic maxims. Furthermore, Chierchia (2006) further develops this logic arguing that constraints on the relevant grammatical representations yields an account of the cross-linguistic distribution of Free Choice items. If these proposals are anywhere close to the mark, then clearly implicatures must be part of grammar

#### 4.5. Non-monotonic contexts: negating alternatives that are neither stronger nor weaker

Consider the following sentence:

- (82) Exactly one student solved some of the problems

Let's assume that (82)'s only scalar alternative is (83).

- (83) Exactly one student solved all of the problems

(83) is neither stronger nor weaker than (82): both sentences can be true in a situation where the other is false. Since (83) is not more informative than (82), Grice's maxim of quantity, under its most natural understanding, does not require that one utter (83) rather than (82) even when both are believed to be true and relevant. So the Gricean approach, unless supplemented with quite specific assumptions, predicts no SI in the case of (82). In contrast to this, a theory that incorporates the exhaustivity operator, which is modeled on the semantics of *only*, does predict an implicature for (82) when the exhaustivity operator takes matrix scope (it also predicts the possibility of an embedded implicature under the scope of *exactly one*, as discussed in section 2.2).

Indeed, applying the exhaustivity operator to a given sentence S with alternatives ALT(S) generally returns the conjunction of S and of the negations of all the alternatives of S that are not entailed by S (modulo the modification we have introduced above in order to reach a correct treatment of disjunctive sentences), which include both alternatives that are stronger than S and possibly alternatives that are neither stronger nor weaker than S. So the meaning of (82) (under the parse *O(Exactly one student solved some of the problems)*) is predicted to be the proposition expressed in (84a) which is equivalent to (84b) (Note that the fact that exactly one student solved at least one problem entails that no student except one solved any problem at all):

- (84) a. Exactly one student solved at least one of the problems and it is false that exactly one student solved all of the problems

- b. There is a student  $x$  who solved at least one of the problems, no student except  $x$  solved any problem, and  $x$  did not solve all of the problems.

It seems to us that this prediction is borne out: (84a), which is equivalent to (84b), is indeed a very natural interpretation for (82). The fact that implicature computation seems to involve the negation of non-stronger alternatives is quite unexpected from the Gricean perspective, unless further assumptions are made (for instance the assumption that the set of alternatives of any sentence is closed under conjunction, cf. Van Rooij & Schulz 2004, 2006 and Spector 2003, 2006, 2007b; see Fox 2007 for an argument against this assumption).

#### 4.6. Constraints on the placement of the exhaustivity operator

We have observed that a hallmark of SIs is that they tend to disappear in downward-entailing environments – i.e., the strengthened reading of scalar items is dispreferred under, say, negation or in the restrictor of a universal quantifier. At first sight, this phenomenon makes the pragmatic, neo-Gricean, account of SIs particularly appealing: indeed, as we have seen, the absence of the strengthened reading in DE contexts is directly predicted by the neo-Gricean perspective.

However, as we pointed out in section 2, the strengthened meaning of a scalar item is actually not entirely ruled out in DE contexts; it is only dispreferred. From a purely Gricean perspective, it is a challenge to explain why a scalar item could ever be interpreted under its strengthened meaning in a DE context (so called ‘intrusive implicatures’). To account for such cases, advocates of the purely pragmatic perspective are forced to introduce new mechanisms, such as a mechanism of metalinguistic negation, which then has to be generalized (cf. Horn 1989) to other operators (but if our previous arguments are conclusive, these ‘repairs’ are anyway unable to account for the full range of phenomena). The grammatical view does not face a similar challenge; but it clearly needs to be supplemented with some principles that determine which particular readings are preferred and which ones are dispreferred (and hence marked).

One possibility that suggests itself is that, when a sentence is potentially ambiguous, there is a preference for the strongest possible interpretation. Such a general principle has been suggested independently by various researchers beginning with Dalrymple et al. (1998) – the ‘strongest meaning hypothesis’. If a principle of this sort is adopted, then inserting  $O$  in a DE context would be dispreferred: indeed, for any sentence  $S$ ,  $O(S)$  is stronger than  $S$ ; hence, inserting  $O(S)$  in the (immediate) scope of a DE operator  $X$ , i.e., an operator that reverses logical strength, gives rise to a sentence  $X(O(S))$  that is now *weaker* than what would have resulted if  $O$  were absent, i.e., weaker than  $X(S)$ .

How exactly such a principle should be stated is far from trivial. Given our general perspective, it should state that a Logical Form  $S$  in which  $O$  occur is dispreferred in case  $S$  is a-symmetrically entailed by some well-defined competitor  $S'$ . That is, we have to define, for any such  $S$ , its *comparison class*. One possibility we will briefly consider is the following: an occurrence of the exhaustivity operator is dispreferred if and only if it gives rise to a reading that is weaker than what would have resulted in its absence.

## (85) Strongest Meaning Hypothesis

Let  $S$  be a sentence of the form  $[s \dots O(X) \dots]$ . Let  $S'$  be the sentence of the form  $[s \dots X \dots]$ , i.e., the one that is derived from  $S$  by replacing  $O(X)$  with  $X$ , i.e. by eliminating this particular occurrence of  $O$ . Then, everything else being equal,  $S'$  is preferred to  $S$  if  $S'$  is logically stronger than  $S$ .

(85) predicts that  $O$  should be dispreferred under DE-operators. However, it does not predict any preference between matrix exhaustification and embedded exhaustification in UE-contexts. This can be illustrated by the following example:

(86) For this class, we must read most of the books on the reading list

An exhaustivity operator could be inserted either above or below the modal *must*, giving rise to the following readings:

- (87) a.  $O(\text{we must read most of the books on the reading list})$   
       = we must read most of the books on the reading list and we don't have to read all of them  
       b.  $\text{We must } O(\text{read most of the books on the reading list})$   
       = we must read most of the books on the reading list and we have the obligation no to read them all

(87b) a-symmetrically entails (87a). Yet the principle in (85) does not predict that (87b) should be preferred to (87a) (or the other way around). This is so because according to (85), (87a) and (87b) do not belong to each other's comparison classes. Rather, each of them is to be compared to the proposition that one gets by deleting the operator, namely to the non-strengthened reading of 'We must read *Ulysses* or *Madame Bovary*'. Plainly, the condition stated in (85) is met in both cases, since in both cases the presence of  $O$  has a strengthening effect, and so no preference is predicted. More generally, in UE contexts, (85) does not favor one particular insertion site for the exhaustivity operator. Of course, more general considerations (such as, for instance, the plausibility of a given reading) might create a preference for certain readings.

## 5. Concluding remarks

In this article we tried to show that SIs can occur in all sorts of embedded context. If this attempt has been successful, we think it calls for a reassessment of the semantics/pragmatics interface. In order to establish our point, we have adopted the view that implicatures arise through a silent exhaustification operator, akin to *only*, which acts on scalar alternatives. We think that the idea – while leaving many open issues – has significant benefits: in many cases (involving Hurford's Constraint, iterated applications of  $O$ , etc.) it makes just the right predictions.

The grammatical view of SIs retains the most beautiful feature of the Gricean insight: the sensitivity of SIs to embeddings within polarity affecting contexts. And, through the



link to alternative sensitive operators, this view also creates a powerful bridge to a host of like phenomena occurring in very diverse corners of grammars (from the analysis of plurals, through free choice, to intervention and the like). Within the limits of the present article, these remain largely promissory notes. But we hope that we were able to lay out the strategy that needs to be pursued in a fairly clear manner. Finally, we hope that it will be possible begin to reap additional benefits from the entrance of SIs (and of, possibly, implicatures of other sorts) into the computational system of grammar.

*We would like to thank participants in various classes, colloquia and seminars in which this work was presented (by at least one of us), in particular Columbia University (2008), Institut Jean-Nicod (2008), the LSA summer institute (2005), University of Georgetown (2006), LOGOS (Barcelona 2008), Harvard-MIT seminar in semantics (2006), MIT-Paris workshop in linguistics (2007), and the University of Vienna (2009). Special thanks to Emmanuel Chemla, Irene Heim, Maribel Romero, Daniel Rothschild and Philippe Schlenker.*

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*Gennaro Chierchia, Cambridge, MA (USA)*  
*Danny Fox, Cambridge, MA (USA)*  
*Benjamin Spector, Paris (France)*



# XVIII. The semantics-pragmatics interface

## 88. Semantics/pragmatics boundary disputes

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### Abstract

*The boundary between semantics and pragmatics has been the subject of heated debates, most notably in post-Gricean theories of meaning and communication. I present a survey of the standpoints on the boundary issue beginning with Grice's distinction between what is said and what is implicated, through various attempts at redrawing the boundary towards a version of the contextualist stance in which the truth-conditional content of the utterance is enriched in a way that reflects the speaker's intentions and the addressee's intuitions about what is said. I acknowledge the role of radical pragmatics in the 1970s in putting forward the idea of semantic underdetermination and move on to discussing the most influential concepts and approaches in post-Gricean accounts. I present some differences between contextualist accounts, mainly with respect to the acceptance or rejection of unarticulated constituents, and place contextualism in the wider perspective of the debate concerning the scope of semantic content, ranging from the minimalist accounts (Borg, Cappelen & Lepore, Bach) to the late Wittgensteinian view of so-called meaning eliminativism. I conclude with a brief discussion on the significance of the boundary disputes.*

### 1. Sentences, utterances, and truth conditions

Truth-conditional semantics is at present the best developed approach to sentence meaning, benefiting from high predictive power, formal rigour, and intuitive plausibility in that it associates sentence meaning with the truth and falsity understood as correspondence with eventualities in a model. But there are some aspects of meaning that go beyond the meaning of sentences so understood. For example, while the sentential connective *and* in English acquires a truth-conditional analysis that is founded on the properties of its formal equivalent of conjunction in propositional logic, it is evident that English *and* conveys more than its formal equivalent does. Sentence (1) should be true when both conjuncts are true and its truth value should be resistant to the change in the order of the conjuncts as in (1a).

- (1) The janitor left the door open and the prisoner escaped.  
(1a) The prisoner escaped and the janitor left the door open.

It is clear, however, that (1a) is not as felicitous as (1). In fact, according to the judgment of many native speakers of English, it is plainly false as a description of the situation depicted in (1). This shows that there is more to the meaning of *and* than the straightforward conjunction of two phrases. In (1) and (1a), *and* also conveys the consequential meaning *as a result*, as in (1b).

(1b) The janitor left the door open *and as a result* the prisoner escaped.

Alternatively, we can surmise that it is not the connective *and* that is responsible for the meaning of consequence but rather the very juxtaposition of the description of two events: leaving the door open and the prisoner's escaping. Be that as it may, there is more to the meaning of (1) than the truth-conditional analysis of the sentence reveals. The translation into the metalanguage of first-order logic leaves the consequence relation between the clauses unaccounted for.

It seems that in addition to the analysis of the structure of the sentence and the encoded lexical content attended to in standard truth-conditional analysis, we have to look for information about meaning that comes from other sources. The most important of these sources is the context of utterance, understood broadly as the background knowledge of the interlocutors, information conveyed in other parts of the conversation or written text (co-text), as well as the baggage of world experience brought to the situation of discourse by the interlocutors. But we can only bring this information in when we agree to alter the object of study of the theory of meaning to something more intuitively appealing and useful than an abstract unit of a sentence. The speaker and the addressee attend to the meaning of the *utterance*: the real, concrete unit of meaning that carries some information content through the words used, the structure, the exact placement in the structure of the conversation, the additional senses it brings to mind in the particular context, the immersion in the overall system of gestures and other ways of conveying meaning, and so forth.

Examples that testify to the importance of the extra-sentential means of conveying information are ample. Deictic expressions such as pronouns and demonstrative noun phrases rely on the context of utterance to convey meaning. In fact, they even rely on the context in order to make a contribution to the sentence that would make this sentence truth-evaluable. Definite descriptions such as 'the best Austrian novelist' are also dependent on the context in their interpretation: they can refer to a particular individual (say, for me, it is Robert Musil and I can make it clear in the conversation that when I use this description I indeed mean Robert Musil) or they can be used attributively, to mean whoever happens to be the best Austrian novelist. Once a truth-conditional semanticist has recognised the importance of these extra-sentential factors and contemplated the alteration of the object of study from the sentence to the utterance, and from sentence meaning to the speaker's meaning, he/she has two options to choose from: either to (i) reject truth-conditional semantics and look for an alternative theory, or (ii) try to preserve truth-conditional semantics and adapt it to the new object of study. Let us assume that our semanticist is a devoted supporter of the methods of truth-conditional semantics and opts for the latter solution. At this juncture he/she is faced with two options again: either (ii.a) to advocate that there is more to meaning than truth conditions alone and allow for a pragmatic overlay to the thereby saved semantic theory, or (ii.b) to propose that pragmatic factors contribute to the truth-conditional content and 'shift' the truth-conditional

analysis from sentences to utterances. The latter avenue opens up the option of adding information about meaning that comes from sources other than the lexicon and the structure.

Let us now see what actually happened in the history of the semantics/pragmatics interface, beginning with the philosopher who is generally recognised as the founder of modern pragmatic theory: Paul Grice. Grice pursued the path of preserving the truth-conditional analysis but was rather ambivalent as to the options (ii.a) and (ii.b) above: he allowed some pragmatic input in the truth-conditional content, while keeping most of it outside of this content. Needless to say, this kind of proposal had to generate a heated debate, a debate that is still at the forefront of theorising in semantics and pragmatics and that is still producing cutting edge analyses.

## 2. The pragmatic wastebasket: Grice on *what is said* and *what is implicated*

It is a common fact of conversation that speakers often mean more than they physically utter. They also often mean something different from what they actually utter. In the exchange in (2), speaker B communicates that Smith may in fact have a girlfriend, contrary to what A assumes:

- (2) A: Smith doesn't seem to have a girlfriend these days.  
B: He has been paying a lot of visits to New York lately.

(from Grice 1975: 32). In order to retrieve the relevance of B's statement, one has to perform some basic inference. B's response is relevant and informative but not in virtue of the truth-conditional content of the sentence alone, but rather in virtue of what it implies (or, to use Grice's term, *implicates*) in this conversation. This implicated meaning, called a conversational implicature, is pragmatic through and through. The implicature 'Smith may have a girlfriend in New York' bears no structural resemblance to the sentence uttered by B, it is constructed by the addressee entirely on the basis of pragmatic inference.

Now, it seems that in the interest of shifting the object of study from sentence meaning to speaker's meaning we may have obliterated the differences in the understanding of the term 'meaning'. In order to clarify the term, we have to go to Grice's (1957) seminal paper 'Meaning' and look for the principles on which his notion of meaning is founded. Grice stresses that he is not interested in the instances of the so-called *natural meaning*, where meaning that *p* entails that it is the fact that *p*. 'These spots mean meningitis' is an example of the natural meaning: there is a natural connection between the symptom and the disease. Instead, he is interested in speaker's meaning which he calls *non-natural meaning* (meaning<sub>NN</sub>). This meaning is conventional but not natural; it does not carry the strong requirement of entailment. Meaning<sub>NN</sub> will henceforth be the object of study in post-Gricean pragmatics, and also the object of the following discussion of the semantics/pragmatics interface in the remainder of this article. Grice defines this meaning by resorting to speaker's intentions and the recognition of these intentions by the addressee: "A meant<sub>NN</sub> something by *x*' is roughly equivalent to 'A uttered *x* with the intention of inducing a belief by means of the recognition of this intention'." (Grice 1957: 219).



The role of intention, also stressed in the speech-act literature of that period (e.g. Austin 1962; Searle 1969), is further spelled out in Grice's 'Utterer's Meaning and Intentions' (1969):

"'U meant something by uttering *x*' is true iff [if and only if], for some audience A, U uttered *x* intending:

- [1] A to produce a particular response *r*
- [2] A to think (recognize) that U intends [1]
- [3] A to fulfill [1] on the basis of his fulfillment of [2]" (Grice 1969: 92).

In some cases, the recognition of the speaker's intentions is short-circuited, so to speak, in that the response is secured because the meaning is so conventionalized in a language that conventions create a 'shortcut' through the recognition of the intentions. By a response Grice means here any physical or a cognitive reaction to the speaker's utterance, including an understanding of what was intended to be communicated. It also has to be stressed that by an 'utterance' he means any act of communication, not only a linguistic one. So, drawing a picture for the addressee or making clearly recognisable facial expressions such as a smile of approval or contempt are also subsumed under the category of an utterance. Bearing in mind this possibility of a conventional uptake, we can sum up that on this account communication is explained in terms of intentions and inferences. An intention to inform the addressee is fulfilled simply by the recognition of this intention by the addressee.

This intention-based theory of meaning lays the foundations for the theory of implicature in which Grice spells out the principles of a cooperative conversational behaviour. Most implicatures are considered to be meanings intended by the speaker but in the case of literary texts, for example poetry, the speaker or writer may intend to leave the range of plausible implicatures deliberately open (see also Davis 1998 on speaker's implicature vs. sentence implicature). *Nota bene*, originally, the term 'implicature' referred to the process of implicating some meaning, while the product was dubbed an 'implicatum' (plural: 'implicata'). In the post-Gricean literature, however, the Latin nominal has gone out of use and the term 'implicature' now serves to name the product of implicating. An utterance can give rise to a number of additional thoughts called implicatures.

In his theory of conversational behaviour, Grice (1975) makes the important assumptions that participants in a discourse are rational agents and that they are governed by principles of rational communicative behaviour. Their behaviour is predictable in the sense that meaning is implicated according to some principles of rationality. The umbrella term for this rationality is the Cooperative Principle:

"Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged."

(Grice 1975: 26. See also Mill 1872: 517; Ducrot 1972: 134.)

Subsumed under this principle are particular so-called maxims of conversation, stating that the speaker's contribution is to be sufficiently but not overly informative (the maxims of quantity); that the contribution is to be true in the sense that the speaker has to say what he/she believes to be true and supported by sufficient evidence (the maxims of quality); that the contribution is to be relevant (the maxim of relation); and that the form of

the contribution is to be clear (perspicuous): not obscure, ambiguous, excessively long, or reporting events in the wrong order (the maxims of manner). The exact content of the maxims will not concern us here, especially in view of the later developments of the theory in which it was demonstrated that there was a considerable overlap and redundancy among the maxims and that we could make do with fewer, perhaps two (Horn 1984, 1988, 2004), three (Levinson 1987, 1995, 2000 and section 4.5 below), or even one (Sperber & Wilson 1986 and section 4.2 below) principle instead (See Jaszczolt 2002: chapter 10 and Jaszczolt 2010a for an overview).

It has to be remembered that although Grice's maxims are formulated as if they were prescriptive laws, their *raison d'être* is to spell out the principles that the human mind naturally follows. Although it is possible to consciously disobey the maxims or even overtly opt out of them, the standard presumption in every conversation is that they do apply. In (3), which we can imagine to be an extract from a review of a piano recital, the implicature that the pianist was a bad one comes from the unnecessary prolixity with which information was conveyed.

- (3) The pianist sat down at the instrument and hit the keys in a way resembling Chopin's nocturne in C minor.

Since the description of the performance is clearly more demanding on the reader's time and effort than just reading that the pianist played Chopin's nocturne in C minor, the reader rationally infers that there must be some implicated meaning to it such as that the performance was a particularly bad one. To sum up, implicatures can arise through observing or violating the maxims of conversation.

Implicatures are clearly pragmatic constructs: they are thoughts and do not have direct counterparts in sentences or in physical utterances. So, by the very nature of being inferred meanings, they have to be weaker than meanings of sentences or utterances. They are also weaker than deductive inferences of the type of *modus ponens* (if *p* then *q*; *p*; therefore: *q*). Implicatures are cancellable. We can always cancel the implicatures in (2) or (3) by adding (2a) and (3a) respectively.

- (2a) But I don't mean to suggest that he has a girlfriend in New York. His company is based there and he is very busy commuting.

- (3a) After a few bars, I realised it *was* Chopin's nocturne in C minor, played with unprecedented skill, insight and feeling.

We are now in a position to discuss and assess Grice's view on the boundary between semantics and pragmatics. The motivation behind the proposal of the cooperative principle and the maxims was to explain how expressions of a natural language differ in their properties from their translations in the metalanguage of first-order logic. The assumption was that the truth-conditional semantic analysis is to be preserved and the discrepancies are to be explained as a pragmatic overlay. But the boundary is not as clear-cut as it may seem. Firstly, words and structures can be ambiguous. In order to assign truth conditions to such constructions, they have to be disambiguated and this disambiguation is a pragmatic process. Next, there are context-dependent expressions such as personal and demonstrative pronouns and demonstrative noun phrases that do not pick out a

referent on their own: the referent has to be assigned in a context, in a pragmatic process. Hence, Grice (1978) had to admit the output of such pragmatic processes into the truth-conditional part of meaning<sub>NN</sub>. The remainder, what is implicated, is a graded category: some types of implicatures are closer in their characteristics to the semantic content than others. The implicatures in (2) and (3) are far removed from what is said in that they rely on the particular context: they are what Grice called particularized conversational implicatures (PCIs). But there are also implicatures that occur in virtue of the sentence alone: they are standard, normal predictions, or salient meanings, that arise independently of the context—unless, of course, the context makes it clear that they have to be cancelled or should not be computed. The implicature of (4) in (4a) is an example of such a generalized prediction, called by Grice a generalized conversational implicature (GCI).

(4) Some of the guests like oysters.

(4a) Not all of the guests like oysters.

The inference from *some* to *not all* is a standard prediction that goes through in virtue of the words used rather than in virtue of the context. Such examples subsequently gave rise to a theory of scalar implicature: lexical items <all, some> form a semantic scale and when the weaker term (the term to the right) is used, it is implicated that the stronger terms (here: *all*) do not apply to the situation talked about. It is possible to expand the scale to <all, most, many, some, few, . . . >, possibly adding some more terms. Scalar predicates are then semantically lower-bounded: *some* means *at least some*, and pragmatically upper-bounded: *some* means *at most some (not all)*. This upper bound is provided by the maxim of quantity (see Horn, e.g. 1988, 2004). While it has been demonstrated that scales themselves can sometimes be context-dependent, the fact remains that it is easy to pinpoint a class of implicatures that do not rely on the context of the utterance but instead arise as assumed meanings. And context-free scalar implicatures make a substantial part of such generalized predictions.

When Grice presented his maxims of conversation as a natural complement to the truth-conditional semantics, he thus offered a tool for explaining the behaviour of sentential connectives such as *and* and *or*. Disjunction (*or*) in propositional logic is inclusive: *p or q* means *p, q, or both*. In English, we normally use *or* with an exclusive meaning: *either p, or q, but not both*. This discrepancy can be explained by means of adding an implicature of exclusiveness that comes from a semantic scale: <and, or> form such a scale and when the speaker utters ‘or’, he/she implicates that ‘and’ does not hold for the described situation. This implicature can, of course, be cancelled as in (5).

(5) In August I will go to the seaside or to the mountains, or both.

GCIs are thus closer to the truth-conditional content than PCIs: they arise in virtue of the words and constructions used, and hence have a strong semantic flavour.

Grice also distinguished another category that blurs the distinction between semantics and pragmatics even further: this is the category of a conventional implicature. This implicature does not share the properties with conversational implicatures: it is not cancellable, not calculable, and detachable when a synonymous sentence is substituted. So, it is in fact a species of lexical content. Words such as ‘but’, ‘manage’, or ‘therefore’ are said to

convey conventional implicatures of contrast, overcome difficulty, and consequence respectively. One may wonder why complicate the theory by distinguishing such meanings from lexical, coded content *simpliciter*. The reason was that there are no obvious translations of such expressions into the metalanguage of first-order logic, and Grice assumed that the translation is an indispensable component of truth-conditional semantics, where the latter was itself regarded as indispensable, just in need of some patching up. So, 'but' became translated as logical conjunction, on a par with 'and', and the contrast sense was dubbed a conventional implicature. To sum up, for Grice, truth-conditional semantics is the core of the analysis of meaning, and pragmatic inference is added as and when it fits—within the truth-conditional content (disambiguation and reference assignment), or outside it, but with varying degrees of 'semanticity': from conventional implicatures that are a species of coded content, through generalized implicatures that arise in virtue of such coded meanings, and finally context-dependent particularized implicatures that are most 'pragmatic' of them all.

Retrospectively, we are in a position to say that the fact that Grice (i) admitted the output of some pragmatic processes in the truth-conditional aspect of meaning and (ii) arranged implicatures on a scale of progressive detachment from the semantic content opened a door for the current boundary disputes in that once some pragmatic inference finds its way into the propositional representation, it becomes a matter of debate (and empirical evidence) how much exactly should be allowed in. Moreover, Grice employed the theory of implicature to argue against the methodological superiority of postulating ambiguities where a unitary semantic account can be given. For disjunction in English, for example, it suffices to admit the meaning of its propositional-logic equivalent as its semantic content and account for the exclusive reading by means of an implicature: there is no need to postulate semantic ambiguity on a par with the lexical ambiguity of 'bank' or 'port'. This economy of senses was spelled out as a Modified Occam's Razor (Grice 1978: 47):

*Senses are not to be multiplied beyond necessity.*

Again, retrospectively, we can judge that this was a landmark in pragmatic theory and in the semantics/pragmatics boundary disputes. Once unnecessary ambiguities are exorcised on methodological grounds, we are left with semantic meanings that cannot always be precisely delineated. And this was the foundation stone for the radical pragmatics in the 1970s and for the idea of semantic underdetermination to which we now turn.

### 3. Redrawing the boundary

Grice's proposal to assign a different status to disambiguation and reference assignment than to the other kinds of pragmatic elaborations of what is contained in the sentence generated many theoretical discussions: if the result of the process of reference assignment and disambiguation belonged to the semantic, truth-conditional content, then why not also include the results of other pragmatic processes that shed light on what is said by the speaker? The slogan 'pragmatics equals meaning minus truth conditions' started to lose its appeal when it was recognised that the truth-conditional content does not correspond to a clear-cut semantic object. Let us take sentential negation for example. Sentence (6) seems to allow for two interpretations, depending on

whether the presupposition of the existence of the king of France is fulfilled at the time of the utterance.

(6) The king of France is not bald.

On the reading (6a), there is a king of France and he doesn't have a property of being bald.

(6a) There is somebody who fulfils the property of being the king of France, there is only one such person, and whoever fulfils this property is not bald.

Or, formally:

(6a')  $\exists x (\text{KoF}(x) \wedge \forall y (\text{KoF}(y) \rightarrow y = x) \wedge \neg \text{Bald}(x))$

The other reading is (6b).

(6b) It is not true that the king of France is not bald.

—for example, because there is no such person. Let us try to represent this reading formally just by varying the position of the negation operator as in (6b') which contains a wide-scope, sentential negation and states that it is not the case (for whatever reason) that there is a king of France who is bald. This reason can be that France is not a monarchy or that the king is not hairless.

(6b')  $\neg \exists x (\text{KoF}(x) \wedge \forall y (\text{KoF}(y) \rightarrow y = x) \wedge \text{Bald}(x))$

It says that it is not the case that there is somebody who fulfils the following two conditions: being the (unique) king of France and being bald. It would be easy and natural to assume on the basis of this analysis that negation is ambiguous in that it can take wide or narrow scope as represented formally by the above logical forms advocated by Bertrand Russell. However, the two logical forms in (6a') and (6b') are not disjoint: the former entails the latter. So, representing the difference between the two readings of (6) by invoking these logical forms and ambiguity of negation is not very satisfactory. Moreover, there is no strong intuition among native speakers that negation in English is indeed ambiguous. Instead, why not assume that the semantics of sentential negation in English underdetermines the meaning? According to such a view, the processing of the lexicon and the structure of (6) results in an underspecified semantic representation and the exact reading, (6a) or (6b), is given by pragmatic enrichment performed in the particular context of discourse. This position of *semantic underdetermination*, also called *sense-generality*, was an important landmark in semantic theory. We owe it to a group of Gricean pragmaticists working in the 1970s, and among others to Jay Atlas's and Ruth Kempson's remarks on the underdetermination of negation—the so-called Atlas-Kempson thesis (see Atlas 1977, 1979, 1989, 2005a, 2006a; Kempson 1975, 1979, 1986; see also Wilson 1975). The movement resulted in the increasing acceptance of the standpoint that there is no semantic ambiguity and the cases such as that of the scope of negation can be handled by the pragmatic additions to the semantically underspecified representation.

Semantic analysis takes us part-way, and pragmatic enrichment completes the recovery of utterance meaning. The movement also came to be known as *radical pragmatics* (Cole 1981). To sum up, while lexical and syntactic ambiguity can be represented as two independent logical forms pertaining to the ambiguous sentence, semantic underdetermination is the case where one underspecified logical form ensues in processing and further determinations of meaning take place through pragmatic inference or through some other pragmatic process such as an application of presumed, salient, default interpretations. Underdetermination and inference are two interconnected aspects of utterance interpretation, as is well captured in Atlas's apt pastiche of Kant: "Pragmatic inference without sense-generalality is blind, but sense-generalality without pragmatic inference is empty." (Atlas 1989: 124). There have been various terms used in the literature for the underdetermination of meaning: underdetermination, underspecification, indeterminacy, sense-generality, vagueness, neutrality, and others (see Zwicky & Sadock 1975: 2; Green 1996: 1). I use 'underdetermination' of meaning as a general concept for the phenomenon and 'underspecified representation' for the property of the logical form as the output of syntactic processing (see van Deemter & Peters 1996; Jaszczolt 1999, 2005). Zwicky & Sadock (1975) presented a battery of tests that can be used to tell ambiguity and underdetermination apart. Perhaps the most important of them is the identity test: conjoining reduced constituents should be possible only when the conjuncts have matching readings. For example, let us take (7) and (8).

(7) They saw her duck.

(8) They saw her swallow.

The conjunction reduction to (9) allows only to juxtapose matching senses: the action of ducking with the action of swallowing, and a duck with a swallow.

(9) They saw her duck and her swallow.

Crossed readings are not semantically well-formed, unless they are used for punning effect (see Lascarides, Copestake & Briscoe 1996). This test is modelled on Lakoff's (1970: 357) 'and the same goes for ...' reduction. Mixed readings are supposed to be freely available for semantic underdeterminacy. However, as in other aspects of the boundary dispute, even here we cannot point to clear-cut distinctions: some examples of underdetermination fare better than others with the tests and hence the tests are not conclusive. The condition of entailment of the logical form is a much safer criterion to follow.

Semantic underdetermination, a revolutionary idea for the theory of linguistic meaning, was a reaction to a widespread attempt in the 1960s and early 1970s to give syntactic explanations to pragmatic phenomena. This tendency was called Generative Semantics. The influence of the Oxford ordinary language philosophy, and most notably John L. Austin, H. Paul Grice, Peter F. Strawson, late views of Ludwig Wittgenstein in Cambridge, as well as subsequent arguments put forward by Bruce Fraser, Gerald Gazdar, Jerry Morgan, Jay Atlas, Ruth Kempson, Deirdre Wilson, and others contributed to the fall of generative semantics and opened up a way to *pragmatic* explanation of clearly *pragmatic* phenomena such as various uses of negation and other sentential connectives. In his 'A Personal History of Linguistic Pragmatics 1969–2000', Jay D. Atlas recalls as follows:

"I read the first, introductory paragraph to Sadock and Zwicky's paper, and I thought to myself, 'That's it. If 'not' is not ambiguous, it's semantically non-specific. Let's try the tests.' Ten minutes later I had satisfied myself that 'not' in definite description sentences failed Sadock's ambiguity tests. And then the power of Grice's notion of generalized conversational implicatural inference hit me full on. The solution had to be in the utterance-meanings, in one of two ways. Either the utterance-meanings were produced by a Griceanish inference, not from classical logical forms as Grice thought, e.g. sentential exclusion negation, but from a non-specific, semantical representation of a sentence-type whose meaning was not that of either a choice or an exclusion negation proposition, or the utterance-meanings were produced by a classical Gricean inference from the sentential exclusion negation logical form, which on classical Gricean grounds one would have to 'posit' as the semantic content of 'what is said' in the asserted sentence—Grice's version of the 'minimal proposition'."

Atlas (2006a: 4).

In short, either there is some underspecified semantic representation given by the processing of the structure, or we adopt (6b') as such an underspecified representation.

The most interesting aspect of radical pragmatics is that such pragmatic resolution of the exact meaning of semantically underdetermined expressions is admitted into truth-conditional semantics. The unit of which we now predicate truth conditions is the *utterance* rather than the *sentence*: it is (6') or (6'') that has truth conditions in any interesting sense, not the sentence in (6). So, the boundary between semantics and pragmatics is shifted even more in the direction of pragmatics. A variety of pragmatic processes of different kinds was allowed to contribute to the truth-conditional representation. For example, in (1) repeated below, the consequence sense of *and* is a pragmatic addition to the semantic content.

- (1) The janitor left the door open and the prisoner escaped.

This blurring of the boundary called for further terminological tidying. Carston (1988) proposed to call the output of syntactic processing of the sentence *linguistic semantics*, reserving the term *truth-conditional semantics* for the amalgam of the output of linguistic semantics and pragmatic inference. In (1),  $p \wedge q$  is a representation in linguistic semantics, while  $p$  and therefore  $q$  is a representation in truth-conditional semantics. At this point we should add a terminological distinction: the representations in linguistic semantics are called logical forms in that they are the same logical forms as those recognised as the semantic structure of sentences in truth-conditional Montagovian semantics (see Dowty, Wall & Peters 1981; Lycan 1984). The enriched representations of truth-conditional semantics in the above (contextualist) sense will be called semantic representations.

The exact scope of application of semantic underdetermination is still a matter of debate. For example, it has often been argued that number terms such as 'three' are semantically underdetermined. According to Horn's early analysis (1976: 33), a sentence containing a cardinal number term  $n$  asserts lower boundedness 'at least  $n$ ', while the upper boundary 'at most  $n$ ' is just an optional addition executed through pragmatic inference. The final product, the 'exactly  $n$ ' meaning, is the output of the two. However, there are also sentences in which the 'at most  $n$ ' meaning is dominant, as in (10).

- (10) She can miss the target three times without dropping out of the competition.

According to some subsequent analyses, number terms are just semantically underdetermined: semantically, they are neither *at least n*, nor *at most n*, nor *exactly n* (see Carston 1998). But more recently, this analysis of number terms has been questioned. Examples such as (11) and (12) strongly suggest that the *exactly n* reading is not arrived at pragmatically but instead is the straightforward coded meaning.

(11) I have at least three pounds in my pocket.

(12) Three men carried the piano up the stairs.

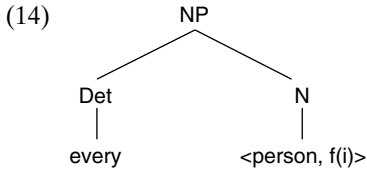
Qualifying the number term by ‘at least’ or ‘at most’ strongly suggests that the basic meaning is just ‘three’. Similarly, (12), where the reading is clearly collective (*three men together*), does not allow for entailments: three men carrying the piano together does not entail that two did. Neither does it mean that perhaps more than three did. So, perhaps the exactly (punctual) semantics of number terms is correct after all (see e. g. Koenig 1993; Geurts 1998; Bultinck 2005; Jaszczolt 2005; Horn 1992, 2006). While experimental evidence is still inconclusive, it suggests that number terms behave very differently from scalar terms. It also shows that the ‘exactly *n*’ interpretation is much more psychologically salient (see e.g. Musolino 2004). The example of number terms shows that semantic underdetermination has to be approached with caution: the correct analysis of the particular expression type need not exhibit it just because from the theoretical point of view it seems to apply.

Once a wide variety of pragmatic additions was allowed in semantic representation, it had to be decided what really matters for the boundary: (i) the distinction between the (by now eclectic, semantico-pragmatic) semantic representation and the separate senses that this meaning gives rise to, or (ii) the distinction between the logical form as the ‘pure’ output of syntax and the ‘pure’ what is physically uttered on the one hand, and the whole array of implicatures on the other, irrespective of whether they contribute to the semantic representation or to some additional senses this primary meaning of the utterance gives rise to. In the following sections I present and assess various views on this matter.

There have also been other attempts to redraw the semantics/pragmatic boundary that can be subsumed under broadly understood contextualism in that they propose various solutions on how to incorporate contextual information into the semantic representation. The most influential ones are perhaps the unarticulated constituents view and Kaplan’s two-dimensional theory. The unarticulated constituents view is an attempt to explain various pragmatic additions to the semantic structure as elements of the unarticulated syntactic structure. On this account, pragmatic enrichment has a syntactic provenance and amounts to filling in slots in the logical form: “[m]uch syntactic structure is unpronounced, but no less real for being unpronounced” (Stanley 2002: 152; see also Stanley & Szabó 2000; King & Stanley 2005). For example, according to Stanley & Szabó, sentence (13) obtains an analysis as in (14), where the node *N* contains information about the contextual restriction of the domain of the universal quantifier ‘every’:  $f(i)$ , where  $f$  stands for a function mapping objects onto quantifier domains and  $i$  for an object provided by the context. As a result, the enriched meaning in (15) is accounted for by means of the syntactic analysis because ‘everybody’ is taken to refer to a restricted domain of, say, invited guests (see Stanley & Szabó 2000 for other possible syntactic analyses using unarticulated constituents and their limitations as compared with that in (14)).



(13) Everybody came to the party.



(15) Every invited guest came to the party.

In a similar vein, Chierchia (e.g. 2004) attempts to derive scalar implicatures such as for example from *some* to ‘not all’ from the logical form of a sentence. He says that grammar (on his understanding: syntax and semantics) allows for two interpretive procedures which give two kinds of values to expressions: a plain value, say, ‘some’, and a strengthened, ‘scalar’ value, say, ‘some but not all’. The latter value is normally selected by the system but is defeasible by context. As he says, “some of the Grice-inspired pragmatics is probably part of the computational system of grammar” (Chierchia 2004: 59). Reversing the monotonicity removes the implicatures. So, downward entailing contexts (such as embedding a sentence *p* under ‘I doubt that . . .’) remove any scalar implicatures of *p* and add new, indirect ones through a process which is governed by a general rule that implicatures must lead to strengthening.

Another view which is represented in current research is a rather less radical Montaguean formal pragmatics as elaborated by Kaplan (1978, 1989) in his two-dimensional semantics. Context is represented there by an index with respect to which sentences are interpreted. The interpretation provides contents or, as we could say, propositions (functions from possible worlds to truth values). The scope of pragmatic information contained in the index is, however, rather limited as compared with the free pragmatic modulation of radical contextualism (see e.g. Stalnaker 1999, but also Predelli 2005a, b, 2006 for a defence). Kaplan’s semantics is two-dimensional in that he distinguishes content from character, where the latter is a way of getting from the context to the content. To repeat, content in turn yields a truth value relative to a possible world (‘circumstances of evaluation’). Or, as Chalmers (2006: 59) puts it,

“The core idea of two-dimensional semantics is that there are two different ways in which the extension of an expression depends on possible states of the world. First, the actual extension of an expression depends on the character of the actual world in which an expression is uttered. Second, the counterfactual extension of an expression depends on the character of the counterfactual world in which the expression is evaluated. Corresponding to these two sorts of dependence, expressions correspondingly have two sorts of intensions, associating possible states of the world with extensions in different ways. On the two-dimensional framework, these two intensions can be seen as capturing two dimensions of meaning.”

There are different varieties of two-dimensional semantics. Kaplan’s (1978, 1989) character and content have their equivalents, albeit exhibiting important conceptual differences, in Stalnaker’s (1978) diagonal proposition and proposition expressed, Chalmers’ (1996) primary and secondary intension, and several other pairs of constructs (see Chalmers

2006: 62). It is still a matter of debate as to whether this approach can handle a wide range of contextual enrichment. While its utility for indexical terms is unquestionable, the scope of application is still a matter of vivid debates (see also e. g. Stalnaker 1999; Chalmers 2006; Predelli 2005a, b, 2006; Balaguer 2005).

In what follows I focus on approaches to the semantics/pragmatics interface which developed more elaborate, albeit less formal and arguably less formalizable, accounts of the role of various types of pragmatic enrichment for semantic analysis.

## 4. Delimiting implicatures

### 4.1. Intentions and intuitive truth conditions

Post-Griceans held different views on how to classify the output of syntactic processing, the pragmatic additions to the semantic representations, and the implicatures proper, understood as separate thoughts implied by the utterance. While for some the main boundary lies between the pragmatically enriched semantic representation and implicatures proper, for others the component of the pragmatic enrichments to the semantic representation is sufficiently distinct in its provenance as compared with the logical form to call for a separate, middle level of meaning. Yet for others all pragmatic aspects of meaning, be it developments of what is said or separate thoughts, should be grouped together as the traditional Gricean category of the implicature. Different views that are in the forefront of the current discussions are presented in the following sub-sections. But before we attend to the differences, it has to be emphasised that there is a lot that unites these views. They are all Gricean in spirit in that they all recognise the important role of intentions in the analysis of meaning. The unit of meaning is an utterance ( $\text{meaning}_{\text{NN}}$ ) rather than a sentence, and the route to the recovery of the speaker's meaning is the recognition of the speaker's intentions. Intentions have received a lot of attention in pragmatic literature. For Bach & Harnish (1979), an intention to communicate certain content is fulfilled when it is recognised by the addressee (see also Bach 1987a, b, 1999; Jaszczolt 1999, Haugh & Jaszczolt 2012). They call it an *illocutionary informative intention* and say that it comes with a so-called *communicative presumption*: when the speaker produces an utterance, the hearer assumes that the speaker produced it with some intention. The next common characteristic is the foregrounding of the intuitive truth conditions. With the growth of Gricean pragmatics, and undoubtedly, in virtue of the general tendency in philosophy of language since the late 1950s to talk about speaker's meaning rather than sentence meaning, the balance shifted from the truth conditions of sentences to those of utterances. Although (16) and (16a) 'mean the same' in virtue of the equivalence of  $p \wedge q$  and  $q \wedge p$ , their utterances normally do not.

(16) They earned a lot of money and went to live in London.

(16a) They went to live in London and earned a lot of money.

What became foregrounded instead was the fact that the addressee would be likely to deny (16a) arguing as in (17).

(17) It's not true that they earned a lot of money and went to live in London; they moved to London first and got good jobs there.

The truth conditions of the pragmatically enriched proposition (*p and then q*), that is the proposition intuitively understood as the one meant by the speaker, became the object of analysis in post-Gricean contextualism.

## 4.2. The explicit/implicit boundary

The pressing problem became to delimit the primary, explicit content of the utterance. To repeat, for some contextualists, what is said includes all sorts of developments of the semantic content of the uttered proposition. Sperber & Wilson (1986) and Carston (1988, 1998) dubbed such a development of the utterance's logical form an *explicature*. This unit of 'explicit' content is particularly useful when a sentence seems to convey an obvious truth, as in (18), or a blatant falsehood, as in (19). The enriched proposition, the explicature, is then the intended meaning of the speaker's—as in (18a) and (19a).

(18) I have eaten.

(19) Everybody was there.

(18a) The speaker has already eaten lunch on that day.

(19a) Everybody who was invited was there.

Explicatures are also helpful when a sentence uttered does not convey a complete proposition, as in (20). Pragmatic processing can then result in a proposition that is assumed by the addressee to have been intended by the speaker.

(20) Tom is not experienced enough.

(20a) Tom is not experienced enough to lead a Himalayan expedition.

It has to be remembered, however, that while Grice's programme was to account for *speaker's* meaning, relevance theorists give an account of utterance *interpretation* (see Saul 2002 and Horn 2004: 22). Explicatures were said to be created by means of pragmatic processes that do not differ from those producing separate, implicit meanings. In other words, both the pragmatic developments of the logical form of the sentence and the truly implicated meanings are arrived at through the same kind of pragmatic inference (but see Recanati 2004, 2007, 2010; Carston 2007).

The problem is that, in principle, such developments of the logical form of the sentence could proceed *ad infinitum*: we need a demarcation line somewhere in order to understand how and when they stop. Carston (1988: 169) suggests that the enrichments stop as soon as optimal relevance is achieved, where by relevance she means the cognitive and communicative principle proposed by Sperber & Wilson (1986, 1995), according to which the effort invested by the addressee in the processing of the speaker's utterance is offset by the so-called 'cognitive effect': gained information or any other improvement to the addressee's information state. The cognitive principle of relevance says that 'Human cognition tends to be geared to the maximization of relevance' (Sperber & Wilson 1995: 260), while the communicative counterpart says that 'Every act of ostensive communication communicates a presumption of its own optimal relevance' (Sperber & Wilson 1986: 158). To bring the idea down to common-sense intuitions, it says that we stop interpreting what

the speaker said once we have reached the satisfactory interpretation. But it does not say more than this intuitive claim: it offers no way of measuring or predicting the explicature in particular cases.

What we also need is a criterion that would tell us which kind of output of pragmatic inference qualifies as part of the explicature and which has to be relegated to implicatures proper. Carston proposes such a criterion. She says that implicatures are *functionally independent* from the explicature. This means that implicatures, if we wanted to spell them out, would have to have their own logical forms which are independent from the logical form of the sentence. They function as independent premises in reasoning. For example, in (18) repeated below, (18a) is the explicature, while (18b) is a possible implicature.

(18) I have eaten.

(18a) The speaker has already eaten lunch on that day.

(18b) The speaker is not hungry.

By the criterion of functional independence, sentence (1b) repeated below is the explicature of (1).

(1b) The janitor left the door open *and as a result* the prisoner escaped.

(1) The janitor left the door open and the prisoner escaped.

However, functional independence is not a sufficiently precise criterion. When we try to formulate it in terms of entailment, problems arise. The criterion that the implicature must not entail the explicature works for most examples: (1b) entails (1) and hence it would not be plausible to assume that the interlocutors store both propositions in the mind; the propositions are not functionally independent. But entailment does not work when construed in the other direction: it is perfectly normal for an explicature to entail an implicature, as in (21). B's answer entails and implicates that B bought some flowers.

(21) A: Did you buy flowers for Mary's birthday?

B: I bought some roses.

On some scenarios, it is also problematic to take functional independence to mean the relation of entailment even when it proceeds from implicature to explicature (see Recanati 1989 and Carston 1998 for response; see also Carston 2001).

Now, as can be seen from examples (18) and (19), the sentence uttered by the speaker can be perfectly complete, have a complete logical form, and yet pragmatic inference can take place. According to some pragmaticists then, pragmatic enrichment can be free, not syntactically controlled (see e. g. Bach 2000; Carston 1988, 2002; Recanati 1989, 1993, 1994, 2001, 2002a, 2004, 2010; Levinson 2000, Jaszczolt 2005, 2010b). This argument is often used against the unarticulated constituents view discussed in section 3. As Recanati (2002a) says, there are unarticulated constituents that do not pertain to any slots in the logical form: they are aspects of the explicit content that are entirely pragmatic in their provenance. Whether this stance necessitates a contextualist orientation will be discussed in sections 4.4 and 5.

### 4.3. The pragmatic aspects of *what is said*

The criteria for distinguishing the explicit content from implicatures became an important preoccupation of some post-Griceans in the late 1980s. Recanati (1989: 98) agreed with relevance theorists on the scope of the explicit content, called by him *what is said*—not to be confused with Grice’s rather minimal ‘what is said’. He distinguishes pragmatic processes of filling in slots in the logical form as in the case of the assignment of reference to personal pronouns (*saturation*) such as ‘I’ in (18), and a free, not grammatically controlled process of *strengthening* (or sense modulation, Recanati 2004, 2005, 2010), exemplified in (1), (18)–(20) above. Strengthening, or modulation, is a ‘top-down’ process: it is independent of the constitution of the logical form, where the latter is the output of the processing of grammar. He admits that postulating slots in the logical form is theoretically possible but encounters a quandary: in order to postulate the necessary slots to be filled we already have to know what is said. So, we have circularity in the explanation.

Having objected to compulsory syntactic slots as well as to some aspects of the functional independence principle, Recanati (1989) proposes his own criteria for delimiting what is said. What is said is to be specified intuitively and corresponds to ‘pre-theoretic intuitions’, as his Availability Principle states:

“In deciding whether a pragmatically determined aspect of utterance meaning is part of what is said, that is, in making a decision concerning what is said, we should always try to preserve our pre-theoretic intuitions on the matter.”

Recanati (1989: 106).

This principle, being rather general, is adopted in conjunction with the Scope Principle, adapted from Cohen (1971) who, *nota bene*, used it to the opposite effect; to argue for the rich *lexical* meaning of sentential connectives:

“A pragmatically determined aspect of meaning is part of what is said (and, therefore, not a conversational implicature) if—and, perhaps, only if—it falls within the scope of logical operators such as negation and conditionals.”

Recanati (1989: 114).

So, to invoke Cohen’s own example, in (22) below, the temporal ‘and then’ meaning of conjunction *and* in English is part of what is said because in the scope of implication (*if... then*) it is necessary in order to make sense of the assertion.

- (22) If the old king died of a heart attack and a republic was declared Sam will be happy, but if a republic was declared and the old king died of a heart attack Sam will be unhappy.

Formally, the first of the contrasted conjuncts can be represented as in (22a) and the second as in (22b). Since in our metalanguage of propositional logic  $(p \wedge q) \leftrightarrow (q \wedge p)$ , the contrast in *r* and  $\neg r$  only makes sense when we enrich  $\wedge$  to mean ‘and then’.

(22a)  $(p \wedge q) \rightarrow r$

(22b)  $(q \wedge p) \rightarrow \neg r$

Another interesting aspect of Recanati's solution is his claim that what is said is the smallest constituent available consciously. In other words, what is said is arrived at through a pragmatic process which is not consciously available. It is sub-personal, automatic, and it cannot be properly called 'inferential': "communication is as direct as perception" (Recanati 2002b: 109). He dubs this process a primary pragmatic process, to distinguish it from a secondary type of inference proper that produces implicatures (see e.g. Recanati 2004: 38–44, 2007). All in all, the truth conditions of the utterance depend on the interplay of a variety of sources of information. As a result, we obtain what is sometimes dubbed Truth-Conditional Pragmatics (Recanati 2002a).

Recanati advocates a rather strong view of pragmatic enrichment (modulation). He claims that such contextual modulation is *always* present: "there is no level of meaning which is both (i) propositional (truth-evaluable) and (ii) minimalist, that is, unaffected by top-down factors" (2004: 90). This view is thus a strong variety of contextualism and it is currently the subject of heated debates with those who would rather keep semantics simple, 'minimal', close to what is physically uttered.

#### 4.4. The middle level: An implicature

Kent Bach (1994, 2001) recognises the difficulty with subsuming the output of pragmatic inference under the label 'explicit' content and offers a more intuitively acceptable solution: there is what is said and what is implicated, but there are also parts of the content that are *implicit in what is said* and yet are not implicatures proper. He acknowledges that people often speak loosely, non-literally, and that fact is not a deficiency of human communication but rather a positive trait: it is more efficient to do so and to rely on the addressee to recover the missing aspects. For example, when a mother reacts to a child's crying about a cut finger in saying (23), she uses the sentence non-literally:

(23) You are not going to die, Peter.

(from Bach 1994: 267). While the content of the sentence (called the *minimal proposition*) is that Peter is going to live forever, the implicit constituents inferred by him from his mother's utterance ensure that the message is something to the effect of (23a).

(23a) You are not going to die from this cut, Peter.

So, what is meant by the speaker is the expansions of such a minimal proposition.

Similarly, sentences that are semantically incomplete in that they do not have clear truth conditions such as (20) repeated below, require implicit constituents of what is said.

(20) Tom is not experienced enough.

Sentence (20), Bach argues, does not express a proposition; it only expresses a *propositional radical* which is in need of pragmatic completion in order to produce the intended meaning, such as, for example, (20a).

(20a) Tom is not experienced enough to lead a Himalayan expedition.

In short, we have two similar phenomena here: sentence non-literality, where the minimal proposition requires expansion, or, as Bach calls it ‘fleshing out’, and semantic underdetermination, where the propositional radical requires completion, or ‘filling in’ (see Bach 1994: 269). Such expansions and completions constitute a ‘middle ground’ between what is said and what is implicated: they do not belong to what is said and they are not implicatures either. There is no clear boundary to discern. A proposition enriched through expansion and completion he calls an implicature. For Bach (2004, 2006, 2007), although there is a middle ground between what is said and what is implicated, this does not mean that the boundary between semantics and pragmatics is blurred: semantic properties belong to sentences, and pragmatic to acts of uttering them. “Sentences have the properties they have independently of anybody’s act of uttering them. Speakers’ intentions do not endow them with new semantic properties . . .” (Bach 2004: 27). Here Bach takes issue with the contextualist idea that semantics must produce truth conditions and when it does not produce them as in (20) or produces ‘wrong ones’ as in (18), context ‘intrudes’ into the domain of semantics in the form of pragmatic inference and supplies missing information. So, he takes issue with relevance-theoretic and Recanati’s positions. For Bach, the semantic content of sentences and the intended content of utterances have to be kept apart. Sentences uttered normally underdetermine what the speaker means but there is nothing extraordinary about this fact: semantics ends with the sentence meaning, even if it is counterintuitive or incomplete, and pragmatics begins with utterance meaning. In this perspective, the middle level of implicatures is not the middle level between semantics and pragmatics: it is fully pragmatic, it is just not the level of implicatures proper.

This dissociation of semantics from truth conditions has important consequences for the current minimalism-contextualism debate to which I turn in section 5. At this point however it is important to add that the implicature view is gaining popularity in the latest discussions on the boundary dispute. Horn (2004: 22) stresses its compatibility with other neo-Gricean approaches, and most notably with the observation that Grice’s account concerned speaker’s meaning, not utterance interpretation (Saul 2002). In Horn (2006: 24), he adopts Bach’s traditional semantics/pragmatics distinction, as well as his notion of implicature. Similarly, Atlas (2005b, 2006b) argues for keeping semantics and truth conditions apart. The conclusion that must be drawn from these recent developments is this. After three decades of the emotions stirred up by semantic underdetermination, it is now being emphasized that there is nothing so very interesting in the fact that semantic content underdetermines the speaker’s intended meaning. The fault lies in the repeated attempts to use truth conditions as theoretical framework and argue from this that, since the analysis is truth-conditional, it has to be semantic and semantics has to be construed as allowing for the intrusion of context and the result of pragmatic inference. For Bach and his sympathisers, this is an obvious *non sequitur*.

#### 4.5. Presumptive meanings: Between semantics and pragmatics

Bach’s tri-partite distinction is not the only way to cut the pie. Levinson (1995, 2000) proposes a level of meaning that lies between semantics and pragmatics while retaining the contextualist assumptions. Unlike Bach, he allows for the contribution of pragmatic inference to the propositional representation, and unlike Bach, he retains the dominant role of truth-conditional analysis of meaning in semantics. But unlike relevance theorists, he does not emphasise the importance of such an expanded and embellished representation of

meaning. For him, there is a sub-category of such embellishments that is neither semantic nor pragmatic. These are presumed, default interpretations, arrived at by virtue of the repeated scenarios from the past, knowledge of language and the world, and other salient information, processed with the aid of some general principles of human reasoning. These general principles correspond loosely to Grice's generalized conversational implicatures and hence Levinson's theory of presumed ('presumptive') meanings is also called a theory of generalized conversational implicature (Levinson 2000; for other default-based approaches see Asher & Lascarides 2003 and article 39 (Zeevat) *Rhetorical relations*; Blutner & Zeevat 2004; and an overview in Jaszczolt 2006).

According to Levinson, there are three levels of meaning: sentence meaning, utterance-type meaning, and utterance-token meaning. Default interpretations, and among them most notably GCIs, belong to the middle level of utterance-type meaning. Such middle-level meanings are neither properly semantic nor properly pragmatic. Presumptive meanings are dubbed GCIs but they have one important feature that distinguishes them from Grice's GCIs. For Grice, pragmatic inference operated post-propositionally. The output of syntactic processing had to be completed and had to deliver a logical form of the sentence before the speaker's utterances were inferred on the basis of the maxims of conversation. Levinson's GCIs are 'local': they arise at the point at which they are triggered. For example, the word 'some', even when it is the first word of an utterance, gives rise to the default presumption 'not all', unless there are contextual clues that prevent it from arising. Naturally, the presumptive meaning can be cancelled at any later stage as the utterance continues.

Presumed meanings are very useful for human communication. Levinson observes that human speech is transmitted quite slowly: phonetic representations are encoded as acoustic signals with a rate of approximately 7 syllables per second. This is very significantly slower than the rate at which standard personal computers work. On the other hand, humans' mental capacity for speech production and speech comprehension is much higher. He calls this situation a 'bottleneck in the speed of human communication' (Levinson 2000: 28) and presents it as a motivation for communicating through implicatures: while producing speech slows communication down as compared to what it could have been given the mental architecture, inference can help speed it up. As he says, "inference is cheap, articulation expensive, and thus the design requirements are for a system that maximizes inference" (Levinson 2000: 29).

Pragmatic inference proceeds according to three general heuristics which constitute one of three main attempts at a revision of the Gricean maxims of conversations, along with Horn's Q and R principles and Sperber & Wilson's principle of relevance. On the most general formulation, they say the following (from Levinson 2000: 35–39):

Q-heuristic: 'What isn't said isn't.'

This heuristic is responsible for scalar implicatures: if the speaker utters (24), a Q-implicature as in (24a) is normally produced.

(24) Some people have a sense of humour.

(24a) Not all people have a sense of humour.

I-heuristic: 'What is expressed simply is stereotypically exemplified.'



For example, the phrase ‘three men’ in (25) is presumed to give rise to the collective interpretation (‘together’) by force of the I-heuristic.

(25) Three men pushed a lorry out of a snowdrift.

M-heuristic: ‘What’s said in an abnormal way isn’t normal.’

This heuristic works as a complement to the I-heuristic in that while the I-heuristic takes the addressee to the standard, stereotypical interpretation, the M-heuristic captures the fact that when the speaker used a marked rather than an ordinary expression, the intended interpretation is also marked. For example, in (26), the use of ‘it is not impossible that ...’ construction rather than the standard ‘it is possible’ signals that the probability is low: lower than in the case of the alternative expression.

(26) It is not impossible that she will win the piano competition.

To sum up, presumptive meanings are default interpretations in the sense of being context-free. As such, they are also ‘cheap’ in that they require less effort to process than consulting the particular context would. But it seems that they also demand some effort in that, if they are produced on-line, locally, as soon as the triggering word or construction arises, they are likely often to be cancelled.

#### 4.6. Radical contextualism of Default Semantics

Default Semantics (Jaszczolt 2005, 2009, 2010b) goes further than the contextualist accounts discussed earlier in that the explicit (called: *primary*) meaning of an utterance does not have to bear any structural resemblance to the logical form of the sentence. It need not constitute a development of the logical form of the sentence or, in other words, need not obey the *syntactic constraint*. All sources of information about meaning identified there are treated on a par: the output of any of them can override the output of any other. For example, the most salient meaning of B’s response in (2) repeated below is something like (2Ba).

- (2) A: Smith doesn’t seem to have a girlfriend these days.  
B: He has been paying a lot of visits to New York lately.

(2Ba) Smith may have a girlfriend.

On the Default-Semantics construal, (2Ba) is the primary content of B’s utterance and it is this content that enters into the compositional semantic representation (called *merger representation*) of (2B). So, semantics is understood here as the theory that provides the intuitive truth conditions of utterances, but these truth conditions are even ‘more intuitive’, so to speak, than those of truth-conditional pragmatics discussed above. We drop the restriction that one of the sources of speaker’s meaning, namely the logical form of the sentence, has priority over the others and that the contribution of inference and presumed, salient enrichments is to be limited to embellishments of this logical form. This view does not come free though. It requires a substantial rethinking of the principle of

compositionality of meaning. Recanati (2004) already observed that, with intuitive truth conditions of truth-conditional pragmatics, we need a more ‘pragmatic’ approach to compositionality: composition of meaning will have to proceed not on the level of the logical form of the sentence but rather on the level of the semantic representation of the intended proposition. In the above spirit, merger representation is conceived of as the result of an interaction of various sources of meaning identified in the theory. What a semantic theory needs is an algorithm to show how all the sources of information about meaning interact. Another (related) consequence of extending what is said in this way is that we need a new criterion for distinguishing what is said (and a merger representation) from implicatures proper. In Default Semantics, implicatures are produced by two out of the four sources that also build merger representations: conscious pragmatic inference and socio-cultural defaults. The source of information and the process through which the implicature arises cannot differentiate it from the explicit content. In this Default Semantics is closer in spirit to relevance theory than to Recanati’s truth-conditional pragmatics. To repeat, in relevance theory, the same processes are responsible for the explicatures and the implicatures, while in truth-conditional pragmatics, all modulation is automatic, unconscious (i.e. *subdoxastic*), while the processing of implicatures is conscious and more effortful.

In the following section I attend to some differences in the contextualist views and to the opposing view according to which no contextual information is allowed in the semantics (semantic minimalism). This overview will allow us to better assess and compare different stances discussed here.

## 5. Minimalism, contextualism, and beyond

In the preceding sections I discussed the view that every instance of utterance interpretation involves ‘top-down’ processing, called contextualism. I also mentioned briefly one non-contextualist view while introducing Bach’s notion of implicature. In more general terms, contextualism is a position in the philosophy of language that a sentence expresses fully determined content only in the context of a speech act. This view did not arise in a void. It is a development of the position held in the 1950s by ordinary language philosophers such as later Wittgenstein, J.L. Austin, and subsequently J. Searle. Contextualism has now become one of the leading orientations in the study of meaning. To repeat, on the assumption that we want to retain truth conditions in semantic theory, we have to admit context into that theory. And once it is admitted, there is one step from there to saying that talk about meaning only makes sense when the sentence is immersed in the context in which it was uttered. This view holds equally of the Gricean developments and Montaguean approaches such as two-dimensional semantics introduced in section 3 which, to repeat, are also contextualist in a broad sense.

Contextualism is best seen as a reaction to the traditional view that sentences themselves can be ascribed truth conditions. The latter view we shall call, after Recanati (2004, 2005), *literalism*. Examples of semantic underdetermination and sentence non-literality discussed in section 4.4 testify to the deficiencies of this view, and so does the requirement of psychological reality of the object of study (see e. g. Clapp’s (2007) argument against minimal semantics). Now, according to Recanati’s (2005) historical overview, literalism has gone through a ‘gradual weakening’: it has become less and less radical, until it gave rise to stronger and stronger forms of contextualism.

In the current debates on the semantics/pragmatics boundary, only the weakest form of literalism, called *minimalism*, is a real contender. Minimalism itself has two versions. One says that truth-conditional content is indeed permeated with the result of pragmatic inference but this inference is constrained by the grammar: there are slots in the syntactic representation that are to be filled in. This is how utterance meaning is kept very close to the meaning of the sentence type. The main representative of this view is Peter Stanley whose views were briefly introduced in section 3. The other version, dubbed by Recanati ‘the syncretic view’, holds that there is a minimal semantic content, but on the other hand there is also intuitive utterance content. Since the latter can be freely modulated to reflect the speaker’s intended meaning as assessed by the addressee, the first can be kept even ‘more minimal’: slots provided by deictic and other context-dependent expressions have to be filled but there is no temptation to postulate any other contentious slots just in order to capture the intuitive meaning of the utterance: sentence-type meaning and speaker’s meaning can be safely kept apart. A syncretist, Emma Borg (2004), claims in her theory of *Minimal Semantics* that semantic theory is unaffected by any intrusion of aspects of meaning that are not present in the sentence itself. Semantic theory is a theory of ‘literal linguistic meaning’ and its task is only to provide ‘pure’ sentence meaning. She assumes that the understanding of sentence meaning is modular and should be kept apart from the understanding of speaker’s intentions and from any non-deductive inference. Sentences have truth conditions even if it would not be possible to tell what situation would make the sentence true. There is no need for the intrusion of the contextual enrichment. Truth conditions are not conditions of verification as contextualists have it. A similar orientation is presented in Cappelen & Lepore’s (2005) *Insensitive Semantics*: a truth condition can be produced for a sentence even if we are not in a position to discern possible situations that would verify the sentence. So, on this account, Tarski’s T-sentence (27) produces a truth condition just in virtue of having a form of a T-sentence (see Bach 2006 for criticism).

(27) ‘Tom is not strong enough’ is true if and only if Tom is not strong enough.

Cappelen & Lepore claim that it is a mistake to assume that a semantic theory should account for speakers’ intuitions about the content of the utterance, i.e. about the speaker’s meaning. They argue that there is no strong connection between the content of speech acts and the content of sentences and that they should be kept apart. By the same reasoning, semantics and pragmatics should be kept apart.

The boundary dispute would be simple indeed to solve if semantics and pragmatics could be delimited in the way Cappelen & Lepore suggest. However, they seem to cut off parts of each discipline in order to keep the boundary clear: composing sentence meaning is not a simple enterprise of combining clear-cut word meanings in the way provided by the grammar. Neither is pragmatics merely a description of what people say. Post-Gricean pragmaticists aim at generalizations about the speaker’s meaning that stem out of the principles of rational conversational behaviour. Most of them are also interested in the psychology of utterance interpretation and in the application of such principles during this process. So, even leaving aside the debate concerning the unit of which truth conditions should be predicated, it is evident that one must resort to unwarranted simplifications in order to force semantics and pragmatics into separate moulds.

Semantic minimalism gave rise to ample criticism from the contextualists. As we know from the earlier discussion of Recanati’s version of contextualism, the main objection to

the first version of minimalism is that there is no evidence for the kinds of syntactic slots that have to be postulated in order to maintain the view that syntactic form alone accounts for the intuitive truth conditions. The main objection to the second version of minimalism, the syncretic view, is the lack of practical utility of a minimal proposition. The syncretists who opt for verification-free truth conditions are also attacked on the count of redefining truth conditions:

“This move strikes me as an unacceptable weakening of the notion of truth-condition. The central idea of truth-conditional semantics (. . .) is the idea that, via truth, we connect words and the world. If we know the truth-conditions of a sentence, we know *which state of affairs must hold for the sentence to be true*.”

Recanati (2005: 185).

The truth conditions of syncretists do not have to fulfil this requirement of ‘connecting words with the world’: they only provide a formal procedure for a theory of meaning. The debate is at present in the focus of attention of most post-Griceans and is likely to occupy us for some time. Suffice it to say that objections to weakening truth conditions should not be taken lightly.

There is another view that we should consider in that it shares some assumptions with the above versions of minimalism, while rejecting others. We have seen in section 4.4 that Kent Bach advocates a clear-cut boundary between the tasks of semantics and those of pragmatics. He does so by claiming that the semantic analysis of a sentence need not result in a truth-conditional content: not every declarative sentence expresses a proposition, even if it is free from indexical expressions. Instead, sentences can just express propositional radicals. Bach (2006) calls this view Radical Semantic Minimalism. This view seems to have been increasing in popularity recently (see e. g. Horn 2006; Atlas 2005b). But, as we have seen, other minimalists do not share this view of the dissociation of semantics from truth conditions, so it has to be distinguished as a separate variety, only tentatively subsumed under the umbrella label of ‘minimalism’.

Returning to contextualism, we can go even further in the direction of context-dependence. We can assume that words don’t have determined, coded sense. Instead, they act like pointers to particular senses in particular contexts. Truth conditions are then assigned to utterances that owe nothing to sentence-type meaning, but neither do they owe anything to lexical meanings. Neither of the two exists. Words have only a so-called *semantic potential*. All they have is particular uses. This view is thus clearly reminiscent of later Wittgenstein’s view that meaning is language use and thus of the theoretical orientation of ordinary language philosophy. Although this view is not currently in the forefront of theorizing, it is the next logical step from the contextualist stance represented in truth-conditional pragmatics and other approaches that allow top-down pragmatic enrichment which is not dictated by grammar.

## 6. Summary: The significance of the boundary disputes

The current state of the debate concerning the interface between semantics and pragmatics is to a large extent the upshot of the revolutionary period in the study of meaning known as radical pragmatics, aided by the views of ordinary language philosophers. Two relatively separate disciplines, the formal study of sentence meaning and the

relatively informal study of the properties of speech acts became more and more intertwined as a result of the adoption of semantic underdetermination and the admittance of pragmatic inference about the speaker's intentions, as well as some other context-bound information, into the semantic content. This facilitated the shift of the centre of attention from the sentence to the utterance. However, the direction of change has not been steady throughout the past three decades. There are attempts to keep semantics and pragmatics apart either through denying that semantics has to provide propositions and hence truth-conditional content, or through keeping the objectives of semantics and pragmatics apart and stressing the theoretical utility of the sentence's truth conditions, like minimalists of the syncretic flavour do. At present the dominant orientations seem to be various forms of contextualism. This state of affairs is undoubtedly aided by the overall desideratum to stay faithful to speakers' intuitions about meaning and to the view that semantic theory should not ignore these intuitions. The desideratum to account for *all* kinds of enrichment by postulating one type of mechanism is also an important consideration. Whether contextualism will retain its power, succumb to minimalism, or evolve into a radical form of occasion-meaning of meaning eliminativism remains to be seen.

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Katarzyna M. Jaszczolt, Cambridge (United Kingdom)

## 89. Context dependence

1. Contexts
2. Trivialities
3. Characters
4. Diagonals
5. Extensionality
6. Attitude reports
7. Monsters
8. Parameterization
9. References

### Abstract

*Linguistic expressions frequently make reference to the situation in which they are uttered. In fact, there are expressions whose whole point of use is to relate to their context of utterance. It is such expressions that this article is primarily about. However, rather than presenting the richness of pertinent phenomena (cf. Anderson & Keenan 1985), it concentrates on the theoretical tools provided by the (standard) two-dimensional analysis of context dependence, essentially originating with Kaplan (1989a) – with a little help from Stalnaker (1978) and Lewis (1979a, 1980), and various predecessors including Kamp (1971) and Vlach (1973). The current article overlaps in content with the account in Zimmermann (1991), which is however much broader (and at times deeper).*

### 1. Contexts

Whether spoken, signed, written, telegraphed – whenever language is used, an utterance is produced, under circumstances to which we will henceforth refer as [utterance] *contexts*. It is a characteristic feature of certain expressions – words, phrases, constructions,

features, etc. – that they directly relate to the very context in which they are uttered. Personal pronouns are cases in point. Given an utterance context  $c$ , the first-person pronoun  $I$  refers to whoever produced the utterance –  $\text{SPEAKER}(c)$  for short. We thus have:

$$(1) \quad /I/c = \text{SPEAKER}(c),$$

where  $/A/c$  is the referent of a given (referential) expression  $A$  in a given utterance context  $c$ . It should be noted that the equation (1) is *schematic* in that it applies to any context  $c$ . Hence  $\text{SPEAKER}$  is a function assigning persons to utterance contexts. In fact, this particular function may be thought of as a *communicative rôle*, and (1) as saying that the pronoun  $I$  expresses that rôle in that it always, i.e. in any utterance context, refers to the person playing it. Utterance contexts may in turn be characterized as those situations in which someone plays the rôle expressed by  $I$ , i.e. those situations for which  $\text{SPEAKER}$  is defined.

In a similar vein, the (singular) pronoun  $you$  can be seen to express a communicative rôle in that it is used to refer to the person addressed in a given context  $c$ :

$$(2) \quad /you_{sg}/c = \text{ADDRESSEE}(c)$$

Traditionally, expressions of communicative rôles are categorized as *person deixis*. Languages not only differ as to the expressive means of person deixis, there is also ample variation as to the rôles expressed. Some languages (like French) distinguish more than one second person, depending on the social relationship between speaker and hearer, a phenomenon known as *social deixis*; another common distinction (to be found, e.g., in Tagalog) is between an inclusive and an exclusive first person plural, depending on whether the addressee does or does not belong to the group designated (and thus avoiding embarrassing misunderstandings caused by the indeterminacy of sentences like *We have been invited to the President's dinner*).

Communicative rôles are one example of *contextual parameters* that are commonly used to determine reference. Others include the *time* and *place* of utterance that help determining the referents of *today* (= the day on which the utterance is made); *tomorrow* (= the day after the utterance); *ago* (= before the utterance); and *here* (= the place of the utterance). Traditionally, such expressions are categorized as *temporal* and *local* deixis, respectively. Extending the above notation, one may capture them by means of functions assigning times and places to utterance contexts. Then the most basic deictic expressions directly denote the values of these functions:

$$(3) \quad \begin{array}{ll} \text{a.} & /now/c = \text{TIME}(c) \\ \text{b.} & /here/c = \text{PLACE}(c) \end{array}$$

In (3),  $\text{TIME}$  and  $\text{PLACE}$  are functions assigning to any (utterance) context its temporal and spatial location, respectively. These locations may be thought of as points, intervals or more complex constructions, depending on the semantic operations performed on them. And the denotations of other deictic expressions may be expressed in terms of these functions, or derived from them with the help of standard temporal and spatial measures:

- (4) a.  $/today/^c = \text{DAY}(\text{TIME}(c))$   
 b.  $/yesterday/^c = \text{DAY}(\text{TIME}(c) - 24\text{HRS})$   
 c.  $/ago/^c (X) = \text{TIME}(c) - X$

While the expressions mentioned so far make reference to various *objective* features of utterances, a number of locutions and constructions seem to bring more *subjective* contextual factors into play (cf. Borg 2004: 29ff.):

- (5) a. *This belongs to me.*  
 b. *He is an enemy.*  
 c. *John's book is expensive.*  
 d. *Everybody had a great time.*

*Demonstratives* like the subject of (5a) are frequently accompanied by a pointing gesture that helps the hearer to identify their referents. Arguably, it is this *demonstration* that determines the referent. Of course, as a bodily movement, the gesture itself is as objective a part of the context as the speaker or the addressee. However, the referent of the demonstrative is not the gesture but its target, which may not be so easily identified (*pace* von Kutschera 1975: 127); arguably and within certain limits, what this target is, is up to the person performing the gesture, i.e. the speaker. Hence, inasmuch as the demonstration determines the referent of the demonstrative, the speaker's intentions are decisive, and they make this kind of expression context-dependent in a more subjective way; see Kaplan (1978, 1989b: 582ff.), Wettstein (1984), Bach (1987: 182ff., 1992), and Reimer (1991, 1992a, 1992b) for more (and different views) on the subject. Despite this subjectivity, there is little doubt that the referent of *this* depends on the utterance context and could therefore be provided by a (speaker-dependent) parameter:

- (6)  $/this/^c = \text{DEMONSTRATUM}(\text{SPEAKER}(c))$

*Third person pronouns* and *implicit arguments* seem to work in a similar way, except that they are not normally accompanied by demonstrations; but their referents are usually taken to be supplied by the background. This is illustrated by (5b), which may be used to subsume a male person as among the foes of a community to which the speaker belongs – which person and which community depending on the circumstances in which the sentence is uttered. Again, it would seem that, within certain limits, the speaker has the last word about who precisely is referred to by these, presumably context-dependent, devices.

*Possessives* come in a variety of guises and with a variety of functions (cf. article 45 (Barker) *Possessives and relational nouns*). A common core is that they express a relation between the referents of two nominal expressions. In many cases the relation is supplied by a (relational) possessor noun like *surface* or *father*; in others it is some default like ownership or a part-whole relation. In typical utterances of (5c) the relevant relation would be reading, writing, or, per default, owning; but it is not hard to imagine situations in which it is the relation holding between *x* and *y* if *x* writes a term paper about *y*, etc. (Williams 1982: 283). It thus seems that the relation a possessive construction expresses is a matter of the circumstances in which it is used; hence possessives are candidates for context-dependent expressions. More precisely, it is the grammatical construction itself,

or the constellation in which possessor and possessee stand, that makes reference to context, possibly by introducing an un-pronounced functional morpheme that expresses a relation whose precise identity may depend on the utterance context (cf. Cresswell 1996: 50ff.). However, unlike the other contextual parameters mentioned above, the possessive relation cannot always be read off from the utterance context all that easily.

*Quantifiers* have domains that are understood as given by their linguistic and extra-linguistic environment. (5d), taken from von Stechow (1996: 28), is a case in point: if the sentence is used as an answer to *How was the party?*, its subject is likely to be construed as quantifying over the participants in the event mentioned in the question – as it would be if the sentence is uttered after said occasion, with happy people leaving the premises in the speaker's view. The phenomenon has aroused much interest among philosophers of language (e.g., Stanley & Williamson 1995; Reimer 1992c, 1998), not least because it is paralleled by definite descriptions whose quantificational status has been under dispute ever since Russell (1905). Again, it is hard to pin down objective features of contexts that would correspond to domains of quantifiers, which in general do not seem to be identifiable without knowing what the speaker has in mind. (But see Gauker 1997 for a skeptical view.)

What the phenomena illustrated in (5) have in common, and what distinguishes them from the classical cases of deixis, is their lack of objectivity: misunderstandings as to what was pointed to, who was left implicit, which possessive relation was alluded to, or who is quantified over arise rather easily – more easily than when it comes to determining who the speaker is, or where and when the utterance is made. If worse comes to worst, the speaker using a possessive would have to make herself clear. Of course, this does not make speakers Humpty-Dumpties, who arbitrarily decide what their words mean: what is intended and left implicit must be salient and accessible to the audience (Lewis 1979b: 348ff.); otherwise the speaker may be perceived as uncooperative, obscure, or even deranged. But within a certain range, it seems to be at the speaker's discretion to decide what the sentences in (5) are about. So there is something ultimately subjective in the way quantifier domains, possessive relations, implicit arguments, and the referents of 3rd person pronouns and demonstratives may depend on the context, which distinguishes them from the classical deictics in (1)–(4).

It is important to distinguish the subjective nature typical of the locutions in (5) from other sources of referential indeterminacy like vagueness and ambiguity. If a speaker uses the (complex) demonstrative *this mountain* to refer to the Eiger, this reference may be quite vague because the Eiger does not have clearly determined boundaries, and presumably the speaker does not (want to) impose or presuppose such boundaries by his utterance either. However, this vagueness has nothing to do with the subjective nature of the demonstrative; in fact, it also occurs with ordinary deictic expressions like *here* (cf. Klein 1978). The subjective nature of the demonstrative shows in the fact that the speaker may refer to the Eiger even though his gesture alone could be interpreted as relating to the Jungfrau, or even a heap of rocks. And these alternatives do not constitute different readings of the sentence; otherwise English syntax would have to supply indefinitely many underlying forms suiting the referential possibilities of arbitrary speakers in arbitrary environments – which is highly implausible, to say the least (cf. Stanley & Szabó 2000: 223, fn. 16). In sum, it is not vagueness or ambiguity that distinguishes the cases in (5) from the context-dependencies in (1)–(4) but the fact that matters of reference are – at least in part – determined by the speaker's intentions.

The subjectivity of certain context-dependent expressions and constructions must also be distinguished from uncertainties in the identification of the utterance situation. Thus, e.g., the hearer does not always know who is speaking or writing, anonymous phone calls and letters being cases in point; still, the hearer does know that the speaker is referring to him- or herself when using a first-person pronoun. Similarly, if a speaker uses local or temporal deixis, the hearer may be uncertain as to which places she is referring to because he might not know where or when the utterance was made; still she does know that the speaker was referring to the time and place of utterance. This kind of ignorance may even occur with speakers who are confused as to where they are, what time it is, and maybe even who they are. (The latter possibility appears hard to imagine, but see Perry (1977: 492f.) and Lewis (1979a: 520f.) for pertinent *gedanken-experiments*.) In all these cases though, the deictic expressions work as usual; it is only the communicants that lack knowledge of the utterance situation and are thus not in a position to fully exploit their meaning. The epistemic uncertainty about the utterance context may also concern the question which situation should count as the context in the first place. For sometimes an utterance is properly understood only under the pretense that it had been uttered under different circumstances. This is the case with certain recorded utterances in which the speaker pretends to be speaking at a later time (as in some TV shows), but also in more remote 'utterances' like first-person inscriptions on tombstones (Kratzer 1978: 17ff.), where the intended utterance context may well be an impossible scene! Note that in all such cases despite the pretense concerning the exact circumstances, the utterance as such is not taken to be fictional as it would be the case in a theatre performance. In sum, even with classical deictics like those in (1)–(4) matters of reference are not always as clear as we have been assuming; but the unclarity lies in the utterance situations at large, not in the meanings of these expressions.

What follows is a survey of one type of semantic analysis of context dependence. In it we will not bother to distinguish between various forms of context dependence. In fact, most of the time we will concentrate on the 1st person pronoun as given in (1), with occasional glimpses of other deictic expressions like those in (2)–(4). Still whatever will be said below is meant to apply, *mutatis mutandis*, to all context-dependent expressions alike, whether relating to objective features of the utterance situation or to more subjective, intentional aspects like those in (5), which may be thought to be interpreted by subjective, speaker-dependent contextual parameters as indicated in (6).

## 2. Trivialities

In the above examples (aspects of) the utterance situation played a crucial role in determining the reference of the expressions under scrutiny. However, this alone is not what makes these expressions deictic or context-dependent. In fact, to the extent that an expression can be said to refer to anything at all, what it refers to usually depends on the utterance situation. For instance, when used around the time of writing this contribution, the definite description *the German chancellor* refers to Angela Merkel, whereas some ten years ago its referent would have been Gerhard Schröder. Hence what the expression refers to may change with, and depends on, when it is or was uttered, and thus on the utterance situation. In this respect the definite *the German chancellor* is like the first-person pronoun *I*. To highlight the context-dependence of the referent of the description and bring out the analogy with the personal pronoun, we may use the same kind of notation:

- (1)  $/I/^c = \text{SPEAKER}(c)$   
 (7)  $/the\ German\ chancellor/^c = \text{GC}(c)$ ,

where GC is a function assigning to any utterance context  $c$  that person (if any) that happens to be the German chancellor at the utterance time,  $\text{TIME}(c)$ . To be sure, there is an obvious difference between (1) and (7): while the SPEAKER rôle is likely to be associated with the pronoun  $I$  for lexical reasons, the equation in (7) would have to be derived by general compositional mechanisms from the meanings of the lexical items that somehow conspire to express GC. This difference also accounts for the relatively idiosyncratic nature of the function GC as opposed to the arguably more natural and straightforward SPEAKER aspect of utterance contexts. These differences notwithstanding, it would still seem that both the reference of first person pronoun  $I$  and that of the definite description *the German chancellor* depend on the utterance context, and this common feature shows clearly in (1) and (7).

Given the rough analogy between (1) and (7), it is tempting to regard context dependence as a special case of the more general phenomenon of the situation dependence of reference. Yet although (1) and (7) will fall out of the standard approach to context dependence, these equations are deceptively simple: as it turns out, the two cases at hand differ fundamentally in the precise way reference depends on the utterance context. This can be seen by looking at *uninformative* statements like the following:

- (8) *No bachelor is married.*  
 (9) *The German chancellor is a politician.*  
 (10) *I am here.*

(8) is clearly trivial: being a bachelor means, among other things (like being a male person), never having married. Consequently, an utterance of (8) is likely to be construed in some non-literal sense, or to be used in some purely rhetorical function. We may take it for granted that, whatever the communicative effects of utterances of (8) may be, and however they may come about, they do not constitute the literal, conventional meaning of the sentence. If it were only for its literal meaning, (8) would be totally pointless. And it is easy to see why this is so: to use a Kantian phrase, the predicate concept of being married is contained in the subject concept of not applying to bachelors. Extending our notation to nouns and (predicative) adjectives, we may write the two extensions as  $/bachelor/^c$  and  $/married/^c$ , the upper index indicating that the extension depends on the utterance context  $c$ . Since the function of the determiner *no* is to express disjointness of the two extensions, the *truth condition* (8) imposes on  $c$  can now be formulated as follows:

- (11)  $/bachelor/^c \cap /married/^c = \emptyset$

Indeed, it is hard to see how any context  $c$  could fail to meet (11), which is why (8) is trivial.

(9) too has an air of triviality: being the chancellor of Germany means holding a particular political office, and holding a political office makes a politician. Maybe (9) is not *entirely* trivial in that there are (or rather: were) contexts in which Germany did not have a chancellor. However, as long as we fix the general political situation, (9) is not really helpful. Consequently, an utterance of (9) is likely to be construed in some non-literal sense, perhaps as an allusion to certain stereotypes. Again we take it that whatever the

communicative effects of (9) may be, and however they may come about, they do not constitute the literal, conventional meaning of the sentence. Rather, given a context  $c$ , (9) is literally true just in case (12) obtains:

$$(12) \text{ GC}(c) \in \text{ /politician/}^c$$

This truth condition is trivially satisfied by any context  $c$  in which the subject of (9) has a referent; and for simplicity we will not bother about other contexts, in which the use of (9) would be inappropriate anyway.

(10) parallels (8) and (9) in its triviality: given an utterance context, the speaker in that context is certainly located at the place where the utterance is made. This truth condition can be brought out in terms of a binary ‘locality’ relation between objects and their locations, which we take to be the extension of the preposition *at* (in its locative sense) and which depends on the context  $c$ , because in different contexts, things may be in different places:

$$(13) (\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(c) [= \text{ /at/}^c]$$

Again it would seem that no context could fail to satisfy (13), which is why (10) cannot be uttered falsely and thus appears trivial.

While there is doubtlessly something trivial about (10), the sentence is not quite as uninformative as (8), and not in the same way. In fact, an utterance of (10) may tell the hearer something she did not know before – which is hardly possible with (8). One may imagine John coming home unexpectedly early to hear his wife speak to someone over the phone, saying that she is not expecting her husband before the end of the week – whereupon he enters the room uttering (10), and surprising Mary. Though the surprise effect may be attributed to the very fact that John is standing there visibly and audibly, it also appears that the very *content* of John’s utterance, i.e. what is (literally) said by it, expresses precisely what Mary is surprised about. For even though the surprise could not have been smaller had John uttered (8), say, the content of that utterance would not have been the object of her surprise, only the fact that an utterance with such content is made.

The contrast between (8) and (10), then, turns on a difference in their *content*, i.e. what is (or can be) said, or expressed, by uttering these sentences. To the extent that content is a semantically relevant notion, so is the difference in the kind of triviality these two sentences exemplify. Indeed, it would seem that the content of a sentence depends on its meaning. However, it is not determined by its meaning alone. Had Mary’s son Peter uttered (10) on the same occasion, he would have expressed something much less surprising – as John might have, had he made his utterance somewhere else. In other words, what John expressed with (10) in the circumstances was that he, John, was at the place of his utterance, viz. John and Mary’s home; whereas Peter would have expressed that he, Peter, was at that same place; etc. And clearly, none of these contents would have been as trivial as what anybody would (literally) express by uttering (8). Hence which content is expressed by a given sentence may depend on the context in which the utterance is made. So while (8) and (10) are both trivially true whenever uttered, the content of the latter need not be trivial, whereas that of the former always is. That the content of (10) as uttered on the occasion described above is non-trivial can be seen from the fact that there

are many circumstances that it rules out. In this respect, it differs from what is expressed by (8), in whichever context it may be uttered: even if things get as crazy as one may imagine, there will be no married bachelors. However, things do not have to be particularly wild for John to not be at home; in fact, this is what Mary thought would be the case, and she is pretty down to earth.

In order to model these differences in informativity, we will identify the content of a sentence with the circumstances to which it truthfully applies, i.e. those situations that it does not rule out. (Cf. article 33 (Zimmermann) *Model-theoretic semantics*, sec. 2, for more on the general setting.) More specifically, we will take the content  $\llbracket S \rrbracket^c$  of a sentence  $S$  to be a subset of the stock of all possible situations, a set called *Logical Space*:  $\llbracket S \rrbracket^c \subseteq LS$ . Thus, if  $c^*$  is the above context in which John utters (10), we find that  $\llbracket 10 \rrbracket^{c^*} \neq LS$ , because  $\llbracket 10 \rrbracket^{c^*}$  only contains the situations in which John is at home, leaving out innumerable situations in which he is not. More generally, if a speaker  $x$  utters (10) at a place  $y$ ,  $x$  thereby expresses a content that rules out the situations in which  $x$  is not located at  $y$ . We thus have:

- (14) a.  $\llbracket (10) \rrbracket^{c^*} = \{s \mid (\text{John}, \text{Home}) \in \text{AT}(s)\}$   
 b.  $\llbracket (10) \rrbracket^c = \{s \mid (\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(s)\}$

According to (14a), whether a situation  $s$  ends up in the content expressed by (10) in  $c^*$ , then, depends on John's location in that situation: if  $s$  is such that John is at his (actual) home, then  $s \in \llbracket 10 \rrbracket^{c^*}$ ; otherwise  $s \notin \llbracket 10 \rrbracket^{c^*}$ . Hence  $\llbracket 10 \rrbracket^{c^*} \neq LS$  because there are various possible (and actual) scenarios in which John is not at home; so the content of (10) as uttered in  $c^*$  is not trivial in that it excludes a host of possible situations. On the other hand, in  $c^*$ , John is at home, and thus  $c^* \in \llbracket 10 \rrbracket^{c^*}$ . According to (14b), whether a situation  $s$  ends up in the content expressed by (10) in an arbitrary context  $c$ , depends on where the speaker in  $c$  is in that situation: if  $s$  is such that the speaker (in  $c$ ) is at the place where  $c$  is located, then  $s \in \llbracket 10 \rrbracket^c$ ; otherwise  $s \notin \llbracket 10 \rrbracket^c$ . Hence  $\llbracket 10 \rrbracket^c \neq LS$  because the location of individuals is a contingent matter; so the content of (10) is never trivial. On the other hand, quite generally the speaker is where the utterance is made, and thus  $c \in \llbracket 10 \rrbracket^c$ . This is what makes (10) trivial, although its content is not.

Readers are advised to briefly stop to ponder over the difference between the truth condition (13) of (10) and the general characterization (14b) of its content (in a context  $c$ ). On the one hand, a context  $c$  satisfies condition (13) just in case it is a member of the set in (14b); in other words, (10) is true in  $c$  just in case it is among the situations the content of (10) *as expressed in*  $c$ , applies to:

- (15)  $c \in \{s \mid (\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(s)\}$   
 iff  $(\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(c)$

On the other hand, the set characterized in (14b) is not the set of contexts in which (10) is true. To begin with, as we have just seen, the content of (10) in a given context  $c$  does not only contain utterance contexts, but all sorts of possible situations including ones in which no utterance is made. More importantly, not every context in which (10) is true, ends up in  $\llbracket 10 \rrbracket^c$ : what (10) expresses *in a context*  $c$  – viz. that the speaker *in*  $c$  is at the place of  $c$  – need not be true in a context  $d$ . Take  $c^*$  again where John is speaking at home. Since John's home is far away from Rome,  $(\text{SPEAKER}(d^*), \text{PLACE}(d^*)) = (\text{John}, \text{Rome})$



$\in \text{AT}(d^*)$ ,  $(\text{SPEAKER}(c^*), \text{PLACE}(c^*)) = (\text{John}, \text{Home}) \notin \text{AT}(d^*)$ . Consequently,  $d^* \notin \llbracket 10 \rrbracket^c$ , though (10) is true in  $d^*$  as in any other context; indeed,  $d^* \in \llbracket 10 \rrbracket^{d^*}$ .

What makes (10) trivial, then, is the fact that its content is true in that context – despite the fact that its content does not apply to every context; in particular, its content varies from context to context. In this respect, (10) differs from (8); for no matter what the context is, the content of (8) is always the same triviality, applying to all possible situations alike, whether utterance contexts or not. Plainly, for any context  $c$  we have:

$$(16) \quad \llbracket (8) \rrbracket^c = LS$$

Now for (9), which we placed in the middle, because it seems to share features of both (8) and (10). We have already said that it is next to tautological. However, its triviality notwithstanding, there is a sense in which it conveys, or may convey, genuine information. For instance, if it is used as (part of) an explanation of, or a comment on, what Angela Merkel did in a certain situation, it may be understood as expressing the content that she, Angela Merkel is a politician. This content is by no means trivial, and the way it relates to the trivial, tautological construal of (9) may be reminiscent of the triviality of (10) and its content in a given utterance context: the non-trivial content (17a) associated with (9) results from understanding the subject as getting its referent ‘directly’ from the utterance context – just like the 1st person pronoun and the locative adverb in (10); cf. (15). On the other hand, on its near-tautological construal, subject and predicate are ‘evaluated’ relative to the same situation:

$$(17) \quad \begin{array}{ll} \text{a. } \{s \mid \text{GC}(c) \in /politician/\} & [\neq LS] \\ \text{b. } \{s \mid \text{GC}(s) \in /politician/\} & [\approx LS] \end{array}$$

The squiggly equality in (17b) is meant to capture the fact that GC is not defined throughout  $LS$ , because there are situations  $s$  without German chancellors; however, whenever it is defined, its value is a member of  $/politician/$ , or so we have been assuming. It seems that both sets in (17) are plausible candidates for the content expressed by (9). We will return to the shifty ‘character’ of (9) in due course.

(8)–(10) show that there are at least two different ways in which a (declarative) sentence may be trivial: it may be that, in any context in which it could be uttered, it carries a content that does not exclude any possibilities whatsoever; and it may so happen that, in any context in which it could be uttered, it carries a content that does not exclude the context itself. To be sure, both kinds of triviality result in total pointlessness; for in both cases the sentence is guaranteed to be true no matter where and when it is uttered, or by whom. But the cases differ in that the pointlessness of the utterance is not due to its content; that this is possible is due to the fact that this content varies from context to context.

### 3. Characters

Summing up these observations, we arrive at the following general picture, not just of informational voidness but also of (sentential) meaning at large. The content of a sentence is a set of possible situations, and what the content of a particular sentence is, depends on the context of utterance. A sentence has trivial content in a given context if its content

in that context coincides with the set  $LS$  of all possible situations; it is trivially true when uttered if every context of utterance is itself a member of its content at that context. The following definitions reformulate these findings in standard terminology, mostly due to Kaplan (1989a):

### Definition

Let  $S$  be a (declarative) sentence, and let  $C \subseteq LS$  be the set of all utterance contexts.

- a) The *character* of  $S$  is a function  $\llbracket S \rrbracket: C \rightarrow \wp(LS)$  that assigns to any utterance context  $c \in C$  a set  $\llbracket S \rrbracket^c \subseteq LS$  of (possible) situations, the *content* of  $S$  in  $c$ .
- b)  $S$  is *true* of a situation  $s \in LS$  in a context  $c \in C$  iff  $s \in \llbracket S \rrbracket^c$ ; and  $S$  is *false* of  $s$  in  $c$  iff  $s \notin \llbracket S \rrbracket^c$ .
- c)  $S$  is *necessarily true* [*false*] in a context  $c \in C$  iff  $S$  is true of every possible situation, i.e. iff  $\llbracket S \rrbracket^c = LS$  [ $\dots = \emptyset$ ].
- d)  $S$  is *true* [*false*] in a context  $c \in LS$  iff  $S$  is true [*false*] of  $c$  in  $c$ , i.e. iff  $c \in \llbracket S \rrbracket^c$  [ $c \notin \llbracket S \rrbracket^c$ ].
- e)  $S$  is *a priori true* [*false*] iff  $S$  is true [*false*] in every context  $c \in C$ .

Some remarks on these definitions are in order. Taken together, they form the core of the *two-dimensional* theory of context-dependence; note that they presuppose the general notions of a possible situation, an utterance situation, and Logical Space. *a)* should be read as programmatic rather than abbreviatory: a full account of linguistic meaning must be inclusive enough so that the character function can be determined from it. This need not mean that meaning, or even literal meaning, *coincides* with character. Neither does the notion of character have to be confined to sentences; in fact we will soon see how to construct characters of arbitrary expressions. – *b)* brings out that, once characters come into play, truth and falsity is a matter of two parameters, viz. the context in which the sentence is uttered and the situations to which its content may be applied. Intuitively, this difference may be described as that between the situation in which an utterance is made and the situations that the utterance is about. However, this characterization should be taken with a grain of salt. After all, characters are defined for all contexts of utterance whether or not the sentence (or expression) analyzed is uttered in it; and it is not obvious which situations intensions are about, given that they are defined for all of  $LS$  (for the time being, anyway). – *c)* defines the kind of triviality exemplified by (8). However, note that (8) is special in that its content is the same across arbitrary contexts (or so we have assumed); this is not a requirement of necessity as defined in *c)*. We will later see examples of necessary truths and falsehoods with ‘unstable’ characters. – *d)* shows how the ordinary notion of truth (and falsity) relative to an utterance context is grounded in the binary notion defined in *b)*, viz. by having the context play two rôles: determining content, and applying the latter to it. This rôle identification is a key tool of the theory presented here, known as *diagonalisation*. We will meet it in various guises as we go along. – To prove the point, it already makes an appearance in *e)*, where the kind of triviality exemplified by (10) is defined.

In order to generalize characters from sentences to (almost) arbitrary expressions, we return to the dependence of reference and extension on situations but now take the two parameters into account. We illustrate the general strategy with a few simple examples:

$$(18) \llbracket I \text{ am married} \rrbracket^c = \{s \mid \text{SPEAKER}(c) \in /married/\}^s$$

In (18),  $c$  is an arbitrary context, and the extension of *married* consists of all persons that are married in the situation at hand. Then, like (14b), (18) reflects the fact that the content of the sentence depends on the utterance context: if John utters it, he expresses that he is married, and the content consists of the (possible) situations in which John is married; if Jane utters it, she expresses that she is married, etc. Of course, this time there are contexts to which the resulting content does not truthfully apply: *I am married* is not *a priori* true. Still what (18) and (14b) have in common is the fact that the referent of the subject solely depends on the context  $c$  whereas the extension of the predicate solely depends on the situation  $s$  the content is applied to. This asymmetry of subject and predicate is somewhat coincidental, as the following example shows:

$$(19) \llbracket No \text{ politician is married} \rrbracket^c = \{s \mid /politician/\}^s \cap /married/\}^s = \emptyset$$

If uttered in a context  $c \in C$ , the sentence whose character is described in (19), expresses that there are no married people among the politicians, thereby ruling out those possible (in fact, likely) situations in which the extensions of *politician* and *married* overlap. Hence neither the extension of the subject nor that of the predicate depend on the utterance context. (Remember that we ignore temporal reference altogether.) So it is not in the nature of subjects to bring context into play, as (18) may have suggested; rather it is the very context-dependence of the personal pronoun that does. The following example confirms this, at least at first blush:

$$(20) \llbracket The \text{ German chancellor is married} \rrbracket^c = \{s \mid GC(s) \in /married/\}^s$$

The sentence interpreted in (20) may be used to rule out the possibility that the German chancellor is unmarried, i.e. those situations in which there is a spouseless German chancellor – *whoever he or she may be*. Given this, the referent of the subject should not depend on the utterance context; otherwise the content of the sentence would come out as ruling out that Angela Merkel – *chancellor or not* – is unmarried (given a realistic context at the time of writing this). So, as in (19) there is no context-dependence in the subject (nor elsewhere in the sentence). On the other hand, it would seem that the sentence may be used to convey precisely a piece of information about a certain person. If so, its content would have to look different. To avoid ambiguity, we may use a notational device distinguishing this, somewhat more unusual construal:

$$(21) \llbracket The_a \text{ German chancellor is married} \rrbracket^c = \{s \mid GC(c) \in /married/\}^s$$

The above examples may suggest that the reference (or extension) of subjects is always exclusively a matter of context or else not a matter of context at all. However, there are also mixed cases, i.e. subjects whose referents depend on both the context of utterance and the situation to which the content is applied:

$$(22) \llbracket No \text{ friend of mine is married} \rrbracket^c = \{s \mid /friend/\}^s(\text{SPEAKER}(c)) \cap /married/\}^s = \emptyset$$

In (22) we have assumed that the extension of the relational noun *friend* is the function assigning to each individual the set of his or her friends. If uttered by John, say, the

sentence rules out the possible situations in which John has any married friends. Hence, obviously, the 1st person possessive relates to the speaker at the context of utterance. Had the set of friends been determined by context too (i.e. had we written ‘/friend/’ instead of ‘/friend/’), the content would have ruled out that any of a particular group of people, viz. those who happen to be John’s friends at the context of utterance, is married. Now, even though – somewhat analogously to (20) – the sentence might be interpreted that way (which we will leave open here), this is certainly not its most straightforward reading, let alone the only one. It appears that a more obvious way of understanding what it says is given in (22), according to which the extension of the subject partly depends on the utterance context, but not entirely so.

In general, nominal constituents (noun phrases, determiner phrases, quantifiers, etc.), like sentences, have extensions that depend on both the context of utterance and the situation to which the (sentential) content is ultimately applied. As it turns out, the same goes for verbal constituents, and almost any other kind of expression (logical words being famous exceptions). In order to combine these extensions in a consistent and compositional way, it is thus natural to assume that the extensions of *all* expressions depend on the utterance context and a situation to which the content is applied. Hence, we may generalize (and slightly adjust) the above definition *a*):

### Definition

Let  $\alpha$  be an expression (of any category), and let  $C \subseteq LS$  be the set of all utterance contexts.

*a*\*) The *character* of  $\alpha$  is a function  $\llbracket \alpha \rrbracket$  that assigns to any utterance context  $c \in C$  a function  $\llbracket \alpha \rrbracket_c: LS \rightarrow D_\alpha$ , the *intension* of  $\alpha$  in  $c$ , where  $D_\alpha$  is the set of possible extensions of  $\alpha$ .

*a*\*) presupposes the notion of a possible extension of a given expression, which needs to be settled independently. For the purpose of this survey we continue to assume that certain category-dependent restrictions apply; in particular, we take it that the extensions of (declarative) sentences are truth values, that those of nouns and predicates are sets of individuals, and that the extensions of referential expressions like proper names, personal pronouns, and definite descriptions coincide with their referents.

To see that *a*\*) does generalize *a*), one needs to identify sets  $M \subseteq LS$  of possible situations with their *characteristic functions*  $f_M$ , which distinguish members of  $M$  from other situations by assigning corresponding truth values:  $f_M(s) = 1$  if  $s \in M$ ; and  $f_M(s) = 0$  if  $s \in LS \setminus M$ . Due to this correspondence, the contents assigned to sentences by characters conforming to *a*) may be represented by their characteristic functions, which assign truth values to situations. Since truth values may be regarded as the extensions of sentences, sentential characters according to *a*) turn out to be special cases of *a*\*); and the intensions of sentences come out as functional representatives of their contents as conceived above. But, of course, *a*\*) is much more general. In particular, the characters of referential expressions  $\alpha$  are said to assign *individual concepts* to contexts, i.e. functions from possible situations to individuals; and the extensions of predicates will be *properties*, i.e. sets of individuals depending on contexts and situations.

Following *a*\*), the extensions of the context-dependent expressions considered above can now be assigned by their characters:

- (23) a.  $\llbracket I \rrbracket^c(s) = \text{SPEAKER}(c)$   
 b.  $\llbracket you \rrbracket^c(s) = \text{ADDRESSEE}(c)$   
 c.  $\llbracket now \rrbracket^c(s) = \text{TIME}(c)$   
 d.  $\llbracket here \rrbracket^c(s) = \text{PLACE}(c)$

The equations in (23), which must be read as generalizing over arbitrary utterance contexts  $c \in C$  and situations  $s \in LS$ , all conform to  $a^*$ ). In each case, the character of an expression  $\alpha$  assigns to a given context an individual concept (assuming that times and places are individuals). However, in each of these cases, the individual concept is constant across all of Logical Space:  $\llbracket \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^c(s')$  whenever  $s, s' \in LS$ . This is so because the referent of a deictic expression only depends on the context in which it is uttered, not on the situation to which the content of the sentence in which it occurs is applied; this much can be gleaned from the above description of a typical sentence like (18):

- (18)  $\llbracket I \text{ am married} \rrbracket^c = \{s \mid \text{SPEAKER}(c) \in /married/s\}$

So the situations  $s$  in (23) are there but for uniformity: characters in general need them, even though these particular ones could do without them. This hybrid treatment pays once we turn to the predicates considered above, which come out as the mirror images of deictic expressions in that their extensions are determined exclusively relatively to the situations that make up sentence content, without the utterance context coming in. Again, this can be seen from a typical case like (18) above, where *be married* is the predicate under scrutiny and its extensions are all of the form  $/married/s$  where  $s$  is a situation in Logical Space. According to  $a^*$ ), these extensions should be thought as given by the character of the predicate, which for reasons of uniformity again, comes out as somewhat redundant in that it assigns the same property to every context:

- (24) a.  $\llbracket be married \rrbracket^c(s) = /married/s = \{x \mid x \text{ is married in } s\}$   
 b.  $\llbracket be a politician \rrbracket^c(s) = /politician/s = \{x \mid x \text{ is a politician in } s\}$

The difference in character between the deictic expressions in (23) and the predicates in (24) gives rise to a natural distinction (cf. Zimmermann 1991: 162):

### Definition

- f) An expression  $\alpha$  is *direct* iff  $\llbracket \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^c(s')$ , for any context  $c$  and situations  $s$  and  $s'$ .  
 g) An expression  $\alpha$  is *absolute* iff  $\llbracket \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^{c'}(s)$ , for any contexts  $c$  and  $c'$  and situations  $s$ .

Hence the deictic expressions under (23) are direct, whereas the predicates in (24) are absolute. Note that directness does not *per se* imply context dependence in that a character may be *both* direct *and* absolute, and thus the extension would not depend on the utterance context after all. Logical words like *and* and *every* are cases in point; so may be proper names (according to Kaplan 1989a: 558ff., anyway). The term (which generalizes the more common *directly referential*) is meant to suggest that no content layer gets in the way between context and extension: the intension is a degenerate, constant function; such

intensions are also called *rigid*, in the tradition of Kripke (1972) where, famously, proper names are argued to be ‘rigid designators’. The term defined in g) is meant to suggest independence from context.

One should note that characters may be *mixed*, i.e. neither direct nor absolute. As a case in point, the truth of the sentence *I am married* as analyzed in (18), depends on both the context of utterance and a situation to which its content is applied. In other words, it is neither direct, because its content (in a given context) may assign different truth values to different situations, nor absolute, because its character may assign different contents to different contexts. (We note in passing that none of our sample lexical items has a mixed character, which gives rise to the conjecture that this is always so; cf. Zimmermann 1995 and Bierwisch 2004 for more on this so-called *Hypothesis (L)*, originating with Zimmermann 1991: 164.) It is obvious how the predicates analyzed in (24) combine with deictic subjects to produce doubly-dependent sentence characters, viz. by way of the following *character composition* rule:

$$(25) \quad \llbracket SUBJ \ PRED \rrbracket^c(s) = \begin{cases} 1, & \text{if } \llbracket SUBJ \rrbracket^c(s) \in \llbracket PRED \rrbracket^c(s) \\ 0, & \text{otherwise} \end{cases}$$

(25) is a *pointwise* characterization of the characters of sentences with referential subjects: for each context  $c \in C$  it says which truth value the content of the sentence in  $c$  assigns to any situation  $s \in LS$ ; under the assumption that a function is completely characterized by its course of values (i.e. the set of its argument-value pairs), this fixes the content at each  $c$ , which in turn fixes the character. Alternatively, the combination defined in (25) may be formulated in terms of characteristic functions, rather than sets, as predicate extensions:

$$(25') \quad \llbracket SUBJ \ PRED \rrbracket^c(s) = \llbracket PRED \rrbracket^c(s)(\llbracket SUBJ \rrbracket^c(s))$$

As long as it is unlikely to lead to confusion, we will not bother to distinguish between (25) and (25').

It is readily seen that (25) yields (18) when applied to the characters given in (23a) and (24a). And we also obtain the intended (and expected) result when applying the combination to sentences with non-deictic subjects, like (9) above:

$$\begin{aligned} (26) \quad & \llbracket \textit{the German chancellor is married} \rrbracket^c(s) = 1 \\ & \text{iff } \llbracket \textit{the German chancellor} \rrbracket^c(s) \in \llbracket \textit{is married} \rrbracket^c(s) \\ & = \textit{the German chancellor}^s \in \{x \mid x \text{ is married in } s\} \end{aligned}$$

Sentences with quantificational subjects may be treated in a similar way, the difference lying in the direction of application: whereas the truth value in a predication like (26) ensues from applying the extension of the predicate to that of the subject, quantificational subjects work the other way round. The tautology (8) discussed earlier is a case in point:

$$\begin{aligned} (27) \quad & \llbracket \textit{no bachelor is married} \rrbracket^c(s) = 1 \\ & \text{iff } \llbracket \textit{is married} \rrbracket^c(s) \in \llbracket \textit{no bachelor} \rrbracket^c(s) \\ & \text{iff } \dots \\ & \text{iff } \{x \mid x \text{ is a bachelor in } s\} \cap \{x \mid x \text{ is married in } s\} = \emptyset \end{aligned}$$

The intermediate steps, which only involve standard combinations and denotations of quantifier extensions, have been skipped. Since the condition in the final line of (27) does not mention the context, (8) turns out to be absolute in the sense of  $g$ , i.e. it has the same content in every utterance situation; and since the condition is met by any situation  $s \in LS$ , this content coincides with  $LS$ . As a consequence, (8) also comes out as an *a priori* truth: its (rigid) content contains all situations whatsoever – and thus *a fortiori* the (changing) utterance context.

The character (14b) of (10) is different:

$$(14) \text{ b. } \llbracket (10) \rrbracket^c = \{s \mid (\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(s)\}$$

In order to derive it compositionally, we first have to dissect its predicate into the locative adverbial and a corresponding reading of the copula. Since the latter relates the referent of the subject and a location in the situation the content is applied to, it is absolute:

$$(28) \llbracket be_{Loc} \rrbracket^c(s) = \text{AT}(s) = \{(x, y) \mid \text{in } s, x \text{ is located at } y\}$$

The general definition of the character composition corresponding to locative predicate formation is left to the reader. Its effect on the case at hand is straightforward:

$$(29) \begin{aligned} \llbracket be_{Loc} \text{ here} \rrbracket^c(s) &= \{x \mid (x, \llbracket \text{here} \rrbracket^c(s)) \in \llbracket be_{Loc} \rrbracket^c(s)\} \\ &= \{x \mid (x, \text{PLACE}(c)) \in \text{AT}(s)\} \end{aligned}$$

Note that according to (29), the predicate of (10) is no longer absolute, due to the directness of *here*. Neither is the whole sentence whose character can now be determined with the help of (25):

$$(30) \begin{aligned} \llbracket I \text{ am}_{Loc} \text{ here} \rrbracket^c(s) &= 1 \\ \text{iff } \llbracket I \rrbracket^c(s) &\in \llbracket \text{am here} \rrbracket^c(s) \\ \text{iff } (\text{SPEAKER}(c), \text{PLACE}(c)) &\in \text{AT}(s) \end{aligned}$$

Thus unlike (8), (10) never expresses a necessary truth, for reasons we have already seen: the location of any individual, including the speaker at a given context, is instable across Logical Space, and so the content will never cover all of the latter. However, it will always contain the utterance situation, which means that the sentence comes out true in every context and is thus *a priori* true, in the sense of Definition *e*).

#### 4. Diagonals

The two kinds of triviality thus come out as reflected by a difference in character. Sentences like (8) are necessarily true and express trivial content, coinciding with Logical Space. Sentences like (10) are *a priori* true and thus true in every context. The difference did not show in their respective truth conditions (11) and (13), which are equivalent because (8), apart from always being necessarily true, is an *a priori* truth too:

$$(11) \text{ /bachelor/}^c \cap \text{ /married/}^c = \emptyset$$

$$(13) (\text{SPEAKER}(c), \text{PLACE}(c)) \in \text{AT}(c)$$

From the character point of view, these truth conditions pertain to the unary notion of truth in a context, as introduced in Definition *d*), and thus water down the binary one of Definition *b*) by selecting those contexts to which the content expressed by the sentence applies. Technically this step comes down to an identification of the two parameters, which is quite a general procedure:

*Definition*

- h*) The *extension*  $/\alpha/^c$  of an expression  $\alpha$  in a context  $c \in C$  is the value  $\alpha$ 's intension at  $c$  assigns to  $c$  itself:  $/\alpha/^c = \llbracket \alpha \rrbracket^c(c)$ .
- i*) The *diagonal* of a character  $/\alpha/$  (of an expression  $\alpha$ ) is the function  $/\alpha/: C \rightarrow D_\alpha$  that assigns to each context  $c$  the extension of  $\alpha$  at  $c$ :  $/\alpha/(c) = / \alpha / ^c$ .

Using the above terminology (and our identification of sets with their characteristic functions), we thus see that the diagonal of a sentence is the set of contexts in which it is true. In particular, *apriority* turns out to be a matter of the diagonal: according to Definitions *d*) and *e*) a sentence  $S$  is *a priori true* iff for any  $c \in C$ ,  $c \in \llbracket S \rrbracket^c$ , which means that  $/S/ = C$ , by Definition *i*); and similarly for *a priori* falsehoods, whose diagonal is empty. Given that contexts are situations, i.e.  $C \subseteq LS$ , diagonals may be conceived of as (possible) sentence contents. Hence *apriority* is to the diagonal what necessity is to content. It is in view of this distinction between the content of a sentence (or more generally: the intension of an expression) on the one hand and the diagonal of its character on the other, that the current approach has been dubbed ‘two-dimensional’. Hence the dimensions are not the two parameters extensions depend on but the two kinds of content deriving from this dependence: ordinary content as expressed in a given context distinguishing between genuine possibilities and situations that may be ruled out; and diagonal content as determined by the character at large and distinguishing between contexts in which the sentence is (or would be) true or false when uttered. The current section takes a closer look at the relation between these two dimensions.

The term ‘diagonal’ derives from a representation of characters in terms of look-up tables with lines (conventionally) corresponding to contexts of utterance, columns to arbitrary possible situations, and cells containing the extensions. This is what the character of the first-person pronoun  $I$  looks like:

Tab. 89.1: The character of  $I$

|       | $c_0$      | $c_1$      | $c_2$      | $c_3$      | ... | $s^0$      | $s^1$      | ... |
|-------|------------|------------|------------|------------|-----|------------|------------|-----|
| $c_0$ | $\Sigma_0$ | $\Sigma_0$ | $\Sigma_0$ | $\Sigma_0$ | ... | $\Sigma_0$ | $\Sigma_0$ | ... |
| $c_1$ | $\Sigma_1$ | $\Sigma_1$ | $\Sigma_1$ | $\Sigma_1$ | ... | $\Sigma_1$ | $\Sigma_1$ | ... |
| $c_2$ | $\Sigma_2$ | $\Sigma_2$ | $\Sigma_2$ | $\Sigma_2$ | ... | $\Sigma_2$ | $\Sigma_2$ | ... |
| $c_3$ | $\Sigma_3$ | $\Sigma_3$ | $\Sigma_3$ | $\Sigma_3$ | ... | $\Sigma_3$ | $\Sigma_3$ | ... |
| ...   | ...        | ...        | ...        | ...        | ... | ...        | ...        | ... |

Each row represents the intension of  $I$  in a given context  $c$ , by running through  $LS$  (as represented by the columns) and assigning the referent of  $I$  in  $c$  to each of the situations. Since the referent coincides with the speaker in  $c$ , it will be the same one in each



situation; consequently the columns all look the same. For convenience we abbreviated ‘ $\text{SPEAKER}(c_n)$ ’ by ‘ $\Sigma_n$ ’; this is not meant to exclude that in some cases  $\Sigma_n = \Sigma_m$ , even though  $n \neq m$  and consequently  $c_n \neq c_m$ . Note that we are using subscripts to distinguish different contexts and superscripts to distinguish possible situations that do not happen to be utterance contexts. Also note that the columns have been arranged so that the contexts  $c \in C \subseteq LS$  come first, and in the same order as in the rows. This helps keeping track of the diagonal, which we have moreover shaded. Finally note that the diagonal only cuts through part of the character, because there are no rows for non-contexts.

Using similar notational devices, our representation of the character of *here*, or in fact any direct expression, would look almost the same, with each row repeating the place of utterance (‘ $\Pi_n$ ’) all over the place ( $= LS$ ); we do not bother to write this down. Absolute expressions are, of course, a different matter. Thus, e.g., the character of locative *be* has the following form:

Tab. 89.2: The character of  $be_{LOC}$

|       | $c_0$           | $c_1$           | $c_2$           | $c_3$           | ... | $s^0$           | $s^1$           | ... |
|-------|-----------------|-----------------|-----------------|-----------------|-----|-----------------|-----------------|-----|
| $c_0$ | AT <sub>0</sub> | AT <sub>1</sub> | AT <sub>2</sub> | AT <sub>3</sub> | ... | AT <sup>0</sup> | AT <sup>1</sup> | ... |
| $c_1$ | AT <sub>0</sub> | AT <sub>1</sub> | AT <sub>2</sub> | AT <sub>3</sub> | ... | AT <sup>0</sup> | AT <sup>1</sup> | ... |
| $c_2$ | AT <sub>0</sub> | AT <sub>1</sub> | AT <sub>2</sub> | AT <sub>3</sub> | ... | AT <sup>0</sup> | AT <sup>1</sup> | ... |
| $c_3$ | AT <sub>0</sub> | AT <sub>1</sub> | AT <sub>2</sub> | AT <sub>3</sub> | ... | AT <sup>0</sup> | AT <sup>1</sup> | ... |
| ...   | ...             | ...             | ...             | ...             | ... | ...             | ...             | ... |

Of course,  $AT_n = AT(c_n)$ , and  $AT^n = AT(s^n)$ . In this case the rows all look the same; this is of course, due to the fact that the extension of locative *be*, like that of any absolute expression, does not depend on the context of utterance. One restriction, not visible in the table but important in what follows is that for any subscript  $n$ , it holds that  $(\Sigma_n, \Pi_n) \in AT_n$  (cf. Kaplan 1979: 89, clause 10). Given this restriction and the fact that according to our above analysis (30), (10) is true of a situation  $s$  in a context  $c_n$  if  $(\Sigma_n, \Pi_n) \in AT(s)$ , we may conclude that the diagonal of its character is entirely made up of 1s; the other truth values depend on the specifics of the situations  $s$  and contexts  $c_n$  and have been filled in arbitrarily:

Tab. 89.3: The character of (10)

|       | $c_0$ | $c_1$ | $c_2$ | $c_3$ | ... | $s^0$ | $s^1$ | ... |
|-------|-------|-------|-------|-------|-----|-------|-------|-----|
| $c_0$ | 1     | 1     | 0     | 0     | ... | 0     | 1     | ... |
| $c_1$ | 1     | 1     | 0     | 0     | ... | 1     | 1     | ... |
| $c_2$ | 0     | 0     | 1     | 1     | ... | 0     | 0     | ... |
| $c_3$ | 1     | 1     | 1     | 1     | ... | 1     | 1     | ... |
| ...   | ...   | ...   | ...   | ...   | ... | ...   | ...   | ... |

To get a grip on Tab. 89.3, suppose that  $\Sigma_0 = \text{Mary}$  and  $\Pi_0 = \text{Frankfurt}$ . Then the first row has a 1 in a given column representing a situation  $s$  if  $s$  is a situation in which Mary is in Frankfurt (which we take to be immovable). Arguably, this row represents the content of:

(31) *Mary is in Frankfurt.*

To actually derive the equivalence in content between (31) and (10) as used in  $c_0$ , we must make the (debatable) assumption that the reference of proper names is neither context-dependent nor a matter of intension. Consequently, their characters are completely degenerate, with all cells filled in by the same individual (per name):

Tab. 89.4: The character of *Mary*

|       | $c_0$ | $c_1$ | $c_2$ | $c_3$ | ... | $s^0$ | $s^1$ | ... |
|-------|-------|-------|-------|-------|-----|-------|-------|-----|
| $c_0$ | m     | m     | m     | m     | ... | m     | m     | ... |
| $c_1$ | m     | m     | m     | m     | ... | m     | m     | ... |
| $c_2$ | m     | m     | m     | m     | ... | m     | m     | ... |
| $c_3$ | m     | m     | m     | m     | ... | m     | m     | ... |
| ...   | ...   | ...   | ...   | ...   | ... | ...   | ...   | ... |

Tab. 89.4 gives the simplistic character of *Mary*; a similar table, full of 'f's would represent that of *Frankfurt*. Hence, given the above treatment of locative predications, (31) comes out as having an absolute character:

$$\begin{aligned}
 (32) \quad & \llbracket (31) \rrbracket^c(s) = 1 \\
 & \text{iff } (m, f) \in \text{AT}(s) \\
 & \text{iff } (\Sigma_0, \Pi_0) \in \text{AT}(s) \\
 & \text{iff } \llbracket (10) \rrbracket^c(s) = 1
 \end{aligned}$$

Note that (32) holds for any context  $c \in C$ ; indeed, (31) is absolute, with the first line of Tab. 89.3 repeating itself all the way down ( $C$ ):

Tab. 89.5: The character of (31)

|       | $c_0$ | $c_1$ | $c_2$ | $c_3$ | ... | $s^0$ | $s^1$ | ... |
|-------|-------|-------|-------|-------|-----|-------|-------|-----|
| $c_0$ | 1     | 1     | 0     | 0     | ... | 0     | 1     | ... |
| $c_1$ | 1     | 1     | 0     | 0     | ... | 0     | 1     | ... |
| $c_2$ | 1     | 1     | 0     | 0     | ... | 0     | 1     | ... |
| $c_3$ | 1     | 1     | 0     | 0     | ... | 0     | 1     | ... |
| ...   | ...   | ...   | ...   | ...   | ... | ...   | ...   | ... |

The treatment of *Mary* as in Tab. 89.4 also gives rise to the construction of a kind of sentence character that we have not met so far, exemplified by:

(33) *I am Mary.*

Under the (uncontroversial) assumption that *identity statements* are true just in case the extensions of the equated expressions coincide, the character of (33) is split into two parts: in any context  $c$  in which Mary is speaking, it is necessarily true, because all situations are such that Mary (=  $\text{SPEAKER}(c)$ ) is identical with Mary (= the extension of

Mary according to Tab. 89.4); but in a context  $c$  in which Mary is not the speaker, (33) is necessarily false, because all situations are such that  $\text{SPEAKER}(c) \neq \text{Mary}$ . We thus arrive at the following character, where Mary is speaking in  $c_0$  and  $c_1$ , but not in  $c_2$  and  $c_3$ :

Tab. 89.6: The character of (33)

|       | $c_0$ | $c_1$ | $c_2$ | $c_3$ | ... | $s^0$ | $s^1$ | ... |
|-------|-------|-------|-------|-------|-----|-------|-------|-----|
| $c_0$ | 1     | 1     | 1     | 1     | ... | 1     | 1     | ... |
| $c_1$ | 1     | 1     | 1     | 1     | ... | 1     | 1     | ... |
| $c_2$ | 0     | 0     | 0     | 0     | ... | 0     | 0     | ... |
| $c_3$ | 0     | 0     | 0     | 0     | ... | 0     | 0     | ... |
| ...   | ...   | ...   | ...   | ...   | ... | ...   | ...   | ... |

As one can immediately tell from the diagonal of its character depicted in Tab. 89.6, sentence (33) is not *a priori* true; in particular it is not tautological in the way (8) is. Still, like (8), it is necessarily true in some contexts, viz. those in which Mary is speaking. Hence (33) comes out as trivial in the restricted sense that its content may be uninformative, depending on the context. The fact that it is not trivially true in every context may be seen as the beginning of an explanation why it is not uninformative *tout court* even though its content is. A hearer who is not fully informed about the context – and particularly about who is speaking – may rule out (being part of) any context in which the speaker is not Mary, as long as (s)he is prepared to trust the speaker. Such a hearer could take the diagonal of the character as a substitute for the content expressed by the sentence, thereby eliminating all contexts in which Mary is not speaking and thus learning that Mary is the speaker. This *pragmatic* analysis, which makes heavy use of the diagonal, may even be applied to utterance situations in which the speaker does not know which person is being referred to by the name *Mary*, thus extending well beyond the semantics-pragmatics divide. However, it also has to rely on a wider conception of contexts and characters and thus goes far beyond this short survey. A fuller story along these lines can be found in Stalnaker (1978) and Haas-Spohn (1991); see also Haas-Spohn (1995) for a different (though related) approach.

The diagonal may also be seen to play a rôle in the shifty interpretation of the (surface) sentence (9), to which we attributed two different characters, repeated here:

$$(20) \llbracket \text{The German chancellor is married} \rrbracket^c = \{s \mid \text{GC}(s) \in /married/\}$$

$$(21) \llbracket \text{The}_d \text{ German chancellor is married} \rrbracket^c = \{s \mid \text{GC}(c) \in /married/\}$$

The difference between the two analyses lies in the interpretation of the subject, which is absolute according to (20) and direct according to (21):

$$(34) \llbracket \text{the German chancellor} \rrbracket^c(s) = \text{GC}(s)$$

$$(35) \llbracket \text{the}_d \text{ German chancellor} \rrbracket^c(s) = \text{GC}(c)$$

Comparing the corresponding character tables reveals how one can be derived from the other:

Tab. 89.7: The character of *the German chancellor*

|       | $c_0$           | $c_1$           | $c_2$           | $c_3$           | ... | $s^0$           | $s^1$           | ... |
|-------|-----------------|-----------------|-----------------|-----------------|-----|-----------------|-----------------|-----|
| $c_0$ | CG <sub>0</sub> | GC <sub>1</sub> | GC <sub>2</sub> | GC <sub>3</sub> | ... | GC <sup>0</sup> | GC <sup>1</sup> | ... |
| $c_1$ | GC <sub>0</sub> | GC <sub>1</sub> | GC <sub>2</sub> | GC <sub>3</sub> | ... | GC <sup>0</sup> | GC <sup>1</sup> | ... |
| $c_2$ | GC <sub>0</sub> | GC <sub>1</sub> | GC <sub>2</sub> | GC <sub>3</sub> | ... | GC <sup>0</sup> | GC <sup>1</sup> | ... |
| $c_3$ | GC <sub>0</sub> | GC <sub>1</sub> | GC <sub>2</sub> | GC <sub>3</sub> | ... | GC <sup>0</sup> | GC <sup>1</sup> | ... |
| ...   | ...             | ...             | ...             | ...             | ... | ...             | ...             | ... |

Tab. 89.8: The character of *the<sub>d</sub> German chancellor*

|       | $c_0$           | $c_1$           | $c_2$           | $c_3$           | ... | $s^0$           | $s^1$           | ... |
|-------|-----------------|-----------------|-----------------|-----------------|-----|-----------------|-----------------|-----|
| $c_0$ | GC <sub>0</sub> | GC <sub>0</sub> | GC <sub>0</sub> | GC <sub>0</sub> | ... | GC <sub>0</sub> | GC <sub>0</sub> | ... |
| $c_1$ | GC <sub>1</sub> | GC <sub>1</sub> | GC <sub>1</sub> | GC <sub>1</sub> | ... | GC <sub>1</sub> | GC <sub>1</sub> | ... |
| $c_2$ | GC <sub>2</sub> | GC <sub>2</sub> | GC <sub>2</sub> | GC <sub>2</sub> | ... | GC <sub>2</sub> | GC <sub>2</sub> | ... |
| $c_3$ | GC <sub>3</sub> | GC <sub>3</sub> | GC <sub>3</sub> | GC <sub>3</sub> | ... | GC <sub>3</sub> | GC <sub>3</sub> | ... |
| ...   | ...             | ...             | ...             | ...             | ... | ...             | ...             | ... |

A quick inspection shows that both tables contain the same function  $f$  from contexts  $c$  to the German chancellor  $GC_c$  in  $c$ , only arranged in different ways: whereas Tab. 89.8 repeats  $f$  in every column, Tab. 89.7 has  $f$  on the left side of every row. Hence the character in Tab. 89.8 can be obtained from that in Tab. 89.7 by inserting its diagonal into each column; in fact, this operation is perfectly general and does not even require absoluteness:

### Definition

- j) The *direct interpretation*  $\nabla\alpha$  of an expression  $\alpha$  is that character that assigns to every context  $c \in C$  the intension that assigns to every situation  $s \in LS$  the extension of  $\alpha$  in  $c$ :  
 $\nabla\alpha(c)(s) = / \alpha^c = \llbracket \alpha \rrbracket^c(c)$ .

Obviously, the direct interpretation of an expression is always direct in the sense of Definition *f*) – thence the term; moreover, it is easy to verify that the direct interpretation of a direct expression coincides with its ordinary character:  $\nabla\alpha = \llbracket \alpha \rrbracket$ . If direct interpretation could be shown to be the result of a general interpretative strategy of applying the intension directly to the context of utterance, then the uncertainty as what kind of content is expressed by sentences like (9) might be approached in pragmatic terms (cf. Kripke 1977); in fact, it is even conceivable that separate pragmatic processes make use of the (ordinary) character and the direct interpretation of one expression at the same time. Alternatively, one may try and seek an explanation in terms of ambiguity, in which case  $\nabla$  would have to be an operator in the object language embedding (suitable) expressions  $\alpha$  (cf. Kaplan 1978, relating to Donnellan 1966):

$$(36) \quad \llbracket \nabla\alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^c(c)$$

When restricted to referential expressions  $\alpha$ , the operator in (36) is also known as *dthat*, which is short for ‘demonstrative *that*’ and pronounced [dðæt]; applied to sentences  $\alpha$ , it

boils down to a combination of the operations expressed by certain readings of *actually* and *now* (cf. Kaplan 1979).

It is tempting and natural to consider a reversal  $\Delta$  of direct interpretation that turns any character into an absolute one. Whereas  $\nabla$  pastes the diagonal into each column,  $\Delta$  would have to insert it in the rows of the resulting table. In analogy with (36),  $\Delta$  would thus have to satisfy the equations:

(37)  $\Delta\alpha(c)(s) = \llbracket\alpha\rrbracket^s(s)$

However, there is an obvious problem with this construction, due to the asymmetry of characters: they are only defined for utterance contexts, and not for the remaining situations in Logical Space. In the case of absolute expressions  $\alpha$  the intension assigned by their character is the same across  $C$  and may thus be generalized to all of  $LS$ . However, with direct or even mixed expressions, this "extrapolation" obviously does not work. Hence the right side of (37) is not always defined; as a consequence, the intensions assigned by characters  $\Delta\alpha$  would have to be partial, only defined for situations  $s \in C$ .

*Definition*

- k) The *diagonal character*  $\Delta\alpha$  of an expression  $\alpha$  is that function that assigns to every context  $c \in C$  the partial intension that assigns to every utterance situation  $s \in C$  the extension of  $\alpha$  in  $s$ :  $\Delta\alpha(c)(s) = / \alpha / ^c = \llbracket\alpha\rrbracket^s(s)$ .

Note that we continue to use 's' as a variable for situations to which intensions apply, even if they are restricted to members of  $C$ , as in k); this should remind of their rôle as determining extensions. Obviously, the diagonal character of an expression is always absolute in the sense of Definition g); moreover, it is easy to verify that the diagonal character of an absolute expression coincides with its ordinary character if the values are restricted to utterance contexts (or "extrapolated" in the sense indicated above):  $\Delta\alpha \approx \llbracket\alpha\rrbracket$ .

The partiality of the intensions assigned by diagonal characters may be construed as presuppositional. Take the character of the first-person pronoun,  $I$ , given in Tab. 89.1. The result of applying the operation defined in (37) to it may be represented as in Tab. 89.9, where '#' stands for undefinedness:

Tab. 89.9: The partial character  $\Delta I$

|       | $c_0$      | $c_1$      | $c_2$      | $c_3$      | ... | $s^0$ | $s^1$ | ... |
|-------|------------|------------|------------|------------|-----|-------|-------|-----|
| $c_0$ | $\Sigma_0$ | $\Sigma_1$ | $\Sigma_2$ | $\Sigma_3$ | ... | #     | #     | ... |
| $c_1$ | $\Sigma_0$ | $\Sigma_1$ | $\Sigma_2$ | $\Sigma_3$ | ... | #     | #     | ... |
| $c_2$ | $\Sigma_0$ | $\Sigma_1$ | $\Sigma_2$ | $\Sigma_3$ | ... | #     | #     | ... |
| $c_3$ | $\Sigma_0$ | $\Sigma_1$ | $\Sigma_2$ | $\Sigma_3$ | ... | #     | #     | ... |
| ...   | ...        | ...        | ...        | ...        | ... | ...   | ...   | ... |

The character depicted in Tab. 89.9 is gappy for a systematic reason: there are no extensions  $\Sigma^n = \text{SPEAKER}(s^n)$  because only utterance situations have (uniquely defined) speakers. Hence the partial character presupposes that the content is applied to utterance

situations only, i.e. to situations with speakers. This partial character may be described somewhat more perspicuously (and revealingly) by the following equation:

$$(38) \quad \Delta I(c)(s) = \begin{cases} \text{SPEAKER}(s), & \text{if } s \in C \\ \#, & \text{otherwise} \end{cases}$$

According to (38), the intension  $\Delta I$  assigns to a context  $c$  is always the *SPEAKER* function. Hence  $\Delta I$  coincides with the (ordinary) character of *the speaker*, which refers to the speaker in a given utterance situation. In a similar vein,  $\Delta$  may be combined with other deictics like *here* and *now*, always resulting in absolute expressions that turn their context-dependence into a partial intension:  $\Delta$ *here* comes out as expressing the character of *the place of utterance*;  $\Delta$ *now* corresponds to *the time of utterance*; etc. In order to better understand operation  $\Delta$ , one may study its effect on various kinds of sentences:

- (39) a.  $\Delta I \text{ am married}(c) = \{s \in C \mid \text{SPEAKER}(s) \in /married/\}$   
 b.  $\Delta I \text{ am here}(c) = \{s \in C \mid \text{SPEAKER}(s), \text{PLACE}(s) \in \text{AT}(s)\}$   
 c.  $\Delta I \text{ am Mary}(c) = \{s \in C \mid \text{SPEAKER}(s) = \text{Mary}\}$

For simplicity, (39) ignores the differentiation between utterance contexts of which the content (intension) is false and non-utterance situations of which it is undefined. In any case, due to the presupposition introduced by  $\Delta$ , the situations to which it assigns the truth value 1 are confined to utterance situations; and these are the ones mentioned in (39). As expected, these diagonal characters (which may be derived by combining interpretive mechanisms introduced above) correspond to certain absolute expressions:

- (40) a.  $\llbracket \text{The speaker is [identical with] Mary} \rrbracket^c(s) = \{s \in LS \mid \text{SPEAKER}(s) = \text{Mary}\}$   
 b.  $\llbracket \text{The speaker is married} \rrbracket^c(s) = \{s \in LS \mid \text{SPEAKER}(s) \in /married/\}$   
 c.  $\llbracket \text{The speaker is at the place of the utterance} \rrbracket^c(s) = \{s \in LS \mid (\text{SPEAKER}(s), \text{PLACE}(s)) \in \text{AT}(s)\}$

The sentences analyzed in (40) all have straightforward presuppositional readings, which on closer inspection coincide with the corresponding diagonalized characters given in (39), due to the fact that the *SPEAKER* function is defined for utterance situations and only them and provided that *the place of the utterance* expresses a partial intension defined on utterance situations and assigning their respective location to them. So the characters in (40) may be seen as equivalent to the diagonal characters in (39), thereby offering a glimpse of what diagonalization in general amounts to: instead of taking their referents directly from the utterance situations, the diagonal character takes them from the situation described by the content of the sentence. In the case of (40a), which has been disambiguated to avoid unwelcome (e.g., information-structural) side-effects, we have already seen that this is the non-trivial content that a hearer who is initially unaware of the speaker's identity, may associate with an utterance of *I am Mary*; such a hearer may thus be said to *diagonalize* the utterance, thereby learning who is speaking. And a hearer who does not know who is uttering *I am married*, may still learn that the speaker – *whoever she is* – is married; again he may do so by diagonalization (Stalnaker 1978). But nothing can be gained by diagonalizing *I am here*: the result is just as uninformative as the content it expresses according to its ordinary character.

The uses of diagonalization indicated here are all pragmatic. As we already mentioned, we will not go into the full story here, because it ultimately necessitates a much more refined setting. Apart from these pragmatic applications, there is reason to believe that diagonalization is of no avail to semantic analysis. In particular, we will soon (in Section 7) see reasons why it should not be rendered by an operator in the object language, modelled after (and mirroring)  $\nabla$  as analyzed in (36):

$$(41) \quad \llbracket \Delta \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^s(s)$$

## 5. Extensionality

The examples discussed so far suggest that the characters of complex expressions can be derived by combining those of their immediate parts. In fact, in all the above cases, this could be achieved by pointwise combinations, proving them to be extensional:

### Definition

- l)* A syntactic construction  $\Sigma$  is *extensional* if, for every context  $c \in C$  and situation  $s \in LR$ , there is a corresponding operation  $\Gamma^{c,s}$  on (possible) extensions such that for any expression  $\alpha$  built up by  $\Sigma$  from expressions  $\beta_1, \dots, \beta_n$ , the following equation holds:
- $$\llbracket \alpha \rrbracket^c(s) = \Gamma^{c,s}(\llbracket \beta_1 \rrbracket^c(s), \dots, \llbracket \beta_n \rrbracket^c(s)).$$

As is common in the algebraic approach to compositionality (cf. Janssen 1997), we take syntactic constructions (or environments, constellations, ...)  $\Sigma$  to be  $n$ -place structure-building operations. Note that the combination of extensions corresponding to an extensional construction may depend on the context and situation relative to which the extension of the whole expression is determined. If it does not, i.e. if  $\Gamma^{c,s}$  is the same for all  $c \in C$  and  $s \in LR$ , the construction  $\Gamma$  is called *canonically extensional*:

- m)* An extensional syntactic construction  $\Sigma$  is *canonically extensional* if there is a corresponding operation  $\Gamma$  on (possible) extensions such that for every context  $c \in C$ , situation  $s \in LR$ , and any expression  $\alpha$  built up by  $\Sigma$  from expressions  $\beta_1, \dots, \beta_n$ , the following equation holds:
- $$\llbracket \alpha \rrbracket^c = \Gamma(\llbracket \beta_1 \rrbracket^c(s), \dots, \llbracket \beta_n \rrbracket^c(s)).$$

Also note that for the equations in Definitions *l)* and *m)* to hold, it is not enough (though, of course, necessary) that the extensions of  $\alpha$  in *all contexts*  $c$  behave compositionally:

$$(42) \quad / \alpha /^c = \Gamma^{c,c}(/ \beta_1 /^c, \dots, / \beta_n /^c)$$

Rather, in order for the construction building up  $\alpha$  to be extensional, *all* extensions determined by  $\alpha$ 's intension (in arbitrary contexts  $c$ ) must behave compositionally. As a consequence, the equations in Definition *l)* and *m)* fully determine the character of  $\alpha$ . In Section 3, we have already seen an example of such a pointwise definition of the character combination corresponding to an extensional construction, viz. *subject predication*:

$$(25') \quad \llbracket SUBJ PRED \rrbracket^c(s) = \llbracket PRED \rrbracket^c(s)(\llbracket SUBJ \rrbracket^c(s))$$

In (25'), the syntactic construction is the formation of simple sentences by putting together referential subjects with their predicates; and the corresponding operation on extensions is *functional application* – 'APP', for short – combining a (characteristic) function  $f$  with its argument  $x$  to yield the value  $f(x)$ :  $APP(f, x) = f(x)$ . (To shun set-theoretic paradoxes, one must restrict APP and, e.g., prevent it from applying to itself; we are ignoring such complications here.) Using this notation, (25') can be reformulated as:

$$(25'') \quad \llbracket SUBJ PRED \rrbracket^c(s) = APP(\llbracket PRED \rrbracket^c(s), \llbracket SUBJ \rrbracket^c(s))$$

Note that, since APP in (25'') does not depend on  $c$  or  $s$ , subject predication turns out to be canonically extensional; in fact, it may well be that all extensional constructions are canonical (Zimmermann 1991: 167).

Given the generality of (25''), the equation fully determines a function that combines the characters of (referential) subjects and predicates into the characters of the corresponding sentences. More specifically, the relevant character composition is (*pointwise*) *functional application* –  $APP^*$ , for short – combining two characters  $\chi_1$  and  $\chi_2$  into one that assigns to each context  $c \in C$  an intension  $F(c)$  that in turn assigns  $APP(\chi_1(c)(s), \chi_2(c)(s))$  to each situation  $s \in LR$ . Using this notation, (25'') can be reformulated as:

$$(25^*) \quad \llbracket SUBJ PRED \rrbracket = APP^*(\llbracket PRED \rrbracket, \llbracket SUBJ \rrbracket)$$

Generalizing from this example, it is readily seen that for any (not necessarily canonically) extensional construction  $\Sigma$  satisfying the equation in Definition 1) there is a (unique) corresponding pointwise operation  $\Gamma^*$  on characters satisfying the general compositionality equation (43); the pointwise definition of  $\Gamma^*$  is given in (43\*), where the  $\Gamma^{c,s}$  are as in Definition 1) and  $\chi_1, \dots, \chi_n$  are (suitable) characters:

$$(43) \quad \llbracket \alpha \rrbracket = \Gamma^*(\llbracket \beta_1 \rrbracket, \dots, \llbracket \beta_n \rrbracket)$$

$$(43^*) \quad \Gamma^*(\chi_1, \dots, \chi_n)(c)(s) = \Gamma^{c,s}(\chi_1(c)(s), \dots, \chi_n(c)(s))$$

A function like  $\Gamma^*$  that combines the characters of the (immediate) parts of an expression  $\alpha$  into the character of  $\alpha$  itself, will be called the *character composition* associated with the pertinent syntactic construction. Hence  $APP^*$  is the character composition associated with subject predication, which is (canonically) extensional, given (25''); derivatively,  $APP^*$  will also count as (canonically) extensional. As pointed out above, many more syntactic constructions and their associate character compositions are extensional, prime examples being the combination of determiners with noun phrases, and of (ordinary, 'extensional') verbs with their quantificational subjects or any kind of (nominal) objects.

## 6. Attitude reports

It has been well known since the beginnings of modern semantics that not all syntactic constructions are extensional (let alone canonical). In particular, classical substitution arguments show that *clausal embedding* cannot be so interpreted (Frege 1892). Sentences of the following form are cases in point (where  $S$  is any declarative sentence):



(44) *John thinks that S*

Whatever the exact parts of such *attitude reports* are – *John; think; thinks that S; . . .* –, as long as *S* itself is one of them, the whole sentence is a (possibly quite complex) syntactic combination  $\Sigma$  of them. Now, if all syntactic constructions were extensional, then so would be all combinations of them. In particular,  $\Sigma$  would have to be associated with an extensional character composition  $\Gamma^*$ . By (42), then, the following equation would hold for any sentences *S* and contexts *c*:

(45)  $\llbracket \textit{John thinks that S} \rrbracket^c = \Gamma^{c,c}(\llbracket \textit{John} \rrbracket^c, \dots, \llbracket S \rrbracket^c)$

Obviously, this cannot be right. Otherwise any two sentences of the form (44) would have to have the same truth value as long as the embedded clauses do; in other words, substituting the embedded clause in (44) by an extensionally (or ‘materially’) equivalent one would not affect the truth value of the attitude report:

(46) If  $\llbracket S_1 \rrbracket^c = \llbracket S_2 \rrbracket^c$ , then  $\llbracket \textit{John thinks that S}_1 \rrbracket^c = \llbracket \textit{John thinks that S}_2 \rrbracket^c$ .

Readers are invited to instantiate the well-known absurdity (46) by their favourite counter-example.

While such *substitution arguments* show that not all syntactic constructions are extensional, they do not affect the compositionality of characters, i.e. the assumption that any (*n*-place) syntactic construction  $\Sigma$  may be associated with a character composition  $\Gamma$  that determines the characters of expressions constructed by  $\Gamma$  from the characters of its immediate parts (Montague 1970):

(47)  $\llbracket \Gamma(\beta_1, \dots, \beta_n) \rrbracket = \Gamma(\llbracket \beta_1 \rrbracket, \dots, \llbracket \beta_n \rrbracket)$

In particular, (47) could still be applicable to the constructions involved in building up sentences of the form (44). Instead of (45) we would just have.

(48)  $\llbracket \textit{John thinks that S} \rrbracket = \Gamma(\llbracket \textit{John} \rrbracket, \dots, \llbracket S \rrbracket)$

And the consequences from the corresponding substitution argument would be far less absurd than (46):

(49) If  $\llbracket S_1 \rrbracket = \llbracket S_2 \rrbracket$ , then  $\llbracket \textit{John thinks that S}_1 \rrbracket = \llbracket \textit{John thinks that S}_2 \rrbracket$

All (49) says is that substituting the complement of *think* by a clause *with the same character*, preserves the character of the original sentence of the form (44). And, indeed, purported counter-examples to the validity of (49) appear far less obvious than the ones against (47). For the purpose of this survey, we will simply ignore them and assume that characters do behave compositionally. (Cf. Cresswell (1985) and Stalnaker (1991, 1999) for some discussion of compositionality challenges in attitude reports.)

A closer look at pertinent examples suggests that the general mechanisms involved in deriving attitude reports are more restricted than (48) would suggest. Thus, in a context

$c_{50}$  in which Mary is talking to Jane on a Thursday and they are both in Rome, the following two reports amount to the same:

- (50) a. *John thinks that I met you here yesterday.*  
 b. *John thinks that Mary met Jane in Rome on Wednesday.*

Of course, in normal circumstances, Mary would not be inclined to express herself by (50b); in particular, she would not refer to herself as *Mary* and to her addressee as *Jane*. These preferences, which are not restricted to attitude reports, ought to be explicable in pragmatic terms, most likely by a principle of *presupposition maximization* (cf. Heim 1991, 2008; Sauerland 2008). Yet apart from its awkwardness, it is hard to see how, in the context given, (50b) could differ from (50a) in truth value; in fact, in the context at hand the two sentences seem to say the same thing. This might not come as a surprise. After all, the two sentences differ only as to their embedded clauses, and the latter coincide in their content in the context assumed here:

- (51)  $\llbracket I \text{ met you here yesterday} \rrbracket^{c_{50}} = \llbracket Mary \text{ met Jane in Rome on Wednesday} \rrbracket^{c_{50}}$

Indeed it would seem that the substitution of co-intensional clauses goes through precisely because attitude reports report a relation holding between the referent of the subject and the truth-conditional content of the embedded clause, i.e. its intension. This impression is confirmed by an influential analysis of attitude reports (Hintikka 1969; cf. article 60 (Swanson) *Propositional attitudes* for alternatives). According to it, an attitude verb expresses a (situation-dependent) relation between persons – the attitude *subjects* – and situations, which make up the person's pertinent *perspective* in a given situation  $s$ ; in the case of *think* (as appearing in (44)), this would be the so-called *doxastic* perspective, which consists of the set of situations that, for all the subject believes (in  $s$ ), he cannot exclude to be a situation he is in. And a report of the form (44) is true of a situation  $s$  just in the content of the complement clause is a superset of John's doxastic perspective in  $s$ , i.e. if that content applies to all situations that John does not exclude – and thus excludes all situations in which it does not; hence (44) comes out as reporting that John's doxastic perspective is a subset of the content expressed by  $S$ :

- (52)  $\llbracket (44) \rrbracket^c = \{s \in LS \mid \text{DOX}_{\text{John},s} \subseteq \llbracket S \rrbracket^c\}$

... where  $c \in C$  is an arbitrary context and  $\text{DOX}_{x,s}$  is a person  $x$ 's doxastic perspective in a situation  $s \in LS$ . There are various options of deriving (52) compositionally. E.g., one may determine the character of *think* as in (53) and then employ the general rule (54) for determining the extension of a predicate from the extension of the attitude and the intension of its complement clause:

- (53)  $\llbracket \text{think} \rrbracket^c(s) = \{(x,p) \mid \text{DOX}_{x,s} \subseteq p\}$   
 (54)  $\llbracket \text{AttVerb} [\text{that}] S \rrbracket^c(s) = \{x \mid (x, \llbracket S \rrbracket^c) \in \llbracket \text{AttVerb} \rrbracket^c(s)\}$

More generally, a simple (non-quantified) attitude report that derives from (44) by replacing *John* and *thinks* by a (suitable) referential subject and an attitude verb,

respectively, comes out as true of  $s$  just in case the content of the complement clause is a superset of the subject's pertinent perspective in  $s$  (supplied by the lexical meaning of the verb). In the case at hand, this means that Mary's report (50a), as uttered in  $c_{50}$ , is true of a situation  $s$  just in case John's doxastic perspective in  $s$  only contains situations  $s'$  in which  $\text{SPEAKER}(c_{50})$  met  $\text{ADDRESSEE}(c_{50})$  in  $\text{PLACE}(c_{50})$  at  $\text{DAY}(\text{TIME}(c_{50}) - 24\text{HRS})$ . Given our characterization of  $c_{50}$ , (50a) comes out as reporting a situation ( $s$ ) in which whatever John believes excludes the possibility ( $s'$ ) that Mary did not meet Jane in Rome on Wednesday. At first blush, this looks like an adequate truth condition for (the utterance of) (50a). And it obviously does make (50b) come out equivalent in  $c_{50}$ , precisely because, in that context, they express the same content.

So the Hintikka-style analysis of attitude reports supports the initial impression that the substitution of intensionally equivalent complement clauses of attitude reports of the form (44) preserves the content of the report. However, this approach has its limits. In particular, it faces two challenges that go by the name of beliefs (or, more generally: attitudes) *de re* and *de se*:

- A belief *de re* by John is a belief John has *about an object* (= lat. *de re*), i.e. something that he believes *of* something (or someone).
- A belief *de se* (by John) is one that John has *about himself* (= lat. *de se*) *as himself* (as opposed to having it about himself without being aware of this fact); hence every belief *de se* is also a belief *de re* though not *vice versa*.

It is easy to see that (some) sentences of the form (44) can be used to truthfully ascribe beliefs *de re* to John – and thereby present a challenge to semantic analysis, especially (but not exclusively) as based on a Hintikka-style model of attitudes. This is mainly due to two characteristic features of beliefs *de re*:

- (i) In order for John to form a belief *de re* about an *object* (lat. *res*) with a certain property, it is necessary for such an object to exist but not for John to know that it has that property (Quine (1956)). Thus, e.g., if John believes of Mary that she is Swiss and Mary happens to be the shortest Vatican spy, then there is such a spy and John has a belief (*de re*) about her, even though he may not make the connection between her and the Pope (because he only knows her as his polite neighbour, say).
- (ii) Still, in order for John to form a belief *de re*, it is necessary for him to somehow be acquainted with the *res* (Kaplan 1968). Thus, e.g., if John believes that there are Vatican spies without having any specific suspicions, he may deduce, and thus believe, that among them, one is the shortest; yet it seems that even if there is a shortest Vatican spy, John cannot be said to believe of her that she is the shortest spy if there is no connection between him and her.

One problem arising from (i) is that in reports of the form (44), referential expressions occurring within the complement clause  $S$  may refer to objects of belief. Hence their content should not contribute to the content of the sentence characterizing the subject's attitude. For example, the scenario in (i) may be reported by the following instance of (44), even though under the circumstances John may be quite neutral as to the existence of Vatican spies, or may even exclude the possibility that there are any:

(55) *John thinks that the shortest Vatican spy is Swiss.*

This observation suggests that the referent of the underlined expression in (55) needs to be determined relative to the situations in which John is reported as holding his belief (*de re*), rather than relative to his doxastic perspective; the latter would then have to only contain situations in which Mary – Vatican spy or (more likely) not – is Swiss. However, closer inspection of that alleged perspective reveals that it would require John to have some error-proof way of identifying the *res* (Mary) – which is beyond his cognitive capacities: ordinary identification procedures mostly rely on perception and memory and are principally prone to mistakes, however improbable. The (vast) literature on attitudes *de re* is full of pertinent (and sometimes rather exotic) examples to prove this point; *vide*, e.g., Lewis (1981) or Aloni (2001). In fact, it seems that the subject's acquaintance with the *res* observed in (ii) comes in here: in the case at hand, the situations that make up John's doxastic perspective would all have to contain someone who fits his way of identifying Mary and at the same time is Swiss; but this individual does not have to be the same across John's perspective, and *a fortiori* it does not always have to be Mary. If this reasoning – basically due to Kaplan (1968) – is on the right track, then the relation between the contents of the complement clauses in *de re* attitude reports of the form (44) and the subjects' pertinent (doxastic, epistemic, ...) perspectives is much more involved one than subsethood, which is all the Hintikka-style analysis has to offer. One strategy, inspired by Quine (1956), is to assimilate reports of the form (44) to sentences in which the *res* can be treated as an argument of the verb, as in certain infinitival constructions (*wants the shortest spy to leave*). To achieve this one needs to 'dissect' the complement clause in (44) into the expressions that correspond to the *res* (which may be plural!) and a remainder 'predicate' – in (55) this would be the underlined subject and the predicate –, and then describe the content of the report in terms of all these parts. (55) would then come out as akin to (55\*), where the embedded clause must denote a property rather than a sentence content; and the verb could then express a ternary relation between a subject, a *res*, and a property:

(55\*) *John thinks of the shortest Vatican spy that she is Swiss.*

While compositional treatments of (55\*) are conceivable according to which the underlined pronoun is interpreted as property-forming rather than deictic (cf. Chierchia 1989), it is not obvious how to adapt this strategy to (55) and reports of the form (44) in general, given that the number of *res* in them is unlimited; see, however, Cresswell & von Stechow (1982) for a systematic approach within a more fine-grained ('hyperintensional') framework. We will not delve into the details of this discussion but only note that part of the above conclusion that attitude reports only involve the contents of their complement clauses needs to be modified in the light of *de re* reports and depends on a solution of the problems surrounding them.

It should be noted in passing that although sentences like (55) can be used to report beliefs *de re*, they need not. In the scenario described in (ii), e.g., (55) may well be true despite there being no direct connection between John and the Vatican's employees: John may be convinced that only members of the Swiss Guard are eligible for the Vatican Secret Service. In this case, for the report (52) to come out true, the referent of the underlined description needs to be determined relatively to John's doxastic perspective: many

possible situations are compatible with John's beliefs, and though they all contain Vatican spies, they do not all agree as to who is the shortest of them. The description is then said to be construed *de dicto* [= about the expression, or rather its content]. Of course, this is precisely as the Hintikka approach would have it. Given that the difference between reports about beliefs *de re* vs. *de dicto* appears to be an ambiguity (which we will not justify here), the Hintikka analysis turns out to cover part of the reports of the form (44) (which may be better than covering all of them insufficiently). But the *de re* cases remain a challenge to it (and, to be fair, any systematic approach to the semantics of attitude reports).

It should also be noted in passing that although sentences like (55) can be used to report beliefs *de dicto*, those under (50) most likely cannot (*pace* Kripke 1979), due to the fact that the only referential terms they contain are rigid and their truth under a *de dicto* construal would thus require the subject to have 'superhuman' identification procedures at his disposal (cf. Lewis 1981).

Beliefs *de se* pose a different kind of challenge to the two-dimensional approach. To see what is at stake here, let us first look at a famous example, due to David Kaplan (1989a: 533):

If I see, reflected in a window, the image of a man whose pants appear to be on fire, my behavior is sensitive to whether I think, '**His** pants are on fire' or '**My** pants are on fire' [...]

Kaplan characterizes beliefs in terms of the characters of sentences the subject (Kaplan, in this case) would use to describe them. In the scenario at hand he initially has a certain belief *de re* about himself, and subsequently comes to hold the corresponding belief *de se*, which (by definition) is also a belief *de re*, with the same *res*; in fact, he continues to hold his original belief, but this is of no importance here, only the difference is. And there is a difference in his beliefs, a dramatic change indeed: his initial belief might lead Kaplan to start looking for the unfortunate person to warn him; given his updated belief, he is more likely to feel an urge to look for a hose or a bucket, cry for help, etc. The difference is reflected in the way the subject would describe himself, viz. by a certain 3rd person description (*the man whose reflection is visible in the window*) vs. the 1st person pronoun (*I*). Unlike the former belief *de re*, the latter is also a belief *de se*, a belief the subject holds not only about himself but also about himself *as himself*. As Frege (1919: 66) [(1956: 298)] put it, 'everyone is presented to himself in a particular and primitive way, in which he is presented to no-one else' (cf. Perry (1977), Kaplan (1989a: 529ff.), and Künné (1997) for reconstructions of Frege's views); and it is this peculiar mode of presentation, this subjective perspective the subject has on himself, that makes a belief *de re* a belief *de se*. The difference in perspective seems to be as obvious as it is hard to pin down. In particular, it does not show in the *contents* of the sentences that a subject is inclined to accept – as Kaplan's example makes clear: initially the subject would express his belief by (56) but not (57), though in the situation at hand the two sentences (as uttered by Kaplan) would express the same content, eliminating any possibility that Kaplan's pants are not on fire:

(56) *His pants are on fire.*

(57) *My pants are on fire.*

This substitution resistance is reminiscent of an observation made above, in connection with beliefs *de re*: (human) subjects' identification procedures are never quite immune

against error, and thus Kaplan's doxastic perspective could not cover exactly the situations to which (56) and (57) apply. Rather, each situation compatible with his belief would have to contain a person – not necessarily Kaplan himself – whose reflection he sees and whose pants are on fire, whereas his own pants are not. Now, by the same reasoning, the underlined pronouns in this characterization of Kaplan's doxastic perspective would also have to correspond to some way in which Kaplan would describe himself. It is not obvious which description this could be if not the 1st person pronoun (or some synonym like *the person with whom I am identical*). Maybe it should contain everything Kaplan knows about himself (as himself, to be sure)? However, various, at times rather exotic scenarios constructed in the literature on beliefs *de se* make it appear unlikely that the descriptions a subject has of himself eventually add up to his subjective perspective; *vide*, e.g., Geach (1957); Castañeda (1967); Perry (1979); Lewis (1979a). Loosely (but intuitively) speaking, the descriptions a person can give of himself without referring to himself as himself all lack the immediacy of what Frege (*ibid.*) called the 'subjective and primitive way' of the self-presentation characteristic of beliefs *de se*. In fact, it seems that any description a subject may have of any object or situation is based on, or relative to, his subjective perspective – as is illustrated by the underlined pronouns in the above account of Kaplan's beliefs. Moreover, unlike other (human) identification procedures, the subject's identification of himself as himself does seem to be immune to error: though, from his own perspective, it could have turned out that the man Kaplan sees is not he himself after all (or even that there was no man in the first place, only what looked like a reflection of one), it is next to impossible to imagine that he misidentified himself as the observer of that scene. These observations turn out to be important for the reconstruction of subjective perspective, as we will soon see.

Despite their coincidence in content (in the situation at hand), (56) and (57) do display a semantic difference, to wit in character. As it turns out, the subjective perspective corresponds to first person reference in the sentences by which the subject would be inclined to (honestly) describe his beliefs: although he believes certain things about himself *de re*, it is only when he realizes that he himself is the *res*, that he refers to himself in the first person. It would thus seem that the subjectivity characteristic of beliefs *de se* is a matter of character. In fact, closer inspection shows that it is not the whole character but only the diagonal that matters when it comes to characterizing belief in terms of sentence meaning (Stalnaker 1981): in describing his beliefs by sentences, the subject takes them to be true in a context; and if he only accepts the first person in a sentence if he has the corresponding belief *de se*, the context is one in which he himself is the speaker. In sum, if the subject uses a sentence to describe something he believes, he takes himself to be the speaker in a context in which the sentence is true. It would thus appear that the doxastic perspective ought to be characterizable in terms of the diagonal of the sentences accepted by a subject; more generally, it would have to consist of the possible contexts the subject might be in, for all he believes. Unfortunately, this cannot be *quite* correct for the simple reason that subjects do not always take themselves to be in utterance situations. A more accurate characterization of the doxastic perspective (in a situation *s*) thus necessitates a substitution of the SPEAKER parameter by a subject parameter: whereas the word *I* refers to SPEAKER(*c*) in any given context *c*, a subject takes himself to be SUBJECT(*s*), i.e. the subject, in any situation he finds himself in. As a case in point, Kaplan's perspective shifts from a set of situations in which someone other than the subject is reflected in the window, to the corresponding situations in which the (respective) subject's pants are burning. More generally, the *epistemological reinterpretation* [*erkenntnistheoretische Umdeutung*]

of the two-dimensional approach to context dependence (Zimmermann 1991: 178ff.) has all pertinent aspects of the context replaced ('subjectivized') by corresponding subjective categories: subject, subjective time, subjective spatial perspective, etc. and assigns to sentences *S* corresponding epistemological characters whose diagonals then turn out to be supersets of the epistemic perspectives of the subjects that would use them to characterize their beliefs. Technically, this shift involves a revision of Logical Space the details of which need not concern us here; it is usually carried out in terms of the parameterization to be discussed in Section 8 and will briefly be addressed there. Varieties of epistemological reinterpretation have some success in current metaphysics and philosophy of mind (e.g., Chalmers 1996, Spohn 2009: Part V), in particular when it comes to tease apart *metaphysical* ('objective', 'perspectiveless') and *epistemic* ('subjective', 'perspectival') informational content. In the semantics of attitude reports, it may therefore be employed to correct the simplified Hintikka-style approach to psychological attitudes. As a case in point, we may look at a report about Kaplan's unfortunate (though, presumably, imaginary) experience where we take it that the possessive pronoun *his* is anaphoric to the matrix subject and may therefore be interpreted as (directly) referring to David Kaplan:

(58) *Kaplan thinks his pants are on fire.*

Since (58) does not contain any context-dependent material (or so we assume), it is absolute and has the same content across all utterance contexts. And it appears that this content applies to both the initial and the subsequent stage of Kaplan's learning process, to which we will refer as '*s*<sub>0</sub>' and '*s*<sub>1</sub>', respectively. This has to do with the fact that the complement clause shares its content with the contents of the sentences under (56) and (57) as uttered by Kaplan. Yet the connection is not as direct as it might seem: as was already remarked, Kaplan's doxastic perspectives in the situations *s*<sub>0</sub> and *s*<sub>1</sub> do not cover this content. On the other hand, in *s*<sub>1</sub> Kaplan sees himself in a position to assent to (57), and the content he expresses (or would express) by (57) in *s*<sub>1</sub> is precisely the content of the complement in (58). And although he does not assent to (57) in *s*<sub>0</sub>, he does see himself in the mirror and thus could have described his belief by uttering (56), which again coincides in content with the complement of (58). Now, from this observation we might jump to the general conclusion that, for an attitude report to apply to a situation *s*, it is necessary and sufficient that (\*) the content of the embedded clause must coincide with the content of some sentence that the subject would be inclined to agree to in *s*. Alas, things are not so simple, basically due to a radical generalization of Kaplan's (1968) infamous shortest spy problem (ii): given certain harmless side-conditions, (\*) is met as soon as the complement of the embedded clause happens to be true of *s*; rather than pursuing this line of reasoning, we refer the reader to the concise presentation in article 61 (Schlenker) *Indexicality and de se* (p. 1572), based on Crimmins (1998) and von Stechow & Zimmermann (2005). In any case, a more sophisticated account is called for. And though, e.g., the 'hyperintensional' approach (Cresswell & von Stechow 1982) smoothly generalizes from *de re* to *de se* reports (von Stechow 1984), a treatment that conforms to more orthodox compositionality standards is yet to be found.

Sentences of the form (44), then, may be used to report *de se* beliefs. However, as with *de re* beliefs in general, this does not mean that the complement of the attitude verb is something the subject could truthfully utter in the situation described. Otherwise (58\*) would be an adequate report about *s*<sub>1</sub> – no matter who utters the sentence:

(58\*) *Kaplan thinks my pants are on fire.*

However, unless (somewhat unidiomatically) Kaplan himself uses (58\*), the sentence would be a false report of  $s_1$  – for the simple reason that the content the embedded clause expresses in the reporting context does not match the content of the any sentence Kaplan would assent to in  $s_0$ ; in particular, Kaplan does not believe that the person who happens to describe  $s_1$  by uttering (58\*), has burning pants. So although the 1st person as used by the attitude subject expresses his own subjective perspective, in the report it refers to the speaker – despite the fact that it occurs in the clause he uses to describe the subject's attitude. We will return to this elementary observation in the next section.

The fact that sentences of the form (44) (and similar) can be used to report about attitudes *de re* and *de se* does not mean that they are ambiguous in this respect: by definition, attitudes *de se* are attitudes *de re*, and these reports appear to cover them all. That no ambiguity is likely to be involved is suggested by the observation (frequently misattributed to Zimmermann 1991, methinks) that *quantified attitude reports* may generalize over a mixed bag of attitudes *de re* and *de se*:

- (59) a. *Each of these men thinks that his pants are on fire.*  
 b. *Only one of these men thinks that his pants aren't on fire.*

The reader is invited to fill in the details and then check her intuition: (59a) may be true (though a misleading thing to say) if all but one of the men wrongly think their own pants are on fire (*de se*) and one of them believes that he is watching (precisely) one man with burning pants without realizing he is watching himself (purely *de re*). At the same time, (59b) may be judged true in the same scenario, which does indicate that reports of the form (44) have separate *de se* reading after all. However, it is not obvious how to tell apart semantic and pragmatic effects in these cases. In particular, the source of the ease with which attitudes *de se* can be attributed is not obvious; cf. Percus & Sauerland (2003), Maier (2006), and Anand (2006) for different approaches. Unequivocal *de se* readings may still be found beyond the realm of clausal reports like (44), viz. in certain infinitival constructions involving control-verbs (Chierchia 1989).

- (60) a. *John wants to be president.*  
 b. *John wants himself to be president.*

Whereas (60b) can be applied to a situation in which John, who has given up on his political career, sees someone on TV who he judges to be a good candidate without realizing that it was himself, no such interpretation is available to (60a). But for the attitude, the example is quite parallel to Kaplan's scenario. This suggests that, unlike the reflexive in (60b), which is *de re*, the implicit subject (PRO) of the infinitive in (60b) needs to be restricted to a *de se* interpretation, i.e. as standing for the first person were the subject to describe his wishes. Unlike the *de re* construals of reports of the form (44), neither form in (60) presents a compositionality challenge, because in both cases the position of the *res* is structurally identifiable. In particular, the main verb in (60b) can be interpreted as expressing a ternary relation holding between the attitude subject (John), a *res* (John), and the intension of the infinitive, i.e. a function assigning sets of individuals (the presidents) to possible situations; roughly, the relation holds in a given situation  $s$  just in case the



subject's pertinent (in this case: *bouletic*) perspective 'implies' that there is someone he is acquainted with in some way he is actually acquainted with the *res* (as the guy on TV, say) and who is the president. The details of this treatment depend on the precise reconstruction of subjective perspectives within an epistemological reinterpretation. The same goes for the *de se* attitude expressed by (60a), to which we will return in the next section.

In sum, sentences of the form (44) are most easily interpreted as reports about attitudes *de dicto*. As reports about attitudes *de re* they present a serious challenge to compositional interpretation, Hintikka-based or otherwise. The special case of *de se* attitudes adds the complication that the subject's perspective must be taken into account when it comes to characterizing his attitude and his relation to the *res*; moreover it is not clear in which cases they constitute separate readings.

## 7. Monsters

Let us take a step back. In Section 2 we saw that the 'one-dimensional' approach to extensions as solely depending on contexts cannot explain the difference between two kinds of trivialities: those that come out true whenever uttered, and those that express trivial content. The two-dimensional account of extensions in terms of characters introduced in Section 3 was designed to capture this distinction by sneaking in intensions mediating between contexts of utterance and extensions. In Section 4 we saw that, apart from the ordinary content that excludes possibilities in Logical Space, characters also encode diagonal content, which may serve various pragmatic purposes. However, even though we insisted right from the beginning that the observations and subtleties captured by the two-dimensional approach somehow depend on literal meaning, it is not all that obvious that they are themselves semantically relevant. In particular, one may wonder whether the notion of (ordinary) content that was crucial to the distinction between necessity and *apriority* has a rôle to play in semantics, or whether it is just derived from literal meaning by some pragmatic processes. As it turns out though, there is hope to give a purely semantic motivation of the notion of content (and intension in general). To this we will now turn.

The starting point of the preceding section was a classical substitution argument to the effect that clausal embedding under attitude verbs is not extensional. On the other hand, we also observed that once the utterance context is fixed, substitution of intensionally equivalent material does not bear on the truth value of the report (though it may affect its pragmatic acceptability); hence in a suitable context (like  $c_{50}$ ) the following two sentences come out as extensionally equivalent because the embedded clauses coincide in their content:

- (50) a. *John thinks that I met you here yesterday.*  
 b. *John thinks that Mary met Jane in Rome on Wednesday.*

Now, it is worth noting that these substitution facts are independent of the *de re/de dicto* ambiguities:

- (61) a. *John thinks that Mary's husband is Greek.*  
 b. *John thinks that the man who is married to Mary is Greek.*

Given that the underlined descriptions in (61) are intensionally equivalent, both sentences report John to either hold a certain belief *de re* about Mary's husband (whom John

need not associate with Mary then), or else to think that whoever is married to Mary is Greek (in which case Mary could well be husbandless).

Abstracting from the details of the case, we may thus venture the hypothesis that replacing a complement clause in an attitude report of the form (44) by one with the same content does not affect the truth value of the report at large. Instead of the absurd extensional substitution principle (46), the general compositionality principle (49) can be strengthened to (62):

(46) If  $/S_1/^\epsilon = /S_2/^\epsilon$ , then  $/John\ thinks\ that\ S_1/^\epsilon = /John\ thinks\ that\ S_2/^\epsilon$ .

(49) If  $\llbracket S_1 \rrbracket = \llbracket S_2 \rrbracket$ , then  $\llbracket John\ thinks\ that\ S_1 \rrbracket = \llbracket John\ thinks\ that\ S_2 \rrbracket$ .

(62) If  $\llbracket S_1 \rrbracket^\epsilon = \llbracket S_2 \rrbracket^\epsilon$ , then  $\llbracket John\ thinks\ that\ S_1 \rrbracket^\epsilon = \llbracket John\ thinks\ that\ S_2 \rrbracket^\epsilon$ .

Similar observations can be made with other non-extensional constructions. Thus, e.g., in the above context  $c_{50}$ , the following sentences appear to pairwise express the same content:

- (63) a. *It is possible that I met you here yesterday.*  
 b. *It is possible that Mary met Jane in Rome on Wednesday.*

- (64) a. *I want to meet you tomorrow.*  
 b. *Mary wants to meet Jane on Friday.*

- (65) a. *John is looking for a book about Jane.*  
 b. *John is looking for a book about you.*

In each of these cases the underlined constituent can be shown to resist substitution by co-extensional expressions *salva veritate* (= thereby preserving truth [values]). Hence, just like in attitude reports of the form (44), the pertinent syntactic construction cannot be extensional. However, the substitutions in (63)–(65) do go through because the underlined constituents happen to have the same (pairwise) intensions in the context at hand. Hence, though not extensional, the constructions in question do seem to have a special property that would explain the substitutivity facts:

### Definition

- n*) A syntactic construction  $\Sigma$  is *intensional* if, for every context  $c \in C$ , there is a corresponding operation  $\Gamma^c$  on (possible) intensions such that for any expression  $\alpha$  built up by  $\Sigma$  from expressions  $\beta_1, \dots, \beta_n$ , the following equation holds:
- $$- \llbracket \alpha \rrbracket^\epsilon = \Gamma^c(\llbracket \beta_1 \rrbracket^\epsilon, \dots, \llbracket \beta_n \rrbracket^\epsilon)$$

A comparison of Definitions *l*) and *n*) reveals that every extensional construction is intensional:  $\Gamma^c$  in *n*) can always be constructed from the  $\Gamma^{c,s}$  as given in *l*) by putting:  $\Gamma^c(\iota_1, \dots, \iota_n)(s) = \Gamma^{c,s}(\iota_1(s), \dots, \iota_n(s))$ , for any situation  $s \in LS$  and (suitable) intensions  $\iota_1, \dots, \iota_n$ . (The verification of the details are left to the reader.) Hence ‘intensional’ means ‘at most intensional’; if a construction is intensional without being extensional, we may say that it is *properly intensional*.

In general, properly intensional constructions are characterized by a failure of extensional substitution, i.e. the fact that the extension of the whole (partly) depends on the

intension of (at least) one of its (immediate) parts; since this intension itself consists of the extensions of that part at all possible situations, one may think of intensional constructions as having the extension of the whole at a given situation depend on the extensions of one of the parts at other situations than that situation alone (otherwise the construction would be extensional and not properly intensional). So intensional construction can be loosely characterized as involving a *shift* from the situation at hand to other situations relevant to determine the intension of the substitution-resistant part, and thus the extension of the whole. As a case in point, if analysed à la Hintikka (1969), belief reports (and attitude reports in general) involve a shift from the situation reported to the subject's doxastic (or otherwise pertinent) perspective. Though this characterization is not without intuitive appeal (which explains its popularity among semanticists, logicians, and philosophers of language alike), one should be aware that it is quite loose in that the purported 'shift' normally does not replace one situation by another *one*, but brings in a whole bagful of relevant alternative situations; it may even bring in all of Logical Space, as in the case of (a certain reading of) the adverb *necessarily* that characterizes a sentence as true if its intension holds of every possible situation. In fact, mere shifts that would replace the situation described by another *one* seem to be unattested; but we will meet something close to it in a minute. Given this, it would be more accurate to speak of *abstraction* from the situation at hand, or *generalizing* over possible situations. Despite these qualms, we will follow tradition and say that the hallmark of intensionality is the *shiftiness* of the situation described.

The case of clausal embedding and the examples in (63) indicate that not every intensional construction is extensional. Neither is every (conceivable) character composition intensional. In fact, we have already seen an example of a non-intensional 'construction', viz. diagonalization:

$$(41) \quad \llbracket \Delta \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^c(s)$$

Whatever the syntactic details of (presumed) expressions of the form ' $\Delta \alpha$ ', they must involve some non-intensional construction if (41) is to hold. To see this, let us look at  $c_{50}$  again, where Mary is speaking in Rome and we thus have:

$$(66) \quad \llbracket I \text{ am here} \rrbracket^{c_{50}} = \llbracket Mary \text{ is in Rome} \rrbracket^{c_{50}}$$

However, by the observations made in connection with (39) in Section 4, we may conclude:

$$\begin{aligned} (67) \quad & \llbracket \Delta I \text{ am here} \rrbracket^{c_{50}} \\ &= \{s \in LS \mid \llbracket I \text{ am here} \rrbracket^c(s) = 1\} \\ &= \{s \in LS \mid \llbracket \text{SPEAKER}(s), \text{PLACE}(s) \rrbracket \in \text{AT}(s)\} \\ &= C \end{aligned}$$

The last line in (67) is due to the apriority of *I am here* (which takes care of the ' $\supseteq$ '-direction) and the fact that the SPEAKER function is defined for utterance contexts only (' $\subseteq$ '). On the other hand, diagonalizing *Mary is in Rome* is useless because the sentence is absolute:

$$\begin{aligned}
 (68) \quad & \llbracket \Delta \text{ Mary is in Rome} \rrbracket^c_{50} \\
 &= \{s \in C \mid \llbracket \text{Mary is in Rome} \rrbracket^c(s) = 1\} \\
 &= \{s \in C \mid (\text{Mary, Rome}) \in \text{AT}(s)\} (= \llbracket \text{Mary is in Rome} \rrbracket^c_{50})
 \end{aligned}$$

Clearly, the set in (68) does not coincide with  $C$ : it misses out contexts in which Mary (speaker or not) is away from Rome (and, if "extrapolated", it also contains situations in which no word is spoken). Hence although *I am here* and *Mary is in Rome* have the same content (in the context at hand), their diagonalizations do not; as a consequence, diagonalization is not intensional (and cannot be achieved by combining intensional constructions either). Interestingly, its mirror image, direct interpretation operator  $\nabla$  (a.k.a. *dthat*), is:

$$(36) \quad \llbracket \nabla \alpha \rrbracket^c(s) = \llbracket \alpha \rrbracket^c(c)$$

The intensionality of the construction in (36) is brought out by the following equation, where (for any  $c \in C$ )  $\Gamma^c$  is the operation assigning to any intension  $\iota$  the extension  $\iota(c)$ :

$$(69) \quad \llbracket \nabla \alpha \rrbracket^c = \Gamma^c(\llbracket \alpha \rrbracket^c)$$

Since  $\Gamma^c$  obviously depends on  $c$ , direct interpretation is not a canonically intensional construction though; the verification of (69) and the definition of canonical intensionality are left to the reader.

In Section 4 it was mentioned that diagonalization, understood as replacing the content of an utterance by its diagonal, is a pragmatic repair strategy applied to natural language characters, particularly by hearers that lack sufficient knowledge of the context to determine the content of the utterance. If this is the only kind of use made by diagonalization, then there is no need for a diagonal operator in the (natural) object language, as in (41). Given that this was our only example of a (potential) non-intensional construction so far, one may now wonder whether there are any other ones. As it turns out, this is not obvious. In fact, one of the central tenets of the two-dimensional approach to context-dependence has it that there are none:

*Ban on Monsters*

All syntactic constructions are (at most) intensional.

The Ban goes back to David Kaplan's (1989a) *Demonstratives* (originally distributed in 1977, and actually dating from the early 1970s), the *locus classicus* of two-dimensionality. Its name alludes to a section heading ('VIII. Monsters Begat by Elegance', p. 510), under which diagonalization (as a language-internal operator) is discussed as a potential counter-example; another formulation is that there are no monsters, which are then defined as non-intensional constructions. The rationale of the Ban on Monsters is that two-dimensional interpretation comes in two steps: first the context fixes the referents of deictic (and similar) expressions, then compositionality takes over, combining extensions and intensions as in the pre-Kaplanian times of so-called Frege-Carnap semantics (Frege 1892, Carnap 1947). Hence the Ban finally gives an answer to the question of whether content has a rôle to play in semantics, or whether it is merely a derivative of sentence meaning that is primarily of pragmatic interest: like intensions in general, the contents of sentences are what counts for compositionality.

Ever since Kaplan placed the Ban on Monsters, ample confirmation has been found in terms of constructions that conform to it. However, Kaplan's Ban has also been subject to numerous attempts at refutation, especially since Schlenker (2003), a paper aptly titled *A Plea for Monsters*. To get the flavour of the most prominent kind of counter-example, it is instructive to once more return to the topic of the preceding section, where we noticed that (44) cannot be made true by plugging in a sentence *S* that John is inclined to agree to (in the circumstances described). Rather, the subject's 1st person reference would have to be replaced by a corresponding 3rd person referring to him as a *res* (given to him as his self). This is a brute fact about the system of personal pronouns in English and many other languages – but not all. For there happen to be languages in which (what looks like) a 1st person pronoun occurring in an attitude report may indicate the subject's perspective on himself, instead of referring to the producer of the report. The following example from the (Indoeuropean) language Zazaki (spoken in Turkey) and collected by Anand & Nevins (2004: 22) is a case in point:

(70) *Rojda ne va ke mi kes paci kerd.*

Word by word, the sentence reads 'Rojda not said that I anyone kiss did', but it means that Rojda did not say that she kissed anyone. The presence of the negative polarity item *kes* ['anyone'] shows that the embedded clause is not a quotation; hence according to the Ban on Monsters, the underlined pronoun ought to refer to the speaker of the report. Note that (70) is indirect speech rather than an attitude report. As a consequence, it is readily interpreted by *diagonalizing* the underlined pronoun, which then comes out as meaning *the speaker*. Moreover, the phenomenon of an unexpected contextual shift is not restricted to the speaker but also affects other contextual parameters such as the addressee, which can be treated in a parallel way. However, such 'local' diagonal operators are obviously monstrous. One way of avoiding them in the case at hand is to treat the personal pronouns as absolute expressions, lexically interpreted by the diagonal content of ordinary personal pronouns; however, this interpretive strategy would not explain the particular distribution of their readings, for which we have to refer the reader to Anand & Nevins (2004) and Anand (2006). More counter-examples to Kaplan's Ban along the lines of (70) have been observed in a variety of languages. Their precise nature and pattern appears to be in need of further exploration but it is clear that the Ban will not emerge from this scrutiny unscathed; see article 61 (Schlenker) *Indexicality and de se* for the current state of research (and much more on the topic).

Apart from such diagonal readings of personal pronouns in reports there are some other phenomena that appear to be difficult (though not impossible) to reconcile with the Ban on Monsters. In particular, sometimes a deictic expression that would normally have its extension determined by the context of utterance, seems to be used in a more general way. Here are four quite different cases:

- (71) a. *Never put off until tomorrow what you can do today.*  
 b. *Only I did my homework.*  
 c. *Every man faced an enemy.*  
 d. *Only one class was so bad that no student passed the exam*

(71a) is mentioned in Kaplan (1989a: 510, fn. 4) and attributed to Richmond Thomason. The natural way to understand this proverb is as a general advice to be followed on a

day-to-day basis. In particular, the temporal adverbs *today* and *tomorrow* are not understood as referring to the day of utterance and its successor. Yet if they have their ordinary, deictic readings in (71a), this reference could only be overridden by a monster. However, even though a lexical ambiguity is unlikely here, a pragmatic analysis seems to be within reach; cf. Zimmermann (1991: 219) for some speculation and Predelli (1996) for a more specific proposal.

The crucial observation about (71b), due to Irene Heim (c. 1991), is that in it the 1st person possessive *my* does not seem to make reference to the speaker. Rather, the whole sentence quantifies over a domain (of students, most probably) and the object *my homework* is understood as ‘co-varying’ with the objects in that domain, i.e. the persons quantified over by the subject *only I*. Hence this particular use of the 1st person is not deictic but quantificational, and again no ambiguity seems to be involved. It may thus appear that (71b) presents another case of generalization over contexts, though one that cannot be explained in pragmatic terms. However a natural explanation may be found on the other side of the semantic interfaces: it is well known that morphological features (like number, gender, . . .) may generally carry meaning without always being semantically active (or *interpretable*). Thus, e.g., the underlined pronoun in (72), though morphologically plural, expresses singular meaning, co-varying with the persons quantified over by the subject:

(72) *Most students did their homework.*

In this case it is rather obvious that the pronoun *their* is both semantically and morphologically dependent on the quantifier *most students*, the former relation being one of binding, the latter consisting in number and person agreement. Arguably, something similar might be going on in (71b): although the form *my* carries first-person morphology due to its syntactic relation to the subject *only I*, and although this relation itself is semantically interpreted (as quantificational ‘binding’), in this specific constellation, the morphological feature is not. In general, then, words like *I*, *you*, or *my* would have to be treated as complex expressions, with person features as their parts; and these person features are deictic expressions, which however need not be semantically active (or occur properly, i.e. semantically visibly). *Vide*, e.g., von Stechow (2003) for a detailed proposal along these lines, and Sternefeld (2008) for some principled criticism and a different approach.

In Section 1, we have seen that the context may supply the referents of implicit arguments of relational nouns like *enemy*:

(5) b. *He is an enemy.*

This construal is also available for (71c), borrowed from Partee (1984: 301): if, e.g., a Norwegian general utters the sentence, he may speak about a battle fought by the Norwegian army and thus express that each of his soldiers faced a member of the same guerilla army. Hence the general would use the subject as quantifying over Norwegian soldiers (in line with the context-dependence of quantifier domains observed in Section 1); and depending on the exact circumstances (including the general’s intentions), the implicit argument might be the Norwegians or the Norwegian army. However, (71c) could also be used by someone who describes the same battle scene from a more neutral point of view, quantifying over Norwegian and guerilla soldiers alike. In that case, the implicit argument could not be supplied by the context; for it would have to depend on

the respective soldiers quantified over. Again this means that we cannot treat the implicit argument as in (5b), where took it to be the value of some contextual parameter. At first blush this looks like a monster is lurking somewhere behind the quantificational construction; but then it is not obvious how to arrive at the correct truth conditions of (the relevant reading of) (71c) by quantifying over contexts; presumably, the contexts quantified over would have to have soldiers as their speakers, but then the quantification should not affect the other contextual parameters. It seems more promising to treat implicit arguments like variables in logic and allow them to be bound by quantifiers in higher positions while the values of free variables depend on the context of utterance. This would also conform to Partee's (1984: 301) observation that there do not seem to be 'any cases of implicit arguments which can be interpreted *only* as bound variables or *only* as indexicals' [= deictic expressions]. We will soon return to this strategy.

(71d), which is von Fintel's (1996: 31) translation of a German example due to Heim (1991: 508), poses similar problems. Although the domain of the underlined quantifier ought to depend on the context, it does not but rather co-varies with the classes quantified over by the matrix subject. Again, a monster seems to be in sight, and again the remedy could be bindable variables on whose values quantificational domains (may) depend; cf. von Fintel (1996: 28ff.) and Stanley & Szabó (2000: 251ff.) for specific proposals along these lines. Hence sometimes what looks like a deictic expressions captured by a monster may turn out to be a variable bound by a quantifier.

The treatment of seemingly deictic expressions as variables can also be applied to 3rd person pronouns, which (as we have seen in Section 1) bear some similarity to demonstratives in that their referents are (sometimes) supplied by the context, to wit by whatever the speaker intends to refer to. However, it is well known that they too can be bound by nominal quantifiers; the following contrast may be used to illustrate this point:

- (73) a. *Mary likes his teacher.*  
 b. *Everyone likes his teacher.*

Ignoring irrelevant details and alternative readings, we may bring out the difference in the interpretation of the underlined (possessive) pronouns by a bit of (predicate) logical notation:

- (74) a.  $\text{LIKE}(\text{MARY}, \text{TEACHER}(\underline{x}))$   
 b.  $(\forall x) \text{LIKE}(x, \text{TEACHER}(\underline{x}))$

The formulae in (74) may be seen as approximations to the truth conditions of the corresponding sentences in (73), with underlined occurrences of the variable  $x$  corresponding to occurrences of the 3rd person pronouns. The occurrences in (74) differ in their status: the underlined ' $x$ ' in (74a) is free, the one in (74b) is bound (by the universal quantifier). As a consequence, unlike the closed formula (74b), (74a) only denotes a truth value relative to a variable assignment. This may be seen as parallel to the contrast in (73): in (73a) the referent of the pronoun is supplied by the context, in (74b) it is not. In fact, the denotations of both the pronoun in (73b) and the variable in (74b) seem to co-vary with the individuals in the domain of the respective quantifiers, *everyone* and  $\forall$ . Hence we would make the parallel perfect by assuming that the context is to the occurrence of *his* in (73a) what the variable assignment is to ' $x$ ' in (74a). In other words, it looks like we

ought to identify 3rd person pronouns with variables and contexts with variable assignments (cf. Montague 1970). As a consequence, though, the very process of binding would come out as a monster: just like the logical formula in (74b) can only be evaluated by going through its truth values under more than one assignment, so would the sentence in (73b) have to be interpreted by comparing its extensions across different contexts. Hence either the parallel between (73) and (74) or the Ban on Monsters has to go (Zimmermann 1991: 201ff.; Rabern 2012a, 2012b).

As it turns out the question whether the Ban should be upheld is quite tricky, which is partly due to its shifty theoretical status. For it may come either in the guise of an empirical hypothesis (as suggested by the discussion so far) or as an analytic theorem. To the second option we now turn.

## 8. Parameterization

The examples discussed so far suggest that the rôle of the utterance situation in determining extensions is restricted to contributing certain aspects or parameters like *SPEAKER*, *ADDRESSEE*, *TIME*, *PLACE*, etc. We have treated such parameters as functions assigning extensions to specific (possible) situations. Of course, there are innumerable such functions only very few of which are relevant to determining the extensions of context-dependent expressions (via their characters) – as *contextual* parameters. We have left their precise nature and number open and will continue to do so. However, we will assume that there are enough of them to distinguish any two contexts; in other words, we take the correspondence between contexts and their parametric values to be one-one:

### Definition

- o) A *C*-parameterization is a finite list  $\pi = (\pi_1; \dots; \pi_n)$  of functions  $\pi_i$  with domain *C* (and arbitrary ranges) such that,  
 (\*) for any distinct contexts *c* and *c'*:  
 $\pi_i(c) \neq \pi_i(c')$ , for some  $i \leq n$ .  
 For any  $c \in C$ ,  $c^* := (\pi_1(c); \dots; \pi_n(c))$ ; hence  $c^* \neq c'^*$  whenever  $c \neq c'$ .

For definiteness, let us zoom in on a particular *C*-parameterization that includes the four contextual parameters mentioned a few lines earlier as well as the spatio-temporally maximal situation of which the utterance situation is part – its (possible) *WORLD*:

$$(75) \quad c^* = (\text{SPEAKER}(c); \text{ADDRESSEE}(c); \text{WORLD}(c); \text{TIME}(c); \text{PLACE}(c); \dots)$$

We will say that  $c^*$  *represents* the context  $c \in C$  (relative to the parameterization given) just in case (75) holds. Since, by assumption, the contextual parameters suffice to determine all extensions, the utterance situations in all their specificity and abundance, may as well be replaced by their representations. More precisely, we may encode characters  $\chi$  by functions  $\chi^*$  assigning intensions to representations of parametric values:

$$(75^*) \quad \chi^*(c^*) = \chi(c)$$



C-parameterizations are little more than standardizations of characters, and may even be perceived as notational overkill. Moreover, there may be Ockhamian reasons for mistrusting them, due to the danger of proliferation of contextual parameters *praeter necessitatem*, as caricatured by Cresswell (1972: 8, 1973: 111) with his infamous *previous drinks* coordinate, supposedly to account for *Just fetch your Jim another quart*. On the other hand, there seems to be something natural about parameterizing contexts; the technique has been popular ever since Scott (1970). In any case, it turns out to be useful when we step down from characters to intensions and replace the situations in their domains by corresponding lists.

Before doing so, we need to get clear about what should make the difference between a contextual parameter and one that may be employed in the description of (properly) intensional constructions. As was mentioned near the beginning of the previous section, there is quite some variation among such constructions. In particular, constructions differ as to which aspects of the situation they abstract from: modals tend to bring in other possible worlds (cf. article 58 (Hacquard) *Modality*); some ‘frame-setting’ temporal adverbs and prepositions go back and forth in time (see article 57 (Ogihara) *Tense* and the literature cited there for a fuller picture); and, *pace* Maienborn (2001), presumably the same holds for literal uses of locative frame adverbials (Thomason & Stalnaker 1973). Under the assumption (76) that modification by sentence adverbs is interpreted by combining the extension of the adverb with the intension of the modified sentence, we can illustrate each case by (extremely simplified) character descriptions as in (77):

$$(76) \quad \llbracket ADV_{\{mod, temp, loc, \dots\}} S \rrbracket^c(s) = 1 \text{ iff } \llbracket S \rrbracket^c \in \llbracket ADV_{\{mod, temp, loc, \dots\}} \rrbracket^c(s)$$

$$(77) \quad \begin{aligned} \text{a. } \llbracket possibly \rrbracket^c(s) &= \{X \subseteq LS \mid s' \in X, \text{ for some } s' \in LS \text{ such that } s \stackrel{W}{=} s'\} \\ \text{b. } \llbracket now \rrbracket^c(s) &= \{Y \subseteq LS \mid s' \in Y, \text{ for some } s' \in LS \text{ such that } s \stackrel{T}{=} s' \& \text{ TIME}(s') = \text{TIME}(c)\} \\ \text{C. } \llbracket in Rome \rrbracket^c(s) &= \{Z \subseteq LS \mid s' \in Z, \text{ for some } s' \in LS \text{ such that } s \stackrel{P}{=} s' \& \text{ PLACE}(s') = \text{Rome}\} \end{aligned}$$

In (77) the relation  $\stackrel{W}{=}$  should be understood as holding between two situations that may be part of different Worlds but are otherwise (e.g., with respect to their time and place) as similar to each other as possible; and likewise for  $\stackrel{T}{=}$  and  $\stackrel{P}{=}$ , and the Times and Places of the situations related rather than their Worlds. These manoeuvres are necessary in order to account for nested occurrences of these adverbials, as the reader is invited to verify. Given this background, it is easy to pin down in which sense modal, temporal, and locative adverbials respectively *shift* the modal, temporal, and spatial parameter of the situation described:

$$(78) \quad \text{If } \left\llbracket \left\{ \begin{array}{c} ADV_{mod} \\ ADV_{temp} \\ ADV_{loc} \end{array} \right\} S_1 \right\rrbracket^c(s) \neq \left\llbracket \left\{ \begin{array}{c} ADV_{mod} \\ ADV_{temp} \\ ADV_{loc} \end{array} \right\} S_2 \right\rrbracket^c(s),$$

then for some  $s' \in LS$  such that  $\left\{ \begin{array}{c} s \stackrel{W}{=} s' \\ s \stackrel{T}{=} s' \\ s \stackrel{P}{=} s' \end{array} \right\} : \llbracket S_1 \rrbracket^c(s') \neq \llbracket S_2 \rrbracket^c(s')$

We leave it to the reader to verify that each of the characters defined in (77a–c) satisfies one of the conditions in (78), though none satisfies any of the other two. Generalizing from (78), we will say that an  $n$ -place construction  $\Gamma$  *shifts* a function  $\pi$  defined on  $LS$  just in case there is a place  $i \leq n$  such that the following equation holds for any  $c \in C, s \in LS$ , and characters  $\chi_1, \dots, \chi_n$  in the domain of the character composition  $\Gamma^*$  associated with  $\Gamma$ :

$$(79) \quad \text{If } \Gamma^*(\chi_1, \dots, \chi_n)(c)(s) \neq \Gamma^*(\chi_1, \dots, \chi'_1, \dots, \chi_n)(c)(s), \\ \text{then for some } s' \in LS \text{ such that } s \stackrel{\pi}{\equiv} s': \chi_1(c)(s') \neq \chi'_1(c)(s')$$

The relations  $\stackrel{\pi}{\equiv}$  (and even the notation) are reminiscent of so-called *modified assignments* used in the compositional approach to variable binding in logic. However, situations not being assignments, their exact meaning is less clear. Thus, e.g., some  $s \in LS$  could stand in any of these relations to more than one situation, or none at all; which of these cases applies, depends on the specific features of  $s$  as well as the structure of Logical Space at large. It seems that an approach to intensions in terms of parameters is far simpler in this respect. In fact, the examples in (77) suggest that three of the contextual parameters listed in (75) may also be used in the characterization of intensional constructions. Though not strictly necessary, one should then split up the interpretation of (sentence-) adverbial modification (76) into different cases (76<sup>+</sup>a–c) according to the parameters targeted by the modifying adverb; this seeming complication, which is independently supported by syntactic considerations, pays when it comes to adapting the extensions of adverbs, as is done in (77<sup>+</sup>):

$$(76^+) \quad \begin{aligned} \text{a. } \llbracket ADV_{mod} S \rrbracket^c(w; t; p; \dots) &= 1 \text{ iff } \{w' \mid \llbracket S \rrbracket^c(w'; t; p; \dots) = 1\} \in \llbracket ADV_{mod} \rrbracket^c(t; p; w; \dots) \\ \text{b. } \llbracket ADV_{temp} S \rrbracket^c(w; t; p; \dots) &= 1 \text{ iff } \{t' \mid \llbracket S \rrbracket^c(w; t'; p; \dots) = 1\} \in \llbracket ADV_{temp} \rrbracket^c(t; p; w; \dots) \\ \text{c. } \llbracket ADV_{loc} S \rrbracket^c(w; t; p; \dots) &= 1 \text{ iff } \{p' \mid \llbracket S \rrbracket^c(w; t; p'; \dots) = 1\} \in \llbracket ADV_{loc} \rrbracket^c(t; p; w; \dots) \end{aligned}$$

$$(77^+) \quad \begin{aligned} \text{a. } \llbracket possibly \rrbracket^c(w; t; p; \dots) &= \{X \subseteq W \mid X \neq \emptyset\} \\ \text{b. } \llbracket now \rrbracket^c(w; t; p; \dots) &= \{Y \subseteq T \mid \text{TIME}(c) \in Y\} \\ \text{c. } \llbracket in Rome \rrbracket^c(w; t; p; \dots) &= \{Z \subseteq P \mid \text{Rome} \in Z\} \end{aligned}$$

Obviously, these equations can easily be adapted so that the character depends on the representation of the (arbitrary) context  $c$ . In any case, in (76<sup>+</sup>) and (77<sup>+</sup>) intensions are now taken to be functions defined on lists  $(w; t; p; \dots)$  of Worlds, Times, Places, and others.

(76<sup>+</sup>) shows more directly than (76) how an intensional construction may select particular parameters of a situation while leaving the others untouched; and according to (77<sup>+</sup>), these parameters are all the extensions of the sentence adverbs care about. Using the above terminology, we may say that modal, temporal, and locative adverbials respectively *shift* the WORLD, TIME, and PLACE parameter of the situation described. So the rationale behind the parameterization should be that it brings out in the open what was implicit in the earlier approach using situations at large: the *shifting* of particular parameters. We thus obtain the following natural construction, where functions that are shifted by some intensional construction are called *shifty*:

### Definition

- p*) An *I-parameterization* is a finite list  $\rho = (\rho_1; \dots; \rho_m)$  of shifty functions  $\pi_i$  with domain  $LS$  (and arbitrary ranges) such that,
- (<sup>+</sup>) for any distinct situations  $s$  and  $s'$ :
- $\rho_i(s) \neq \rho_i(s')$ , for some  $i \leq m$ .
- For any  $s \in LS$ ,  $s^+ = (\rho_1(s); \dots; \rho_m(s))$ ; hence  $s^+ \neq s'^+$  whenever  $s \neq s'$ .

Condition (<sup>+</sup>) is adopted mainly for parallelism; but it will turn out to be useful. As a matter of fact, it could be dropped if Definition *q*) is slightly strengthened; see below.

Not only elegance and transparency speak in favour of *I*-parameterization. The construction of intensions in terms of lists rather than situations opens the possibility of *free variation* within these lists: instead of defining intensions as operating on lists of the form  $s^+$ , we may extend them to arbitrary combinations of parameters, including those that do not correspond to any situation. Such lists or *indices* are easily constructed if the *I*-parameterization is rich enough. For instance, in order to guarantee condition (<sup>+</sup>), one may include the identity mapping over  $LS$ ; as a result, any minimal modification of a list  $s^+$  would lead to an index that does not represent any situation. Still, free variation would not lead to any change in the formulation of general character descriptions like (76<sup>+</sup>) and (77<sup>+</sup>). In fact, it may even come in handy if parameters get shifted beyond Logical Space but without contradiction. One possible case is discussed in Zimmermann (1991: 170): if, as current-day physics has it, the universe came into existence 14.6 billion years ago, no sentence modified by *16 billion years ago* could be true in an actual situation, which seems to contradict intuition because there would be no way of negating the fact that something or other happened at that time. Again we have to leave the details of this argument for the reader to fill in.

In principle, free variation is also available for contextual parameters, which can be turned against *C*-parameterization (Lewis 1980): since the rôle of contextual parameters is to determine intensions relative to utterance contexts, there seems to be no use of combinations beyond the representations of the latter. However, *C*-parameterizations may still be helpful in reconstructing the ingredients of two-dimensional semantics in terms of *I*-parameterization. In particular, the internal structure of lists of contextual parameters may be exploited in the construction of *diagonals* – provided that the *C*- and *I*-parameters are in tune, in the following sense:

### Definition

- q*) A *C*-parameterization  $\pi = (\pi_1; \dots; \pi_n)$  fits an *I*-parameterization  $\rho = (\rho_1; \dots; \rho_m)$  iff the following conditions hold:
- $n \geq m$ ;
  - $\pi_i$  is not shifty if  $i < n - m$ ;
  - $\pi_i = \rho_i$  for any  $i \geq n - m$ .

In the absence of condition (<sup>+</sup>) in Definition *p*), a further constraint on fitting *I*-parameterizations would have to be imposed, viz. that  $(\pi_{n-m}(c); \dots; \pi_n(c))$  uniquely determines  $c$ .

Hence fitting *C*-parameterizations only add parameters that are not shifty and thus only needed for determining context-dependent intensions (otherwise they should occur in the *I*-parameterization). Thus, e.g., the *C*-parameterization

(SPEAKER; ADDRESSEE; WORLD; TIME; PLACE; ...)

is in tune with the *I*-parameterization

(WORLD; TIME; PLACE; ...)

where  $n = m + 2$  and the ‘...’ stand for the same list of (shifty) parameters. Given Definition *q*), it is possible to construct diagonals in quite the same fashion as in Section 4 above. This may come as a surprise, given that lists of contextual parameters are longer than *I*-parameters and thus there appear to be more of them than there are indices – whereas the contexts of utterance form a proper subset of Logical Space. However, as long as we rule out free variation on *C*-parameters, things do not change dramatically, due to the restrictions (\*) and (+) in Definitions *o*) and *p*): given fitting *C*- and *I*-parameterizations, any  $c \in C$  will be represented by a unique list  $c^*$ , and any  $s \in LS$  will be represented by a unique list  $s^+$ . Consequently, any  $c$  will be represented by a unique pair  $(c^*, c^+)$  – and this pair represents the diagonal point  $(c, c)$ ! To be sure, characters still look slightly different after (fitting) parameterization, but only because of the free variation among *I*-parameters, which extends their right side but leaves the ‘diagonalizable’ left part untouched.

Parameterization, thus conceived, has deep repercussions on the two-dimensional approach to context-dependence. This is because it makes shiftability the criterion for distinguishing between context and index, and thus between intension and character. More specifically, the Ban on Monsters comes out as an *a priori* truth (though not in the technical sense of Definition *e*) of Section 2) rather than an empirical hypothesis. The rationale behind this is that shifty parameters are more clearly identifiable than the contents of utterances (Lewis 1980; see also Rabern 2012b). In Section 2, following the tradition of Kaplan (1989a), we identified the latter with *what is said*. However, this locution is by now means unequivocal, as becomes clear from dialogues like:

(80) John: *Smith said to me: ‘You are my best friend.’*

Mary: *What Smith said* is what he has been telling me all the time.

Mary’s reply may be (and may meant to be) either reassuring or critical, depending on whether the underlined free relative refers to (a) the situations in which *John* is Smith’s best friend, or (b) the situations in which *Smith’s addressee* is his best friend. Both readings seem plausible and, arguably, neither is the better choice for the literal referent of the underlined clause. But whereas (a) is the content of Smith’s reported (alleged) utterance, (b) involves (local) diagonalization of the 2nd person pronoun. So not all is well with the pragmatic definition of content, and thus intension in general, in terms of what is said by (assertoric) utterances. On the other hand, shiftability does not presuppose the notion of content because it directly shows in, and affects, the truth conditions of utterances. This speaks in favour of an identification of intensions in terms of compositional semantics rather than pragmatics.

However, unlike the distinction between utterance situations and non-utterance situations, that between context and index is language-dependent, because it depends on the semantic properties of grammatical constructions. Therefore, any purported counterexamples to the Ban on Monsters can and must be dealt with by turning purported

C-parameters into *I*-parameters. Thus, e.g., since the implicit argument in (5b) may be quantified, as (71c) shows, it would have to be provided by an *I*-parameter:

- (5) b. *He is an enemy.*  
 (71) c. *Every man faced an enemy.*

The fact that the context still provides the value of the parameter thus comes out as merely a reflex of the general dependence of extensions on the utterance situation already observed in connection with Definition *h*) in Section 4: given an utterance context, the extension of an expression is determined by applying its intension to the context itself. As a result, in the absence of any intensional construction shifting the pertinent parameter, the context of utterance provides the values of the *C*-parameters. However, if taken to its limits, the strategy of pushing *C*-parameters into the index runs the risk of eventually emptying the list. Now, this would not make the distinction between context and index totally idle; after all, deictic expressions might coexist with ‘bindable’ ones and share the same parameter. Only in the absence of any deictic expressions, would characters be superfluous because the intensions alone would suffice to determine all extensions relative to any (utterance) situation; and as a consequence, the Ban of Monsters too would be pointless in a language devoid of deixis. This should not come as a surprise, though; for it is deictic expressions that motivated the distinction between intension and character in the first place.

*I am indebted to Jan Köpping for a number of critical comments and suggestions.*

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Thomas Ede Zimmermann, Frankfurt/Main (Germany)

## 90. Deixis and demonstratives

1. Introduction
2. Foundations of deixis
3. Participant deixis
4. Object deixis
5. Conclusion
6. References

### Abstract

*This paper provides an overview of the form, meaning, and use of deictic expressions from a cross-linguistic perspective. The first part of the paper is concerned with the psychological foundations for a linguistic theory of deixis. It is argued that the use of deictic expressions*



*presupposes a theory-of-mind that enables the communicative partners to adopt the perspective of another person. The second part of the paper provides an overview of deictic expressions in the world's languages. Two basic types of deixis are distinguished: participant deixis, which concerns the speech participants, and object deixis, which concerns elements of the situational and discourse context. The paper argues that person deictics are used as anaphors and that participant deictics, notably demonstratives, are used to establish joint attention, which is one of the most fundamental functions of human communication, providing a prerequisite for social interaction, cognition, and discourse.*

## 1. Introduction

The term deixis refers to a class of linguistic expressions that are used to indicate elements of the situational and/or discourse context, including the speech participants and the time and location of the current speech event (cf. Bühler 1934; Frei 1944; Lyons 1977, 1979; Fillmore 1982, 1997; Levinson 1983, 2004). English has a wide variety of expressions that are commonly analyzed as deictics: personal pronouns such as *I* and *you*, spatial adverbs such as *here* and *there*, demonstratives such as *this* and *that*, temporal adverbs such as *now*, *then*, *today*, *ago*, and *recently*, motion verbs such as *come* and *go*, and tense morphemes such as the future auxiliary *will* and the past tense suffix *-ed* (cf. Lyons 1977; Fillmore 1997). In addition, grammatical constructions such as the imperative and the vocative are often characterized as deictics (cf. Levinson 1983).

Deictic expressions raise important issues for semantic theory (cf. article 4 (Abbott) *Reference*). In (formal) semantics, deictic expressions (also called *indexicals*; cf. Peirce 1955) are defined as linguistic signs with “direct reference” (Kaplan 1989: 483). In contrast to content words, deictic expressions do not evoke a concept of some entity (Frege's *sense*) but establish a direct referential link between world and language (cf. article 61 (Schlenker) *Indexicality and de se*). Since the interpretation of deixis is immediately determined by aspects of the speech situation, deictic expressions require a particular treatment in semantic theory (cf. Kaplan 1989; see also papers in Davis 1991, vol. III and Kasher 1998, vol. III).

In the literature, deictic expressions are commonly distinguished from deictic uses (cf. Nunberg 1998; Levinson 2004). Deictic expressions are linguistic elements “with built-in contextual parameters” that must be specified by aspects of the situational or discourse context (Levinson 2004: 14). Other linguistic elements can be used deictically if they are combined with a genuine deictic or referential expression. For example, a noun such as *tree* may refer to a concrete entity in the situational context if it is accompanied by a demonstrative that relates the concept of tree to a concrete entity in the surrounding situation (cf. *that tree*). Alternatively, content words can be grounded in the speech situation by nonlinguistic means such as gesture, eye-gaze, or the presentation of an object. In general, as Levinson (2004) has pointed out, just about any nominal expression can be used deictically if it is accompanied by a communicative device that indicates a direct referential link between language and context.

This paper surveys the form, meaning, and use of deictic expressions from a psycholinguistic and cross-linguistic perspective. Two basic categories of deixis are distinguished: participant deixis and object deixis. Participant deixis concerns the role of the speech participants and their social relationship to each other, whereas object deixis concerns linguistic expressions referring to aspects of the situational or discourse context. The two types of deixis serve radically different functions and are expressed by different types of

words; but they also have important properties in common, which underlie their uniform classification as deictics.

## 2. Foundations of deixis

There is a long tradition in western philosophy of defining human cognition by formal operations over abstract symbols (cf. Montague 1974; see also article 10 (Newen & Schröder) *Logic and semantics* and article 11 (Kempson) *Formal semantics and representationalism*). However, recent work in cognitive psychology, philosophy, and linguistics has argued that this approach is not appropriate to characterize human cognition. Specifically, it has been claimed that cognitive processes are “embodied”, i.e., grounded in our bodily experience with the environment (see Wilson 2002 for a review; see also Steels 1999; Clark 1997; Barsalou 1999). In this view, the sensory and motor activities of the body are important determinants of human cognition, which in turn influence the structure and use of language (Lakoff & Johnson 1980, 1999).

There is perhaps no other linguistic phenomenon that is so fundamentally rooted in our bodily experience than deixis. In fact, one of the reasons why indexicals have been discussed extensively in both linguistics and philosophy is that they pose a serious challenge to semantic theories in which linguistic meaning is decontextualized and disembodied. Philosophers such as Russell and Reichenbach tried to reduce all indexical expressions to a single deictic term that can be translated into some context-free expression in an artificial language; but this account does not provide an adequate description of the use and meaning of deictic expressions. In natural language, deixis is fundamentally grounded in our bodily experience and situated interactions between the interlocutors. Thus, any account of natural deixis has to start from a pragmatic theory of language use and human cognition (cf. article 5 (Green) *Meaning in language use*).

### 2.1. Theory-of-mind

Language use is a triadic behaviour involving the speaker, the hearer, and the entities talked about (cf. Bühler 1934). The triadic nature of language presupposes that the interlocutors understand each other as “mental or intentional agents” (cf. Tomasello 1999). In order to communicate, speaker and hearer must realize that the communicative partner has mental representations and that she views the situation from a different perspective. In other words, language use presupposes a *theory-of-mind* that enables the language users to adopt the perspective of another person (cf. Tomasello 1999; Clark 1996). Interestingly, while other species may communicate in one way or another, it seems that human communication is the only form of communication that involves an understanding of the mind (cf. Butterworth 1998; Povinelli & Vonk 2003; Franco 2005; Tomasello 2006). As Tomasello (1999) and others have pointed out, the ability to adopt another person’s perspective is a unique trait of human cognition that is reflected in the structure and use of language.

### 2.2. The deictic centre

A linguistic phenomenon that crucially relies on this ability is deixis. As Bühler (1934) and other theorists have pointed out, the use of deixis involves a particular viewpoint called the *deictic centre* or *origo* (cf. Bühler 1934; Lyons 1977). The deictic centre is the

centre of a coordinate system that underlies the conceptualization of the speech situation. In the unmarked case, the deictic centre is defined by the speaker's location at the time of the utterance. Deictic expressions are used to indicate a location or point in time relative to the deictic centre. For instance, the spatial adverbs *here* and *there* can be used to express a contrast between two different locations based on their relationship to the origo: *here* marks the area that is conceptualized as the deictic centre, and *there* indicates a location that is not included in this area. In the literature, *here* and *there* are commonly characterized as proximal and distal deictics, but the attributes 'proximal' and 'distal' must not be taken in the absolute sense of these terms because the deictic centre and the speech situation are conceptual units that cannot be equated with the physical location in which the speech event occurs. Consider for instance the use of the spatial deictic *here* in examples (1a-e).

- (1) a. *Here* where I am
- b. *Here* in this room
- c. *Here* in Jena
- d. *Here* in Germany
- e. *Here* on this planet

What these examples illustrate is that the area included in the deictic centre (denoted by *here*) varies with the construal of the speech situation. In (1a), *here* refers to a location that is further specified by the pronoun *I*, indicating that the deictic centre is basically identical with the speaker's body; but in all other examples the deictic centre includes a much larger area organized around the speaker's location at the time of the utterance: In (1b) the deictic centre is the room in which the speech event is taking place, in (1c) it is the city of Jena, in (1d) it is a country, and in (1e) the deictic centre consists of the whole planet. In other words, the referent of *here* varies with the conceptualization of the speech situation. The distal term *there* is used in contrast to *here*; it can refer to any location in the speech situation as long as it is not included in the area conceptualized as the deictic centre. In general, *here* and *there*, and other proximal and distal deictics, do not express absolute measures of distance, but differentiate between two different locations relative to the deictic centre within the current construal of the speech situation.

In conversation, the deictic centre is constantly changing between the communicative partners. Every time a new speaker adopts the turn, the speech event is conceptualized from a different point of view, which means that expressions such as *here* and *there* and *I* and *you* refer to different entities when used by different speakers. Adult speakers are so used to this procedure that they do not realize the constantly changing perspective that is involved in the use of deictic expressions; but children have great difficulties with the alternating point of view. Although English-speaking children begin to use deictic expressions very early, they often misinterpret their meaning and use (cf. Clark 1978; Tanz 1980; Wales 1986). For instance, it is well-known that some children begin to use the personal pronouns *I* and *you* as fixed expressions for the child and an adult speaker. Consider for instance the dialog in (2) between a two-year-old English-speaking boy and his mother (cf. Clark 1978: 101).

- (2) Mother:     What do you want?
- Child:     Daddy toothbrush.

- |         |                                                                                               |           |
|---------|-----------------------------------------------------------------------------------------------|-----------|
| Mother: | Oh you want Daddy's toothbrush, do you?                                                       |           |
| Child:  | Yes ... <i>you</i> want to put the frog in the mug.                                           | [you = I] |
| Mother: | I think the frog is too big for the mug.                                                      |           |
| Child:  | Yes <i>you</i> can put the duck in the mug<br>make bubble ... make bubble.                    | [you = I] |
| Mother: | Tomorrow. Nearly all the water's run out.                                                     |           |
| Child:  | <i>You</i> want Mummy red toothbrush ... yes<br><i>you</i> can have Mummy old red toothbrush. | [you = I] |

In this example, both the boy and his mother use the pronoun *you* with reference to the child, suggesting that the boy misinterprets the term as some sort of proper name. The same absolute use of personal pronouns has been observed in many other studies. Consider for instance the following example from a diary study adopted from Clark (1978: 101).

- (3) a. *I* carry. [= you carry; a request to be picked up]  
 b. Yacky tease *you*. [= Yacky is teasing me]  
 c. Papa help *you*. [= Papa help me]  
 d. *You* want cake. [= I want cake]

In these examples, the deictic pronouns *I* and *you* are used as fixed expressions for the child and one of his parents: the first person pronoun *I* refers to the parent, notably the father, and the second person pronoun *you* is used in self reference to the child.

### 2.3. The frame of reference

The deictic centre constitutes the centre of a relative frame of reference, which must be distinguished from two other reference frames for spatial orientation: the intrinsic frame of reference and the absolute frame of reference (Levinson 1996, 2003; Miller & Johnson-Laird 1976; Pederson et al. 1998). Each frame evokes a coordinate system, but is differently anchored in the speech situation. The relative frame of reference presupposes a viewpoint provided by the speaker or some other person; the intrinsic frame of reference involves an object-centred coordinate system determined by the inherent orientation of an object or person; and the absolute frame of reference is anchored by landmarks in the environment such as a mountain, a river, or the sun (see below).

While the conceptualizations of the three reference frames are in principle independent of language, they can be triggered by particular types of expressions. The relative frame of reference is commonly evoked by deictics such as *I* and *you* and *here* and *there* (cf. 4a-b); the intrinsic frame of reference is triggered by relational terms such as *in front of* and *behind* (cf. 5a-b); and the absolute frame of reference is established by expressions such as *uphill* and *downhill* or *east* and *west* that indicate a geographical location (cf. 6a-b).

- (4) a. Peter is over *there*.  
 b. Can *you* show *me that*?
- (5) a. The ball is *in front of* the car.  
 b. Peter stood on his uncle's *left* side.

- (6) a. The cottage is *uphill*.  
b. They were driving *west*.

Note that although the relative frame of reference provides the conceptual background for the interpretation of spatial deictics, it is in principle independent of the deictic center (cf. Levinson 1996). As can be seen in (7), the relative frame of reference can also be construed from the perspective of a third person (expressed in the *for*-phrase).

- (7) For John, the ball is *in front of* the tree.

Interestingly, if we leave out *for John* the spatial arrangement is interpreted from the speaker's point of view, although the sentence does not include a deictic expression. Thus, while the relative frame of reference does not presuppose the use of deictics, it is construed from the speaker's point of view, i.e., the deictic centre, if there is no other point of reference, suggesting that the deictic centre provides the default viewpoint (or anchor) for this type of frame.

Like the relative frame of reference, the intrinsic frame of reference is derived from our bodily experience. It is based on the vertical and horizontal orientation of the human body, which is commonly expressed by relational terms such as *in front of* and *behind*, *left* and *right*, *up* and *down*, and *above* and *below*. Like deictic expressions, these expressions may involve the speaker's location at the time of the utterance (cf. 8a-c).

- (8) a. The ball *in front of* me  
b. The ball to my *left*  
c. I put the ball *down*.

In examples (8a-c), relational expressions are used to indicate the location of an object based on the speaker's orientation in the speech situation. Note that these examples include a deictic expression referring to the speaker; but even if the utterance does not include a deictic term, relational expressions are commonly interpreted deictically, as in the following example in which *in front of* characterizes a location from the speaker's point of view, although the speaker is not mentioned in the sentence (Levinson 1996).

- (9) The ball is *in front of* the tree.

However, in contrast to deictics relational expressions are in principle independent of the speaker's point of view and the human body. As can be seen in (10a-c), *in front of*, *left*, and *down* may indicate the location of an entity based on the inherent orientation of an object such as *house*, *car*, or *table*.

- (10) a. A horse stood *in front of* the house.  
b. Peter's seat is in the back, on the *left* side of the car.  
c. The bottle fell *down* from the table.

What these examples show is that while relational expressions may involve the speaker's bodily orientation in the speech situation, their interpretation is not inherently tied to the speaker's body or location. That is, while relational expressions can be used deictically,

they are distinct from genuine deictics in that they do not presuppose the deictic centre or the speaker's perspective (cf. Levinson 1996).

## 2.4. Deictic projection

Since the deictic centre is commonly defined by the speaker's location at the time of the utterance, deictic expressions are usually egocentric. However, the deictic centre can be transferred from the speaker to a person in an imaginary situation. This phenomenon, which Lyons (1977: 579) called "deictic projection" (cf. Jakobson 1957; Fillmore 1997), is characteristic of narratives and descriptions. In narratives the speaker creates a story world in which the protagonists provide the anchor for deictic expressions. This is particularly striking in the case of reported speech, in which deictic expressions are grounded by the person whose speech is reported; but the protagonists can also provide the anchor for deictic expressions in other contexts. For instance, if the story includes an I-narrator deictic expressions are commonly used within the narrator's coordinate system. Example (11), for instance, includes deictic expressions (i.e. *I, my, me, there*) that do not refer to the author and entities in his surrounding situation, but to the I-narrator and elements in the universe of discourse.

- (11) The old man was dead. *I* removed the bed and examined the corpse. Yes, he was stone, stone dead. *I* placed *my* hand upon the heart and held it *there* many minutes. *There* was no pulsation. He was stone dead. His eye would trouble *me* no more.  
[Edgar Allen Poe: The tell tale heart]

Interestingly, although deictic expressions presuppose a particular perspective, their occurrence does not entail the existence of a concrete person. As can be seen in the German example in (12) (adopted from Ullmer-Ehrich 1982: 233), spatial descriptions are often construed from the perspective of a fictive observer.

- (12) Ja eh wenn man zur Tür reinkommt, gleich rechts davon ist der Schreibtisch an der Wand, im Anschluss daran ist das Bett, und *dann* kommt schon die Ecke zum Fenster, und *da* ist zwischen Fenster und Wand *dieses* Bücherregal, und an der anderen Seite, ja *da* is nich mehr viel Platz, *da* schließt sich *da* die andere Längswand an, *da* hab ich die Schlafcouch stehen, zwischen Schlafcouch und Bücherregal den Esstisch, an die Schlafcouch ran *kommt* der Kleiderschrank, neben m Kleiderschrank steht der Kühlschrank, und *dann* inner Ecke kommt das Waschbecken.

Well, er as you enter the door, immediately to the right of it is the desk against the wall, connected to it is the bed and *then* comes the corner going up to the window, and *there* between the window and the wall is *this* bookshelf, and on the other side, um, *there* isn't much space left, *there* I have the couch bed, between couch bed and bookshelf the dining table, by the sleeping couch *comes* the wardrobe, beside the wardrobe is the refrigerator, and *then* in the corner is the wash basin.

In this example, the speaker takes the hearer on an "imaginary gaze tour" through his student bedroom (Ullmer-Ehrich 1982: 241). In order to orient the hearer on this tour, the speaker uses various deictic expressions that are grounded by a fictive observer who

describes the room as if individual pieces of furniture come in turn into view (cf. Linde & Labov 1975; Levelt 1989; Taylor & Tversky 1996).

2.5. Deictic categories

Deictic expressions are commonly divided into semantic categories; three categories are traditionally distinguished: person, place, and time (cf. Bühler 1934). In English, each category is associated with particular deictic expressions: *I* and *you* are person deictics, *here* and *there* and *this* and *that* are place deictic expressions, and *now* and *then*, and *today*, *yesterday* and *tomorrow* are temporal deictics. In addition to person, place and time, some studies assume two further deictic categories: discourse deixis and social deixis (cf. Lyons 1977; Levinson 1983, 2004; Fillmore 1997). Discourse deixis is concerned with expressions making reference to linguistic entities in the ongoing discourse, and social deixis is concerned with the social relationship between the interlocutors. Like person, place and time deixis, discourse deixis and social deixis may be expressed by particular terms. For instance, the English expressions *the latter* and *the aforementioned* are discourse deictics, and the French pronouns *tu* ‘you.familiar’ and *vous* ‘you.unfamiliar’ are instances of social deixis. Tab. 90.1 provides an overview of the deictic categories that are commonly distinguished in descriptive approaches to deixis (e.g., Levinson 1983, 2004; Fillmore 1997).

Tab. 90.1: Deictic categories

| Category         | Example                                      |
|------------------|----------------------------------------------|
| Person deixis    | <i>I, you</i>                                |
| Place deixis     | <i>here, there, this, that</i>               |
| Time deixis      | <i>now, then, today, yesterday, tomorrow</i> |
| Discourse deixis | <i>the latter, the aforementioned</i>        |
| Social deixis    | <i>tu, vous</i> [French]                     |

While the traditional classification of deictic categories highlights important semantic distinctions, it ignores differences in their pragmatic use. If we consider the various deictic expressions from the perspective of their communicative function, they can be divided into two basic types: Participant deixis and object deixis. Participant deixis concerns deictic phenomena related to the speech participants, whereas object deixis concerns deictic phenomena that involve a referential link to elements of the situational or discourse context. The two types of deixis serve different communicative functions and are encoded by different types of expressions.

3. Participant deixis

Participant deixis subsumes the traditional categories of person and social deixis. In the literature, it is commonly assumed that person deictics function to identify the speech participants, but this assumption is not consistent with their use. Since speaker and hearer are usually aware of their communicative roles, person deictics are only rarely used to

“identify” the speech participants in the surrounding situation (e.g., *I want to talk to you* [pointing to a person]); instead, they usually function to indicate the semantic roles of speaker and hearer in the event that is expressed by an utterance (e.g., *Peter noticed that I gave you the book*). Since the speech participants are aware of each other, the use of person deictics is similar to the use of anaphors: Both types of expressions function to denote a ‘familiar’ or ‘activated’ referent, i.e., a referent that is in the interlocutors’ current focus of attention. The communicative function of participant deictics is reflected in the semantic features they encode. Four features are important:

1. Communicative role
2. Number
3. Gender
4. Social rank/relationship

All languages have particular expressions referring to speaker and addressee, but these expressions are not always deictic. In some South-east Asian languages, the speech participants are commonly expressed by common nouns (Cooke 1968). In Thai (Tibeto-Burman, Thailand), for instance, speaker and hearer are referred to by various nominal expressions such as *phom* ‘I’ (lit. hair) and *tua* ‘you’ (lit. body/self), which are also used with their literal meaning (cf. Siewierska 2004: 228). However, the vast majority of the world’s languages have deictic pronouns such as English *I* and *you* to indicate the communicative roles of the speech participants. In many languages, the speech participants are expressed by bound morphemes on the verb (cf. Siewierska 2004: Ch. 2), leaving the use of independent pronouns to situations in which the referent is especially emphasized (cf. example 13).

- (13) *wa-yi-ku:-wa*  
 1SG-2SG-give-REALIS  
 ‘I give (it) to you’

In addition to the communicative role, number is a frequent feature of participant deixis. In a world wide sample of 260 languages, Dunn (2005) found only two languages, Acoma (Keresan, New Mexico) and Wari’ (Chapacura-Wanhan, Brasil), in which first and second person pronouns do not have separate singular and plural forms; that is, the vast majority of the world’s languages distinguish between *I* and *we* and *you.SG* and *you.PL* (English is unusual in this regard) (cf. Cysouw 2003; Siewierska 2004).

Note, however, that the plural of first person is conceptually distinct from the plural of other (pro)nominal expressions in that *we* does not denote multiple instances of *I* (cf. Cysouw 2003: Ch. 3). Rather, the plural of a first person pronoun refers to a group of people including the current speaker. Two basic types of first person plural pronouns can be distinguished: Inclusive pronouns, referring to a group of people including both speaker and hearer, and exclusive pronouns, referring to a group of people including only the speaker, i.e., excluding the addressee. For instance, as can be seen in Tab. 90.2, Chamorro (Austronesian, Guam) has three first person pronouns: *hu* meaning ‘I’, *ta* meaning ‘I and you and possibly some others’, and *in* meaning ‘I and somebody else but not you’. While the inclusive-exclusive distinction is rare in Europe, it is a very frequent feature of participant deixis in other parts of the world (cf. Cysouw 2003).



Tab. 90.2: First person pronouns in Chamorro (Topping 1973: 106–108)

| <i>Meaning</i> | <i>Form</i> |
|----------------|-------------|
| ‘I’            | hu          |
| ‘we’ inclusive | ta          |
| ‘we’ exclusive | in          |

Another semantic feature that may be expressed by person deictics is gender. However, compared to number, gender is an infrequent feature of person deixis. In a world wide sample of 378 languages, Siewierska (2004) found only 21 languages in which first and/or second person pronouns carry a gender feature. Moreover, in most of these languages gender marking is limited to the singular; in the plural, first and second person pronouns are almost always unmarked. Tab. 90.3 shows the personal pronouns in Ngala (Sepik, New Guinea), which is one of the few languages in Siewierska’s sample in which both first and second person pronouns carry a gender feature, but only in the singular, i.e., in the dual and plural first and second person pronouns are unmarked.

Tab. 90.3: Personal pronouns in Ngala (Laycock 1965: 133)

|           | <i>Singular</i>  |                 | <i>Dual</i> | <i>Plural</i> |
|-----------|------------------|-----------------|-------------|---------------|
|           | <i>Masculine</i> | <i>Feminine</i> |             |               |
| 1. person | wn               | ñan             | öyn         | nan           |
| 2. person | mən              | yn              | bən         | gwn           |

In contrast to first and second person pronouns, third person pronouns are often gender-marked. In Siewierska’s sample, gender marking in third person pronouns is about five times as frequent as gender marking in first and second person pronouns, suggesting that gender carries a greater functional load in third person anaphors than in participant deictics. While gender marking can help to differentiate between multiple antecedents of third person pronouns, it is irrelevant for the identification of the speech participants because speaker and hearer are sufficiently determined by the communicative interaction (cf. Siewierska 2004: 105).

Unlike gender marking, the marking of social relationships is very common in participant deictics, notably in expressions for the addressee. Many European languages employ two types of second person pronouns to indicate the social relationship between the speech participants. In German, for instance, *du* is used to address family members, friends, and young children, whereas *Sie* refers to strangers and people in professional relationships. A parallel contrast between familiar and respectful forms occurs in other European languages including French and Russian (cf. Tab. 90.4).

Tab. 90.4: Familiar and polite second person pronouns in three European languages

| <i>Language</i> | <i>Familiar form</i> | <i>Polite / respectful form</i> |
|-----------------|----------------------|---------------------------------|
| German          | du                   | Sie                             |
| French          | tu                   | vous                            |
| Russian         | ty                   | vy                              |

In German, French, and Russian, the polite forms are based on plural pronouns, but social deixis can also be expressed by special honorifics derived from common nouns such as ‘master’, ‘servant’, and ‘king’ (Siewierska 2004: Ch. 6). The use of (nominal) honorifics is characteristic of South-east Asian languages such as Thai and Vietnamese, which seem to lack genuine participant deictics (Cysouw 2003: 12–13; Siewierska 2004: 8–15).

## 4. Object deixis

Object deixis subsumes the deictic categories of place, time, and discourse. Place deictic expressions refer to concrete objects and locations in the situation surrounding the speech participants, but time and discourse deixis are more elusive. Time deictic expressions indicate a point in time relative to the moment of the speech event, and discourse deictic expressions locate linguistic elements in the ongoing discourse. Since time and discourse are abstract entities they are not immediately available for a concrete act of reference such as pointing. However, in language time and discourse are commonly conceptualized in spatial terms making them more objective (see below). This explains why time and discourse deixis are frequently expressed by spatial terms, suggesting that place deixis provides the conceptual and linguistic foundation for more abstract varieties of object deixis (cf. Lyons 1977: 718).

### 4.1. Place deixis

The core of place deixis constitutes a small class of expressions that are of fundamental significance to the organization of the deictic system: demonstratives such as English *this* and *that* and *here* and *there* (cf. Himmelmann 1997; Diessel 1999; Dixon 2003; see also article 40 (Büring) *Pronouns*). In the literature, demonstratives are commonly described as one type of place deixis, serving grammatical functions as pronouns, determiners, and adverbs; but this analysis does not adequately characterize their function and status in language (cf. Diessel 2006a).

#### 4.1.1. The communicative function of demonstratives

In their basic use, demonstratives focus the interlocutors’ attention on concrete entities in the surrounding situation; that is, demonstratives serve to establish joint attention, which is one of the most fundamental functions of human communication, providing a foundation for the organization of verbal interactions, the structuring of discourse, and the diachronic evolution of grammar (cf. Diessel 2006a).

Joint attention has been studied in interdisciplinary research on pointing, eye gaze, and theory-of-mind (for a review see Dunham & Moore 1995; Krause 1997; Eilan 2005); it involves three basic components: the speaker, the hearer, and the entities talked about (see above). Communication is thus a triadic behaviour in which the communicative partners are jointly focused on the same referent. In face-to-face conversations, the speaker can use eye gaze and pointing in addition to language to establish a joint focus of attention (cf. Bruner 1983; Carpenter et al. 1998; Tomasello 1999; Eilan 2005). While there are many linguistic means to create joint attention, demonstratives provide the primary linguistic device to manipulate the interlocutors’ attention in the speech situation (cf. Clark 1996). The particular communicative function of demonstratives is reflected in a number of properties that characterize them as a particular word class (cf. Diessel 2006a).

To begin with, one of the most striking features of demonstratives is that they are commonly accompanied by a pointing gesture (cf. Bühler 1934; Enfield 2003; Levinson 2004; Diessel 2006a). Deictic pointing is a communicative device that is used in all cultures to establish joint attention (cf. Kita 2003); it usually involves the index finger, but there are also cultures in which lip pointing is used to direct the other person's attention (cf. Enfield 2002; Wilkins 2003). The frequent cooccurrence of demonstratives and deictic pointing supports the hypothesis that demonstratives function to establish joint attention, which is crucially distinct from the communicative function of person deixis. First and second person pronouns refer to the speech participants, which are automatically activated as part of the speech event, whereas demonstratives create a new focus of attention or else indicate a contrast between two previously established referents (cf. Levinson 2004; Diessel 2006a).

The frequent combination of demonstratives and deictic pointing is especially striking in early child language (cf. Clark 1978). When children begin to produce their first words, at around the age of 15 months, they typically use content words referring to persons, objects, and other entities in their environment (cf. Gentner 1982); but in addition to these words demonstratives are always among the first and most frequent expressions in early child language (cf. Clark 1978; Diessel 2006a). The early appearance of demonstratives is motivated by their communicative function to establish joint attention and their relationship to deictic pointing. The earliest pointing gestures children produce appear a few months prior to the onset of language and can be seen as a sign of the child's emerging ability to engage in triadic interactions, providing a prerequisite for the development of communication and language (cf. Tomasello 1999, 2003, 2006; Franco 2005).

The communicative importance of demonstratives is also reflected in their cross-linguistic distribution. Early work in linguistic typology was based on the assumption that grammatical categories are universal; but more recent work suggests that most linguistic categories have language-specific properties and are often restricted to a subset of the world's languages (cf. Croft 2001). For instance, while definite articles and auxiliaries are commonly found in Indo-European languages, they are often absent from languages in other genetic groups. However, in contrast to definite articles, auxiliaries, and other function morphemes, demonstratives are truly universal (cf. Himmelmann 1997; Diessel 1999, 2003, 2006a, 2006b; Dixon 2003).

What is more, demonstratives appear to be older than other closed-class items. In the literature, linguistic expressions are commonly divided into two basic types: content words and grammatical markers. Recent work in grammaticalization has shown that grammatical markers are frequently derived from content words. For instance, locational prepositions such as English *in front of* develop from relational nouns (or body part terms), and future tense auxiliaries such as English *going to* are often derived from motion verbs (cf. Hopper & Traugott 2003). The development of grammatical markers from content words is cross-linguistically so frequent that it has become a standard assumption of grammaticalization theory that all grammatical expressions are eventually derived from content words (cf. Hopper & Traugott 2003: 104). According to this view, demonstratives are function words, i.e., grammatical markers, that must have originated from a lexical source, i.e., from nouns or verbs. However, in sharp contrast to other closed-class expressions, there is no evidence that demonstratives are historically derived from lexical terms, suggesting that they are older than other closed-class items. If we consider the particular function of demonstratives to establish joint attention, it seems reasonable to

assume that demonstratives may have emerged very early in the evolution of human language and independently of other linguistic terms (cf. Diessel 2006a).

#### 4.1.2. The form and meaning of demonstratives

While demonstratives are universal, they can differ widely in terms of their form, meaning, and use (cf. Diessel 1999; Dixon 2003). The semantic features of demonstratives are divided into two basic types: (1) deictic features, which indicate the location of the referent relative to the deictic centre, and (2) non-deictic features, which characterize the type of referent (cf. Diessel 1999: Ch. 3; see also Fillmore 1982; Rauh 1983; Hanks 1990).

The deictic features of demonstratives are commonly characterized in spatial terms based on their relationship to the deictic centre. As can be seen in (14), if *this* and *that* are used contrastively, *this* denotes a referent that is closer to the deictic centre than the referent of *that*; that is, *this* is proximal and *that* is distal.

(14) *This* one (here) is bigger than *that* one (over there).

However, in non-contrastive situations *this* and *that* are often interchangeable (cf. 15), suggesting that they do not carry an inherent distance feature.

(15) I like *this/that* one better.

Considering the various uses of demonstratives in English, Levinson (2004) argues that while *this* always expresses some sense of proximity, *that* is only interpreted as a distal term if it is used in explicit contrast to *this*; that is, *that* is semantically unmarked for distance, but is interpreted as a distal term by pragmatic contrast via Grice's maxim of quantity ('Be as informative as circumstances permit'). Thus, Levinson concludes that the traditional analysis of demonstratives in terms of spatial features (i.e., proximal vs. distal) is not always adequate to characterize their meaning and use (cf. Enfield 2002).

However, while demonstratives do not generally indicate a contrast between proximal and distal referents, they are usually organized in paradigms of contrastive forms. English has a two-way deictic system, contrasting proximal and distal referents (in some uses); but many languages employ more than two deictic terms (cf. Diessel 2005a; see also Anderson & Keenan 1985 and Diessel 1999). For instance, as can be seen in Tab. 90.5, Irish (Celtic, Europe) has three demonstratives indicating three different locations on a distance scale: proximal, medial, and distal.

Tab. 90.5: Demonstratives in Irish (Bammesberger 1983: 60–61)

---

|          |             |
|----------|-------------|
| Proximal | <i>seo</i>  |
| Medial   | <i>sin</i>  |
| Distal   | <i>siúd</i> |

---

In some languages the medial term is reserved for entities near the hearer. In Japanese, for instance, demonstratives differentiate between entities near the speaker, entities near the hearer, and entities away from both speaker and hearer (cf. Tab. 90.6).

Tab. 90.6: Demonstratives in Japanese (Kuno 1973)

|                              | <i>Pronouns</i> | <i>Determiners</i> | <i>Adverbs</i> |
|------------------------------|-----------------|--------------------|----------------|
| Near speaker                 | kore            | kono               | koko           |
| Near hearer                  | sore            | sono               | soko           |
| Away from speaker and hearer | are             | ano                | asoko          |

Note that Japanese employs three different sets of demonstratives functioning as pronouns, determiners, and adverbs, which many languages do not formally distinguish; in particular the contrast between demonstrative pronouns and determiners is often formally unmarked (Diessel 2005b). But even if the demonstratives are divided into separate syntactic classes, as in Japanese, they tend to carry the same deictic features because they usually include the same deictic roots (cf. Diessel 1999: Ch. 2).

While two- and three-term systems are cross-linguistically very common, there are also languages with more than three deictic terms. In a world-wide sample of 234 languages, Diessel (2005a) found 127 languages with two deictic terms, 88 languages with three deictic terms, and 12 languages with more than three deictic terms (in addition, there were 7 languages in which some demonstratives are deictically not contrastive; cf. Diessel 1999: 37–39). If we look at the languages with more than three deictic terms, we find that they typically include a particular expression for objects and locations near the hearer (cf. the demonstratives in Tab. 90.7 from Hausa (Chadic, Africa)).

Tab. 90.7: Demonstratives in Hausa (Wolff 1993: 119–120)

|                                  |     |
|----------------------------------|-----|
| Near speaker                     | nân |
| Near hearer                      | nan |
| Away from speaker and hearer     | cân |
| Far away from speaker and hearer | can |

Interestingly, in languages of this type there are two different ways of conceptualizing the deictic centre (see Fig. 90.1 below). Demonstratives such as Hausa *nân* ‘near speaker’ and *nan* ‘near hearer’ are interpreted relative to the area determined by the speaker’s location alone, i.e., these two expressions exclude the hearer from the deictic centre (cf. deictic centre 1); whereas the two distal terms, *cân* and *can*, are interpreted relative to the common domain of the speech participants, i.e., in this case both speaker and hearer are included in the deictic centre (cf. deictic centre 2).

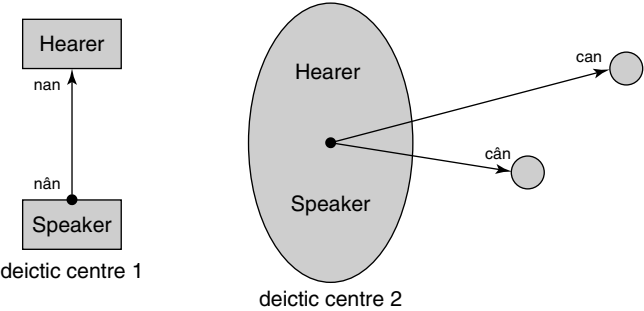


Fig. 90.1: The conceptualization of the deictic centre

Since the deictic centre of the distal terms is conceptualized as the common domain of the speech participants, the interpretation of these terms involves maximally three different entities: the deictic centre, consisting of the common domain of the speech participants, and two other entities that are ‘away’ and ‘far away’ from the deictic centre. Thus, although languages with a hearer-based demonstrative may employ four (or more) deictic terms, conceptually they are usually limited to spatial scenarios with maximally three distinct reference points (cf. Diessel 2005a).

In addition to distance, demonstratives may indicate whether the referent is visible or out-of-sight, at a higher or lower elevation, uphill or downhill, upriver or downriver, or in a particular direction along the coast line (see Diessel 1999: 41–47). While these features are not inherently deictic (cf. Fillmore 1982: 51), they are often expressed by particular demonstratives that are part of the deictic system. Many Native American languages, for instance, have a particular demonstrative for an invisible referent, i.e., a referent out of sight. As can be seen in Tab. 90.8, Tümpisa Shoshone (Uto-Aztecan, North America) has four demonstrative roots that differentiate between three (visible) entities in the surrounding situation and a fourth entity that is invisible from the speaker’s point of view.

Tab. 90.8: Demonstrative roots in Tümpisa Shoshone (Dayley 1989)

|                     |    |
|---------------------|----|
| Right here          | i- |
| Here nearby         | e- |
| There (visible)     | a- |
| There (not visible) | u- |

Similarly, semantic features such as ‘uphill’ and ‘downhill’ are commonly expressed by particular demonstrative forms. For instance, as can be seen in Tab. 90.9, Usan (Sepik, New Guinea) has four demonstratives locating a referent in the surrounding situation; two of them express the usual contrast between proximal and distal referents whereas the two other terms indicate whether the referent is above or below the deictic centre (see Diessel 1999: 41–47 for a survey of these features).

Tab. 90.9: Demonstrative roots in Usan (Reesink 1987)

|                         |    |
|-------------------------|----|
| Here                    | i- |
| There (vertical)        | e- |
| Up there (horizontal)   | a- |
| Down there (horizontal) | u- |

Turning to the non-deictic features of demonstratives, we may distinguish four different categories (cf. Diessel 1999: 47–52):

1. Ontology
2. Number
3. Gender
4. Boundedness

The most frequent non-deictic feature is ontology indicating the type of referent. This feature is well-known from Indo-European languages, where demonstratives such as English *here* and *there* are used with reference to locations, whereas *this* and *that* refer to

other types of entities. The semantic contrast between *here/there* and *this/that* corresponds with their syntactic functions: While *here* and *there* are commonly used as adverbs, *this* and *that* function as pronouns and determiners. Note however that demonstrative adverbs are also commonly used as noun modifiers, as for instance in English *this book here* (cf. French: *ce livre-ci*; German: *das Buch hier*; Swedish: *det här huset*), suggesting that the semantic contrast between locations and other entities is in principle independent of the syntactic contrast between adverbs and pronouns (or determiners) (cf. Diessel 2006a).

Apart from ‘ontology’, ‘number’ is a frequent feature of demonstratives. In a world-wide sample of 85 languages, Diessel (1999) found 64 languages in which demonstratives mark the contrast between singular and plural referents. However, the occurrence of number in demonstratives varies with their syntactic function: Demonstrative pronouns are more often marked for number than demonstrative determiners, which in turn are more often number-marked than demonstrative adverbs.

The two other features, gender and boundedness, occur only in a minority of the world’s languages (cf. Diessel 1999: 48–49). Gender, and the related features of animacy and humanness, are commonly found in languages that lack a particular class of third person pronouns so that unstressed demonstrative pronouns are commonly used as anaphors (cf. Siewierska 2004). Boundedness is a central feature of the deictic system in Inuktitut (Eskimo, North America), in which demonstratives indicate whether the referent is conceptualized as a “restricted” or “extended” entity (cf. Denny 1982).

4.1.3. Place deixis and motion

The demonstratives considered thus far give rise to a stationary construal of the speech situation; but demonstratives can also evoke a dynamic scenario involving direction and movement. For instance, Nunggubuyu (Gunwinguan, Australia) has three kinetic suffixes that are combined with demonstrative roots to indicate whether the referent is moving (1) toward the deictic centre, (2) away from the deictic centre, or (3) across the speaker’s line of vision (cf. Tab. 90.10).

Tab. 90.10: Kinetic demonstratives in Nunggubuyu (Heath 1980: 152)

| Form              | Gloss                                                     | Translation                |
|-------------------|-----------------------------------------------------------|----------------------------|
| yuwa: - gi: - ‘la | <i>that</i> - NounClass - toward speaker                  | ‘There he/she comes’       |
| yuwa: - gi: - ‘li | <i>that</i> - NounClass - away from speaker <i>that</i> - | ‘There he/she goes away’   |
| yuwa: -gi: - yaj  | NounClass - across field of vision                        | ‘There he/she goes across’ |

The Nunggubuyu demonstratives resemble the English demonstratives *hither* and *thither* in that they indicate direction away and towards a particular place. Very often, demonstratives of this type are combined with motion verbs, as in the following examples from German.

- (16) a. hin-/her-kommen      ‘to come hither/thither’  
      b. hin-/her-fahren      ‘to go by vehicle hither/thither’  
      c. hin-/her-laufen      ‘to run hither/thither’  
      d. hin-/her-kriechen    ‘to crawl hither/thither’  
      e. hin-/her-schwimmen   ‘to swim hither/thither’

The verbs in (16a-e) are prefixed by two deictic preverbs, *hin* ‘hither’ and *her* ‘thither’, which occur with a large number of verbs expressing physical motion or metaphorically related activities (e.g., *hin/her-hören* ‘to listen hither/thither’). The deictic preverbs are historically derived from the demonstrative root *hi*, which is also preserved in *hier* ‘here’ and *heute* ‘today’ (cf. Lockwood 1968: 36, 72). Interestingly, although motion verbs are often combined with directional demonstratives, some motion verbs do not need demonstratives to indicate direction towards the speaker because their interpretation involves the deictic centre by default. For instance, although the sentences in (17a-b) do not include a deictic expression, the verb *come* is interpreted deictically. With no further information given, *come* denotes a motion event directed towards the speaker’s location, i.e., the deictic centre (cf. Fillmore 1997).

- (17) a. Peter is coming.  
b. Come in!

Apart from *come*, there are several other verbs that have been analyzed as deictic motion verbs in English: *go*, *bring*, *take*, *leave*, *depart*, and a few others (cf. Talmy 2000). Note, however, that all of these verbs can also be used non-deictically. For instance, in examples (18a-b) *come* and *go* describe motion events between two lexically specified locations.

- (18) a. Peter came from Berlin to John’s party.  
b. Peter went from Jena to Weimar.

Since the interpretation of these sentences does not involve the speaker’s location at the time of the utterance, *come* and *go* are non-deictic in these examples. In general, although motion verbs may have a deictic interpretation, they are different from demonstratives and other deictics in that they do not presuppose the deictic centre as a particular point of reference. Moreover, the deictic interpretation of demonstratives and motion verbs is based on different psychological mechanisms. Demonstratives are interpreted as deictics because they function to establish joint attention, which presupposes the speaker’s body or location. In order to establish joint attention, the speaker indicates the direction of the referent from his point of view, i.e., the deictic centre. However, deictic motion verbs do not establish joint attention; rather, they denote a directed motion event between two locations. Since the speaker’s location is a prominent reference point in the communicative interaction, it is often interpreted as the default endpoint or beginning of a motion event. But motion verbs do not generally involve the deictic centre as a designated endpoint or beginning, suggesting that verbs such as *come* and *go* are not genuine deictics. In other words, the interpretation of motion verbs is distinct from the interpretation of genuine deictics such as demonstratives, which always involve the deictic centre, while motion verbs are only deictic by default, i.e., if no other reference point is specified.

## 4.2. Time deixis

The deictic treatment of time is based on the time-as-space metaphor (Lakoff & Johnson 1980; Radden 2004; see also article 27 (Talmy) *Cognitive Semantics*). Since time is not directly amenable to experience, it is a more elusive concept than space. However, in



language time is commonly objectified by the metaphorical structuring of time in terms of spatial concepts (cf. Lakoff & Johnson 1980; Lakoff 1993; Evans 2004). The conceptual relationship between space and time is reflected in the frequent development of temporal expressions from spatial terms. For instance, temporal adpositions such as *in* and *before* are commonly derived from body part terms (cf. Heine, Claudi & Hünemeyer 1993), and temporal adverbs such as *then* are often based on spatial deictics (see below).

Spatial orientation involves three-dimensions: the front-back axis, the up-down axis, and the left-right axis; but the spatial interpretation of time is uni-dimensional. More precisely, time is commonly conceptualized as a straight line providing the conceptual ground for a fictive observer. There are two variants of the time-as-space metaphor, the ego-moving metaphor and the time-moving metaphor (cf. Lakoff 1993; Boroditsky 2002). In the ego-moving metaphor, the observer is moving along the time line into the future (e.g., *We are approaching Eastern*), whereas in the time-moving metaphor moving events on the time line are passing a stationary observer (e.g., *His birthday is coming up soon*). Since motion is commonly directed to the front, the conceptualization of the time line is usually based on the front-back axis of spatial orientation, but it may also involve the vertical dimension (cf. Radden 2004). For instance, in Chinese temporal expressions are commonly characterized based on the up-down axis: earlier times are up (e.g., *shang.ban.tian* [lit. upper.half.day] 'morning') and later times are down (e.g., *xia.ban.tian* [lit. lower.half.day] 'afternoon') (Yu 1998: 110) (for a recent study of the time-as-space metaphor in sentence processing see Ulrich & Maienborn 2010).

The time line is divided into three domains: present, past, and future. The present is conceptualized as the deictic centre, which in English is commonly referred to by *now*. Like the deictic centre of place, the deictic centre of time varies with the conceptualization of the speech situation: *Now* may refer to the very moment of the speech event, but may also refer to a larger time period that includes the time of the current speech event (e.g., *Peter is now thirty years old*). The deictic centre is distinguished from the time conceptualized as past and future, for which English has a variety of deictic expressions: *Then* can be used with reference to both past and future time (cf. 19a-b), but other time deictic expressions such as *soon* and *ago* refer only into one direction along the time line; that is, they are exclusively used with reference to the past or future (cf. 19c-d).

- |      |    |                                                |          |
|------|----|------------------------------------------------|----------|
| (19) | a. | I was still in school <i>then</i> .            | [past]   |
|      | b. | I'll be ready <i>then</i> .                    | [future] |
|      | c. | I'll be there <i>soon</i> .                    | [future] |
|      | d. | Ten years <i>ago</i> I was a graduate student. | [past]   |

Time deixis often interacts with measures for time periods such as day, week, months, or year (cf. Levinson 1983: 73–76). In English, the two concepts, i.e., deixis and time measurement, are jointly expressed in complex NPs consisting of a demonstrative (or a sequential adjective) and a noun (e.g., *this week*; *next week*); but the combination of time deixis and time measurement can also be lexicalized, as in the temporal adverbs *today*, *yesterday*, and *tomorrow*, which indicate both a point in time, relative to the deictic centre, and a time unit, i.e., a day.

English has a variety of genuine time deictic expressions, but time deixis can also be expressed by demonstratives that are imported into the temporal domain. Anderson & Keenan (1985: 297–298) discuss examples from several languages in which time deictic expressions such as *now* and *then* are realized by demonstratives as in the following

examples from German (Indo-European, Europe) and Urubu-Kaapor (Tupi-Guarani, South America), in which the spatial deictics *da* ‘there’ and *pe* ‘there’ occur with temporal reference.

(20) German

*Da*            war        ich        ganz        unglücklich.  
There/then   was        I        totally    unhappy  
‘Then (at that time) I was totally unhappy.’

(21) Urubu-Kaapor (Kakumasu 1986: 384)

*Pe*        ih?        koty            jangwate        keruh        u-jan        u-wyr  
DEM    me        towards       jaguar        very.big    3.run       3.come  
‘Then the great jaguar came running towards me.’

What is more, temporal deictics are often diachronically derived from demonstratives, as for instance English *then*, which evolved from a deictic root with spatial meaning. Similar developments have been found in many other languages across the world. For instance, in Ainu (Isolate, Japan) temporal deictics such as *tap/tane* ‘now’ and *tanpa* ‘this year’ include the deictic root *ta* ‘this/here’ (Refsing 1986), which also functions as a demonstrative; and in Nama (Khoisan, South Africa) the formation of temporal deictics such as *nee-tse* ‘today’ and  $\parallel n\bar{a}\bar{a}$ -*tse* ‘on that day’ is based on the demonstratives *nee* ‘this’ and  $\parallel n\bar{a}\bar{a}$  ‘that’ (Hagman 1977). Tab. 90.11 shows another example from Mokilese (Austronesian, Pacific), in which nouns for time measurement are combined with the demonstrative suffixes *-e* ‘this (near speaker)’, *-oawe* ‘that (near addressee)’, and *-o* ‘that (away from speaker and hearer)’ if they are used deictically.

Tab. 90.11: Time deictic expressions in Mokilese (Harrison 1976)

| Word                   | Gloss                | Translation |
|------------------------|----------------------|-------------|
| wihkk- <i>e</i> lakapw | week-FUTURE tomorrow | Next week   |
| wihkk- <i>oawe</i>     | week-PRESENT         | This week   |
| wihkk- <i>o</i> aio    | week-PAST yesterday  | Last week   |

In general, since time is commonly conceptualized as motion in space, spatial deictics can function to ‘locate’ an event on the time line relative to the moment of the speech event, i.e., the deictic centre. This explains why time deictic expressions are often realized by spatial terms, notably by demonstratives, which historically may develop into time deictics. However, although time deixis is commonly conceptualized in spatial terms, it remains an abstract concept, which is reflected in the fact that demonstratives usually lose some of their deictic force when they are imported into the temporal domain.

4.3. Discourse deixis

Like time deixis, discourse deixis is based on the metaphorical structuring of time as space. Discourse consists of words and utterances that are processed in sequential order, that is, one element at a time. The sequential ordering of discourse elements is commonly conceptualized as a string of linguistic entities, to which speakers may refer in the same

way as they refer to temporal entities on the time line. Both time deixis and discourse deixis involve a band of successive elements that is divided into separate areas by the deictic centre. However, while the deictic centre of time deixis is defined as the time including the moment of utterance, the deictic centre of discourse deixis is defined by the location of a deictic word in the ongoing discourse, from where the interlocutors' attention is directed to linguistic elements along the string of words and utterances. Bühler (1934) described this as follows:

If discourse deictic expressions could speak, "they would speak as follows: look ahead or back along the band of the present utterance. There something will be found that actually belongs here, where I am, so that it can be connected with what now follows. Or the other way round: what comes after me belongs there, it was only displaced from that position for relief." [Bühler 1934: 390]

Discourse deixis can be realized by a variety of expressions. English has a few linguistic terms that may be analyzed as genuine discourse deictics (e.g., *the aforementioned*, *the latter*); but more frequently discourse deixis involves deictic expressions from other conceptual domains. For instance, sequential adjectives such as *last* and *next*, which are commonly used as time deictic expressions, may be used with reference to linguistic elements in the ongoing discourse (cf. 22a-b).

- (22) a. the last paragraph  
b. the next chapter

The most frequent discourse deictic expressions are borrowed from the spatial domain. Across languages, demonstratives are used as discourse deictics, as in the following example from English.

- (23) I was really interested particularly because he was saying that a lot of the leaning was going to be towards choreography and *that* was my particular interest. I really didn't like technique. I mean I'm too lazy really for *that*, I think, and that was my interest in it. *That's* how I sort of got started in it. (International Corpus of English)

Example (23) includes four tokens of the distal demonstrative *that* referring to a previous chunk of discourse. Like *that*, the proximal demonstrative *this* can be used with reference to linguistic elements; but interestingly while *that* may only refer to previous discourse units *this* can also function as a cataphor announcing a following piece of discourse, as in example (24).

- (24) I forgot to tell you *this* (\**that*). Uhm Matt Street phoned while I was out. (International Corpus of English)

Note that the demonstratives in (23) and (24) refer to propositions (or speech acts); whereas the demonstrative in (25) indicates a link between two discourse participant. In this example, the demonstrative *this* accompanies a noun (plus adjective), which together resume the referent of a prior NP.

- (25) I had sardines once with a fly on it. I was just about to tuck into it and I noticed *this* great fly soaked in tomato sauce. (International Corpus of English)

If demonstratives refer to propositions, as in (23) and (24), they indicate a link between two states of affairs; but if they refer to an NP, as in (25), they continue a prior discourse participant (cf. Himmelmann 1996; Diessel 1999: Ch. 4). In the latter use, demonstratives are similar to third person pronouns in that both types of expressions track a previous discourse participant; they occur, however, in different contexts. Consider for instance the following example from German, contrasting the third person pronoun *er* 'he' with the anaphoric use of the demonstrative *der* 'this/that' (cf. Diessel 1999: 96)

- (26) Peter       bemerkte       einen       Polizisten.       Als       *er/der*       ...  
       Peter       noticed       a       police officer       when       he/that one  
       'Peter noticed a police officer. When he ...'

Although both types of anaphors are coreferential with a previous NP, they have different antecedents. The third person pronoun *er* is coreferential with the subject of the previous sentence, i.e., *Peter*, whereas the demonstrative *der* can only be interpreted as being coreferential with the object, i.e., *einen Polizisten* 'a police man'. The two types of anaphors have different antecedents because they serve different discourse-pragmatic functions. Third person pronouns are used to continue a previously established discourse referent that is already in the interlocutors' focus of attention, whereas anaphoric demonstratives are used to indicate a topic shift, i.e., they direct the addressee's attention to a new discourse participant (cf. Diessel 1999). The same complementary use of third person pronouns and anaphoric demonstratives has been observed in Dutch and Russian (Comrie 1998), To'aba'ita (Lichtenberk 1996), Tagalog (Himmelmann 1997), and Montagnais (Cyr 1993, 1996). In all of these languages anaphoric demonstratives function to shift the interlocutors' attention on a new discourse participant that serves as the main topic in the subsequent discourse (cf. Diessel 1999: 96–98).

In English and German, discourse-related demonstratives are morphologically indistinguishable from demonstratives that are used with reference to concrete entities; but there are languages in which these uses are formally distinguished. In Latin, for instance, the demonstrative *is* 'this/that' can only function as an anaphor, whereas *hic* 'this (near speaker)', *iste* 'that (near hearer)', and *ille* 'that (away from speaker and hearer)' are primarily used for language-external reference. Likewise, in Usan (Sepik, New Guinea) the demonstratives *ende* and *ete* are exclusively used with reference to the previous (*ende*) or subsequent (*ete*) discourse (Reesink 1987; Himmelmann 1997; Diessel 1999: 103–104).

Since discourse referents are not visible, discourse-related demonstratives are not accompanied by a pointing gesture; however, they involve the same psychological mechanism as demonstratives that speakers use with language-external reference. In both uses, demonstratives focus the interlocutors' attention on a particular referent. In the language-external use (also called the exophoric use) they focus the interlocutors' attention on concrete entities in the physical world, and in the discourse use (also called the endophoric use) they focus their attention on linguistic elements in the surrounding context. In other words, in both uses demonstratives function to create a joint focus of attention. Joint attention is thus not only important to coordinate the interlocutors' attentional focus in the speech situation, it also plays a crucial role in the internal organization of discourse.

What is more, when anaphoric and discourse deictic demonstratives are routinely used in particular constructions, they often develop into grammatical markers. For instance, in English the definite article *the* and the third person pronouns *he* and *it* are historically derived from anaphoric demonstrative pronouns. The same developments occurred in many other languages across the world (cf. Himmelmann 1997; Diessel 1999). In general, demonstratives that are routinely used with reference to linguistic elements in discourse provide a common historical source for some of the most frequent grammatical markers including not only definite articles and third person pronouns but also relative pronouns, complementizers, conjunctions, copulas, directional preverbs, focus markers, and a wide variety of other grammatical morphemes (see Diessel 1999: Ch. 6 for an overview). The grammaticalization of demonstratives is cross-linguistically so common that central aspects of grammar such as definiteness marking and clause combining are crucially determined by this process (cf. Diessel 2006a).

## 5. Conclusion

This paper has surveyed deictic expressions in natural language and has considered the psychological mechanisms that underlie their use. Two basic types of deixis have been distinguished, participant deixis and object deixis, which serve different communicative functions expressed by different deictic terms. Participant deictics are primarily used to represent the speech participants in the state of affairs that is encoded in an utterance, whereas object deictics are used to orientate the interlocutors in the situational or discourse context. It has been argued that demonstratives constitute a special class of linguistic expressions that are essential for the communicative interaction between the speech participants and the organization of discourse and development of grammar.

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Holger Diessel, Jena (Germany)

## 91. Presupposition

1. Introduction
2. Projection
3. Cancellability
4. Theories of presupposition
5. Current issues in presupposition theory
6. Concluding remarks
7. References

### Abstract

*We discuss presupposition, the phenomenon whereby speakers mark linguistically the information that is presupposed or taken for granted, rather than being part of the main propositional content of a speech act. Expressions and constructions carrying presuppositions are called “presupposition triggers”, which is a large class including definites and factive verbs.*

*The article (an abridged and adapted version of Beaver & Geurts 2010), first introduces the range of triggers, the basic properties of presuppositions such as projection and cancellability, and the diagnostic tests used to identify them. The reader is then introduced to major models of presupposition from the last 50 years, separated into three classes: Frege-Strawson derived semantic models, pragmatic models such as that offered by Stalnaker, and dynamic models. Finally we discuss some of the main current issues in presupposition theory, including accommodation, which occurs when a hearer’s knowledge state is adjusted to meet the speaker’s presuppositions; presupposition failure, and the interaction between presuppositions and attitudes.*

*Denial, projection, cancellation, satisfaction, accommodation:  
the five stages of presupposition theory.*

## 1. Introduction

Speakers take a lot for granted. That is, they *presuppose* information. As we wrote this, we presupposed that readers would understand English. But we also presupposed, as we wrote the last sentence, repeated in (1), that there was a time when we wrote it, for otherwise the fronted phrase “as we wrote this” would not have identified a time interval.

(1) As we wrote this, we presupposed that readers would understand English.

We also presupposed that the sentence was jointly authored, for otherwise “we” would not have referred. And we presupposed that readers would be able to identify the reference of “this”, i.e. the article itself. And we presupposed that there would be at least two readers, for otherwise the bare plural “readers” would have been inappropriate. And so on and on.

Here note a first distinction: the presupposition that an interlocutor would understand English corresponds to an assumption we made in using English words, but it has nothing to do with the meanings of any of those words. On the other hand, the existence of a time when we wrote the article is a requirement associated with our use of a specific word, “as”. It is a requirement built into the meaning of the temporal preposition “as” that in a phrase “as X”, the “X” has to hold at some time. We say that “as” is a *presupposition trigger*. Similarly, “this” is a presupposition trigger requiring something to refer to, the bare plural is a presupposition trigger requiring existence of multiple individuals, and “would” is a presupposition trigger requiring a salient future or hypothetical circumstance.

We can say that the presupposition that the interlocutor speaks English, like the presupposition that the interlocutor is interested in what the speaker (or writer) has to say, is a *conversational presupposition* or, following Stalnaker (1972, 1974), *speaker presupposition* or *pragmatic presupposition*. The presuppositions associated with specific triggers are said to be *conventional* or *semantic*. In fact, this terminological distinction is of theoretical import: as we will see later, some theorists regard it as an open question whether there are any purely conventional presuppositions. A halfway house, suggested for example by Karttunen (1973) and Soames (1982), is to define a notion of *utterance presupposition*, thus involving both a specific form that is uttered, and a speaker who utters it.

It is important to note that to call presuppositional expressions “conventional” or “semantic” is not necessarily to imply that the presuppositions they trigger don’t depend on the context in any way. For example, although “this” may be viewed as a conventional/semantic presupposition trigger, its interpretation very much depends on the context, obviously.

What makes presuppositions special? That is, to the extent that presuppositions are just a part of the conventional meaning of some expressions, what makes them sufficiently distinctive that they merit their own entries in handbooks and encyclopedias, as well as many hundreds of other articles and book chapters elsewhere? First, presuppositions are ubiquitous. And second, there are various respects in which the behavior of presuppositions differs sharply from other aspects of meaning.

As regards the ubiquity of presuppositions, at least the following lexical classes and constructions are widely agreed to be presupposition triggers:

- (2) Major classes of presupposition trigger
- *Factives* (Kiparsky & Kiparsky 1970)  
 Berlusconi knows that he is signing the end of Berlusconiism.  
 ~ Berlusconi is signing the end of Berlusconiism.
  - *Aspectual verbs* (“stop, continue”)  
 China has stopped stockpiling metals.  
 ~ China used to stockpile metals.
  - *Temporal clauses headed by “before”, “after”, “since”, etc.*  
 The dude released this video before he went on a killing spree.  
 ~ The dude went on a killing spree.
  - *Manner adverbs*  
 Jamie ducked quickly behind the wall.  
 ~ Jamie ducked behind the wall.
  - *Sortally restricted predicates of various categories (e.g. “bachelor”)*  
 Julius is bachelor.  
 ~ Julius is an adult male.
  - *Cleft sentences*  
 It was Jesus who set me free.  
 ~ Somebody set me free.
  - *Quantifiers*  
 I have written to every headmaster in Rochdale.  
 ~ There are headmasters in Rochdale.
  - *Definite descriptions* (see article 41 (Heim) *Definiteness and indefiniteness*)  
 The Prime Minister of Trinidad and Tobago stood up and wagged his finger.  
 ~ Trinidad and Tobago have a (unique) prime minister.
  - *Names*  
 The author is Julius Seidensticker.  
 ~ Julius Seidensticker exists.
  - *Intonation (e.g., focus, contrast)*  
 HE set me free.  
 ~ Somebody set me free.

And this is only a small sample of the words and syntactic constructions that have been classified as presupposition triggers, so even if in some cases there may be doubts about this diagnosis, it can hardly be doubted that presupposition triggers abound in everyday language. In the following sections we will discuss the behaviors which mark out presuppositions from ordinary entailments, and then introduce some of the theories that have been developed to account for those behaviors.

## 2. Projection

The hallmark of presuppositions, as well as the most thoroughly studied presuppositional phenomenon, is *projection* (Langendoen & Savin 1971). Consider (3). This has all the presuppositions in (3-a-c). These presuppositions all follow from utterances of the base sentence in (3), as do the regular entailments in (4): someone who sincerely uttered (3) would certainly be expected to accept the truth of (3-a-c) and (4-a-b), as well:

- (3) It's the knave that stole the tarts.
  - a. There is a (salient and identifiable) knave.
  - b. There were (salient and identifiable) tarts.
  - c. Somebody stole the tarts.
- (4)
  - a. The knave did something illegal.
  - b. The knave took possession of the tarts.

Now consider the sentences in (5):

- (5)
  - a. It isn't the knave that stole the tarts. (*negation*)
  - b. If it's the knave that stole the tarts, he will be punished. (*antecedent of a conditional*)
  - c. Is it the knave that stole the tarts? (*question*)
  - d. Maybe/It is possible that it's the knave that stole the tarts. (*possibility modal*)
  - e. Presumably/probably it's the knave that stole the tarts. (*evidential modal, probability adverb*)
  - f. The king thinks it's the knave that stole the tarts. (*belief operator*)

In all these examples, sentence (3) is embedded under various operators. What is notable is that whereas the presuppositions in (4) do not follow from any of these embeddings (and would not be expected to follow according to classical logics), the presuppositions do follow. We say that the presuppositions are *projected*. Certainly, the inference is more robust in some cases than in others: while it is hard to imagine sincerely uttering (5-a) without believing some tarts to be salient, it is easier to imagine a circumstance in which (5-f) could be uttered when in fact the tarts were not eaten, but hidden. But in the absence of special factors, to which we will turn shortly, someone who sincerely uttered any of the sentences in (5) might be expected to believe all of the presuppositions in (3a-c).

Projection from embeddings, especially negation, is standardly used as a diagnostic for presupposition (hence the term “negation test”). It makes sense to try several such embeddings when testing for presupposition, because it is not always clear how to apply a given embedding diagnostic. Thus, for example, we might be specifically interested in the presuppositions of the cleft construction in (3), but doubt whether the sentence in (5-a) really involves the cleft being within the semantic scope of the negation. However, the other embeddings in (5) confirm that the it-cleft construction is a presupposition trigger. Similarly, although it is widely agreed that “too” is a presupposition-inducing expression, the negation test is awkward to apply in this case, too:

- (6)
  - a. Fred kissed BETTY, too.
  - b. Fred didn't kiss BETTY, too.

If we embed (6-a), e.g., under a modal or in the antecedent of a conditional, it turns out that this sentence presupposes that someone other than Betty was kissed by Fred. However, as (6-b) shows, the negation test fails in this case, because “too” doesn't like being in a negative environment. These examples illustrate how important it is to consider several types of embedding when testing for presupposition.

### 3. Cancellability

What makes the “projection problem” problematic? If some part of the meaning of an expression  $\alpha$  was never affected by the linguistic context in which  $\alpha$  was embedded, that would be philosophically interesting, and would demand a theoretical explanation, but it would at least be trivial to completely describe the data: all presuppositional inferences would survive any embedding, end of story. But that isn’t what happens. Presuppositions typically project, but often do not, and most of the empirical and theoretical work on presupposition since the 1970s was taken up with the task of describing and explaining when presuppositions project, and when they don’t.

When a presupposition does not project, it is sometimes said to be “canceled”. The classic cases of cancellation occur when the presupposition is directly denied, as in the following variants of some of the sentences in (5):

- (7) a. In this court, it isn’t the knave that steals the tarts: the king employs no knaves precisely because he suspects they are responsible for large-scale tart-loss across his kingdom.  
 b. If it’s the knave that stole the tarts, then I’m a Dutchman: there is no knave here.  
 c. Is it the knave that stole the tarts? Certainly not: there is no knave here.  
 d. The king thinks it’s the knave that stole the tarts, but he’s obviously gone mad, since there is no knave here.

Presuppositional inferences are typically subject to cancellation by direct denial only when the presupposition trigger is embedded under some other operator. When the presupposition is not embedded, such cancelation (by the same speaker) is typically infelicitous, just as is cancelation of entailed content which is not embedded. Thus the denial of a presupposition in (8) and the denial of an ordinary entailment in (9) both lead to pragmatically infelicitous utterances (marked by a “#”).

- (8) #It’s the knave that stole the tarts, but there is no knave.  
 (9) #It’s the knave that stole the tarts, but he didn’t do anything illegal.

The fact that presuppositions associated with unembedded triggers are not cancelable is one of the features that distinguishes most presuppositions from Gricean conversational implicatures (Grice 1989) (see article 92 (Simons) *Implicature*). For example, an utterance of (10-a) might ordinarily lead to the so-called scalar implicature in (10-b). But while this implicature is cancelable, as in (10-c), the presupposition that there is a knave, once again, is not cancelable, as shown by the oddity of (10-d).

- (10) a. The knave stole most of the tarts.  
 b. The knave did not steal all of the tarts.  
 c. The knave stole most of the tarts – in fact, he stole them all.  
 d. #The knave stole most of the tarts, but there was no knave.

We can summarize the typical behavior of entailments, presuppositions, and conversational implicatures as follows:

Tab. 91.1.

|                            | <i>entailments</i> | <i>presuppositions</i> | <i>implicatures</i> |
|----------------------------|--------------------|------------------------|---------------------|
| Project from embeddings    | no                 | yes                    | no                  |
| Cancelable when embedded   | –                  | yes                    | –                   |
| Cancelable when Unembedded | no                 | no                     | yes                 |

Because presuppositions are typically only cancelable when embedded, Gazdar (1979a, 1979b) argued that presuppositions are usually entailed when the trigger is not embedded.

The literature is choc-a-bloc with examples of presuppositional inferences apparently disappearing. Whether such examples are appropriately described as involving *cancellation* is partly a theoretical decision, and, as we will see, many scholars avoid using the term “cancellation” for some or all such cases. One reason for this is that the term “cancellation” appears to suggest that an inference has been made, and then removed. But in many cases there are theoretical reasons not to regard this as an apt characterization, and we will now consider one class of such cases.

4. Theories of presupposition

4.1. The Frege-Strawson tradition

Strawson (1950) famously argued against Russell’s (1905) theory of definite descriptions by proposing that when a definite description fails to refer, the result can be a sentence which lacks a truth value. Thus presuppositions are understood as definedness conditions, necessary requirements for an expression to have a meaning. Strawson’s intuition, which can be traced back to Frege (1892), leads to the following definition (cf. Strawson 1952; see Beaver & Geurts 2010 for full references):

**Definition 1 (Strawsonian presupposition)** *One sentence presupposes another iff whenever the first is true or false, the second is true.*

Another definition that is often used is this:

**Definition 2 (Presupposition via negation)** *One sentence presupposes another iff whenever the first sentence is true, the second is true, and whenever the negation of the first sentence is true, the second sentence is true.*

These two definitions are equivalent if negation maps true onto false, false onto true, and is undefined when its argument is undefined. However, the second definition is notable in the context of the above discussion of projection, because it seems to directly encode the projection properties of at least one operator, negation. Specifically, it says that presuppositions are inferences that survive embedding under negation. It is clear that if the above assumptions about presupposition are made, then the presuppositions of a sentence will be the same as the presuppositions of the negation of the sentence. But what about projection from embeddings other than negation? A very simple account of projection is based on the *cumulative hypothesis*, first discussed by Morgan (1969) and Langendoen & Savin (1971). This is the idea that presuppositions always project from embedding, as if there were no effects like cancellation. A trivalent semantics that yields this behavior

is obtained by using the *Weak Kleene* connectives (Kleene 1952). Assume (for all the partial/multivalued semantics given in this article) that for classically valued arguments, the connectives behave classically. Then Weak Kleene connectives (also known as the Bochvar Internal connectives) are defined as follows:

**Definition 3 (Weak Kleene)** *If any argument of a Weak Kleene connective lacks a classical truth value, then the sentence as a whole lacks a truth value.*

Weak Kleene fails as a theory of presupposition because it entails that presuppositions project uniformly, whereas in fact they do not. Another system of Kleene’s, the Strong Kleene connectives, does not have this property:

**Definition 4 (Strong Kleene)** *If the classically-valued arguments of a Strong Kleene connective would suffice to determine a truth value in standard logic, then the sentence as a whole has that value; otherwise it doesn’t have a classical value.*

For example, in classical logic a conjunction is bound to be false if one of its conjuncts is false, and therefore the same holds for Strong Kleene “and”. Similarly, since in classical logic a disjunction must be true if one of its disjuncts is true, the same holds for Strong Kleene “or”. We obtain the following truth tables for the main binary connectives:

Tab. 91.2.

| $\phi \wedge \psi$ | $t$ | $f$ | $*$ |
|--------------------|-----|-----|-----|
| $t$                | $t$ | $f$ | $*$ |
| $f$                | $f$ | $f$ | $f$ |
| $*$                | $*$ | $f$ | $*$ |

| $\phi \vee \psi$ | $t$ | $f$ | $*$ |
|------------------|-----|-----|-----|
| $t$              | $t$ | $t$ | $t$ |
| $f$              | $t$ | $f$ | $*$ |
| $*$              | $t$ | $*$ | $*$ |

| $\phi \rightarrow \psi$ | $t$ | $f$ | $*$ |
|-------------------------|-----|-----|-----|
| $t$                     | $t$ | $f$ | $*$ |
| $f$                     | $t$ | $t$ | $t$ |
| $*$                     | $t$ | $*$ | $*$ |

Now consider the following example:

(11) If there is a knave, then the knave stole the tarts.

Let’s ignore all presuppositions triggers in (11) save “the knave”, and show that Strong Kleene predicts that the sentence as a whole does not presuppose that there is a knave. Using Definition 1, it suffices to find at least one model where (11) has a classical truth value, but there is no knave. This is easy: in such a model, the antecedent is false, and inspection of the above Strong Kleene table shows that when the antecedent of a conditional is false, the conditional is true, as would be the case classically. In fact, Strong Kleene predicts no presupposition for (11). This is in contradistinction to Weak Kleene, which would fail to give (11) a classical value in knave-less models, and hence predict that (11) presupposes the existence of a knave.

There are other cases where Strong Kleene does predict a presupposition, and the presupposition predicted is not what we might have expected. Thus Strong Kleene gives (12-a) a classical truth value in all models where there is a knave, and in all models where there was trouble. So while we might have expected the presupposition in (12-b), Strong Kleene predicts the presupposition in (12-c). We will return to this issue shortly.

- (12) a. If the knave stole the tarts, then there was trouble.  
 b. There is a knave.  
 c. If there was no trouble, then there is a knave.

Much of the discussion of partial and multivalent approaches to presupposition over the last three decades has centered on the treatment of negation. Specifically, the issue has been the treatment of cancellation examples like (13).

- (13) The tarts were not stolen by the knave: there is no knave.

A standard approach is to propose that negation is ambiguous between a presupposition-preserving negation and a presupposition-denying negation; see e.g. the discussion by Horn (1985, 1989). The presupposition-preserving negation (aka *choice* negation) we have already seen, and it is found in both the Weak and Strong Kleene systems. The presupposition-denying (or *exclusion*) negation is typically taken to map true to false and false to true, as usual, but also to map an argument lacking a classical value to true. Thus if (13) is interpreted in a model where there is no knave, but “not” is understood as a presupposition-denying negation, then “the tarts were stolen by the knave” would lack a classical value, but “The tarts were not stolen by the knave”, and (13) as a whole, would be true.

Note that in this analysis the presupposition triggered by the “the knave” is not literally cancelled; rather, the negation is interpreted in such a way that the sentence as a whole doesn’t inherit this presupposition. However, the idea that negation is ambiguous between a presupposition-preserving and a presupposition-denying sense is controversial, e.g. because thus far no language has been found in which presupposition affirming and presupposition-denying negations are realized by different lexical items.

## 4.2. Pragmatic presupposition

Probably the most significant philosophical counterpoint to the Frege-Strawson approach to presupposition, other than the original non-presuppositional work of Russell, is due to Stalnaker (1972, 1973, 1974), and later clarified in Stalnaker (1998) (cf. Simons 2003). Stalnaker suggests that a pragmatic notion of presupposition is needed, so that the proper object of philosophical study is not what words or sentences presuppose, but what people presuppose when they are speaking. A pragmatic presupposition associated with a sentence is a condition that a speaker would normally expect to hold in the common ground between discourse participants when that sentence is uttered.

One consequence of Stalnaker’s view is that, *contra* semantic accounts of presupposition, presupposition failure need not produce a semantic catastrophe. There are, however, two weaker types of failure that can occur: (i) a speaker uttering some sentence *S* can fail to assume that some proposition *P* is in the common ground, even though most utterances of *S* would be accompanied by the presupposition that *P*; and (ii) a speaker can presuppose something that is not in the common ground. The former idea was used by Stalnaker to account for some tricky examples of Karttunen (1971b), involving a subclass of factive verbs that Karttunen referred to as “semifactives”. The naturally occurring examples in (14-a) and (14-b), which involve the (semi-)factive verb “know”, illustrate the point. The first sentence of (14-a) involves a first person, present tense use of “know”, and there is



clearly no presupposition that Mullah Omar is alive. On the other hand, (14-b) involves a past tense, third person use of “know”, and in this case it does seem to be presupposed (at least in the fictional context of the story) that Luke was alive.

- (14) a. I don’t know that Mullah Omar is alive. I don’t know if he’s dead either.  
(General Dan McNeill, Reuters, 19 May 2008)
- b. Vader didn’t know that Luke was alive, so he had no intentions of converting Luke to the Sith. (Web example)

Examples like (14) led Karttunen to propose that “know” only triggers a presupposition in some person and tense forms; whence the term “semifactive”. But, as Karttunen himself realized, such a stipulation is unmotivated. What Stalnaker noticed was that in the context of his pragmatic account of presupposition, these examples are not problematic. In the pragmatic account, the verb “know” need not presuppose that its complement is true. When an addressee hears the first sentence of (14-a), he will realize that if it were in the common ground that Mullah Omar was alive, then the speaker would know this, and so the speaker’s claim would be false. Therefore the hearer can reason that the speaker is not presupposing the complement of “know” to be true. On the other hand, when a hearer is confronted by (14-b), it is consistent to assume that Luke was alive. Since speakers using “know” typically presuppose the truth of the complement, we can assume that this is the case here.

Stalnaker’s work was part of an avalanche of pragmatic attacks on the semantic conception of presupposition. However, unlike Stalnaker’s, many of these proposals had no distinctive role for a notion of presupposition. Working in the immediate aftermath of Grice’s 1967 William James lectures (Grice 1989), many theorists attempted to reduce presupposition to various combinations of entailment and implicature. Thus Atlas & Levinson (1981), Wilson (1975), and Böer & Lycan (1976), among others, present detailed (and partly independent) arguments that presuppositions should be understood as something akin to conversational implicatures. Generally speaking, the approach is to justify presuppositional inferences using the maxims of relevance and quantity. Atlas (1976) suggests that an embedding of a definite under a negation will tend to produce a meaning that is ruled out as insufficiently strong to satisfy the maxim of quantity, unless it is strengthened by treating the definite as if it had wide scope and could act referentially. Contemporary descendants of this pragmatic tradition include Abbott (2000), Simons (2001, 2004), and Schlenker (2008). Both Abbott and Simons are at pains to distinguish between different presupposition triggers, rather than lumping them all together. Thus Simons, for example, makes a case for deriving presuppositional inferences associated with factives and aspectual adverbs using a combination of Stalnakerian and Gricean reasoning, but does not argue for making the same reduction in the case of typically anaphoric triggers like the additive “too”. Schlenker does not make such fine-grained distinctions between presupposition triggers. Instead, he concentrates on deriving projection properties pragmatically, using both standard maxims and at least one rule specific to presuppositions. (Schlenker’s special-purpose rule is: “Be Articulate”. This exhorts speakers to assert content rather than presupposing it, but, because of interactions with other maxims, only forces them to do so when such an assertion would not yield redundancy. The net effect is much like that described for Karttunen’s 1974 model, below.)

There is a contrast among pragmatic approaches to presupposition. Those discussed in the preceding paragraph attempt to derive presuppositional inferences from general conversational principles, thus explaining both the source of presuppositions, and the phenomenon of projection. But Stalnaker made no attempt whatsoever to explain where presuppositions came from, beyond indicating that they are inferential tendencies that might or might not be associated with semantic presuppositions. This emphasis on the projection of presuppositions rather than their source, which holds also of the contemporaneous work by Karttunen (1973, 1974), to which we shall turn shortly, lived on in much of the work influenced by these theories. It is particularly obvious in what we can collectively term *cancellation*-based theories of presupposition, led by Gazdar (1979a, 1979b), and including Soames (1979, 1982), Mercer (1987, 1992), Gunji (1981), Marcu (1994), Horton (1987), Horton & Hirst (1988), Bridge (1991), and, of particular note, van der Sandt (1982, 1988).

Cancellation accounts can be traced back in spirit to the Stalnaker account of semifactives discussed above, in which presuppositions are defeated by competing conversational inferences: the general idea is simply to make presuppositions into defaults, and wipe them out whenever they would cause pragmatic embarrassment. Gazdar's account provided a remarkably straightforward formalization of this account, as well as extending to many other projection phenomena, based on a general principle he characterizes as "All the news that fits". In Gazdar's model, the strategy for a hearer is first to identify sets of entailments, conversational implicatures, and presuppositions, and then to try adding them to the speaker's set of commitments.

**Definition 5 (Gazdar: cancellation)** *Implicatures and entailments defeat presuppositions, so a hearer adds to his or her commitments only those presuppositions that are compatible with both implicatures and entailments. All remaining presuppositions are cancelled.*

Consider (15-a), and assume there are no relevant pre-existing commitments:

- (15) a. If the king is angry, then the knave stole the tarts.  
       b. If there is a knave, then the knave stole the tarts.

(15-a) entails is that if there is an angry king then there is a knave and he stole some set of tarts. (This much all theories agree on; some theories may predict stronger entailments.) The set of implicatures would include the implicature that the speaker doesn't know whether a king is angry, and doesn't know whether a knave stole tarts. The presuppositions (or "potential presuppositions", as Gazdar calls them at this stage) might be that there is a unique king, a unique knave, and a unique set of tarts. The hearer proceeds by adding the entailments to (his representation of) the speaker's commitment set, then adding whatever implicatures fit in, and then adding the presuppositions that fit after that. In this case, all the entailments, implicatures, and presuppositions are consistent, and all can be added without any being cancelled.

But now consider (15-b), repeated from (11). Here there is a implicature that the speaker doesn't know whether there is a knave. The hearer accepts this and other implicatures, and then considers the presuppositions that there is a knave and that there are some tarts. The presupposition that there are tarts is unproblematic, and is added, but the hearer cannot consistently add the presupposition that there is a knave. So this

presupposition is canceled, and (15-b) does not presuppose that there is a knave. Hence, if Gazdar is right, presuppositions are sometimes blocked by conversational implicatures.

Within the space of cancellation-based accounts of presupposition, it is hard to beat Gazdar's for its conceptual and technical simplicity, and its empirical coverage. Some conceptual questions remain, however, such as why it should be that *presuppositions* are the last things to be added in the process of updating commitments. Van der Sandt's (1982, 1988) reformulation of the cancellation model gives us an alternative way to think about this, for in this model presuppositions are considered in terms of whether they could have come first.

**Definition 6 (Van der Sandt: cancellation)** *Project only those presuppositions that could be conjoined to the beginning of the sentence while leaving the utterance consistent with (neo-Gricean) conversational principles.*

The intuitive idea underlying van der Sandt's proposal is that presuppositions are *given* information, and in this sense "precede" their carrier sentences, if not *de facto* then at least *de jure*. In the case of (15-a,b), fronting the presupposition that there are some tarts yields the sentences in (16-a,b), respectively.

- (16) a. There are some tarts and if the king is angry, then the knave stole the tarts.  
b. There are some tarts and if there is a knave, then the knave stole the tarts.

These do not clash with any Gricean principles, so the presuppositions are predicted to project. Similarly, adding the presupposition that there is a knave to (15-a), as in (17-a), produces no clash, so (15-a) presupposes that there is a knave. But adding the presupposition that there is a knave to (15-b), as in (17-b), does result in a clash: since (17-b) is truth-conditionally equivalent to the simple conjunction "there is a knave and the knave stole the tarts", it is redundant. On van der Sandt's analysis, if fronting a presupposition would produce a redundant result, then that presupposition cannot project. So (15-b) is correctly predicted not to presuppose that there is a knave.

- (17) a. There is a knave and if the king is angry, then the knave stole the tarts.  
b. There is a knave and if there is a knave, then the knave stole the tarts.

It should be noted, however, that even if (17-b) is redundant, it is arguably a felicitous discourse, and therefore some subtlety is needed in applying van der Sandt's cancellation principle in the simplified form above. The issue is not simply whether a discourse is felicitous, but whether there is any clash with the maxims. And this will of course depend on how exactly the maxims are formulated. But for the purposes of understanding the intention of van der Sandt's analysis, we can take it that though an utterance of (17-b) could be felicitous, it would be a case of *flouting* (in Grice's sense), a case where a maxim is disobeyed in order to preserve some greater conversational goal.

#### 4.3. Local contexts and the dynamic turn

For the last fifty years, the philosophical literature on presupposition has been primarily focused on definite descriptions. But by the early 1970s, more linguistically oriented work

had expanded the empirical domain of presupposition theory from definite descriptions to other trigger types, including factives (Kiparsky & Kiparsky 1970), implicatives (Karttunen 1971a), focus particles (Horn 1969), verbs of judging (Fillmore 1971) and sortal constraints (Thomason 1972). Stalnaker's discussion of Karttunen's semifactives provides an early example of how this linguistic expansion of the empirical domain has impacted on philosophical work. Also by the early 1970s, linguists had expanded the empirical domain in another direction. The philosophical literature was largely oriented towards unembedded presupposition triggers and triggers under negation, but as we have already mentioned, Morgan (1969) and Langendoen & Savin (1971) generalized the issue by considering arbitrary embeddings. However, it was not until Karttunen (1973) that the full complexity of the projection problem became apparent. By methodically considering projection behavior construction by construction, Karttunen showed that there was more variation in projection behavior than had been previously described, making it quite clear that none of the extant Frege-Strawson derived systems could hope to cover every case.

#### 4.3.1. Karttunen: first intimations of satisfaction

Karttunen (1973) presented a taxonomy of embedding constructions that divided them into three classes: *plugs*, *holes* and *filters*. Plugs comprise a class of predicates and operators which Karttunen claimed block the projection of presuppositions, while holes are a class of predicates and operators which allow presuppositions to project freely. So, since "told that" is a plug, according to Karttunen, (18) is predicted not to presuppose that there is a King of France. On the other hand, since "perhaps" is a hole, (19) is predicted to presuppose that there is a King of France.

(18) Mary told Jim that the King of France was bald.

(19) Perhaps the King of France is bald.

Karttunen's filters include the binary logical connectives "if then", "and", and "or". The intuition behind the filter metaphor is that these constructions allow only some presuppositions to project, and we have already seen examples of this phenomenon. Thus example (11) showed that sometimes a presupposition in the consequent of a conditional does not project: here the presupposition that there was a knave is, to use Karttunen's metaphor, filtered out. But the same example includes an occurrence of the definite "the tarts" in the consequent, and the presupposition that there are (or at least were) some tarts projects from the conditional. Karttunen concluded that the consequent of a conditional acts as a hole to some presuppositions, but filters out all those presuppositions which are entailed by the antecedent, or, more generally, by a combination of the antecedent and contextually supplied background information. (Here, of course, we simplify as regards the semantics of conditionals: see article 59 (von Fintel) *Conditionals*.)

Karttunen's key example showing the role of context bears repetition:

(20) Either Geraldine is not a mormon or she has given up wearing her holy underwear.

The second half of (20) contains (at least) two presupposition triggers: the definite description "her holy underwear" and the aspectual verb "give up", which trigger

the presuppositions that Geraldine used to have and wear holy underwear, respectively. Karttunen's filtering condition for disjunctions removes from the right disjunct any presuppositions that are entailed by a combination of the context and the negation of the left disjunct. Now consider a context supporting the proposition that all mormons have holy underwear which they wear regularly. It follows from this proposition and the negation of the left disjunct, i.e. the proposition that Geraldine is a mormon, that Geraldine has holy underwear and has worn it regularly. But these are exactly the presuppositions triggered in the right disjunct, so they are filtered out. It follows that (20) has no presuppositions.

Karttunen's (1973) account is of interest not only for its triptych of plugs, holes and filters, but also because it sets the background for a crucial shift of perspective in Karttunen (1974), and thence to the dynamic approaches to presupposition that have been dominant in recent years. What remained completely unclear in the 1973 paper was why certain presuppositions should be filtered out if they were entailed by other material. Karttunen (1974) suggests an alternative conception based on the idea of *local contexts* of evaluation. The idea is that the parts of a sentence are not necessarily evaluated with respect to the same context as that in which the sentence as a whole is evaluated: a local context may contain more information than the global context. For example, when evaluating a conjunction, the second conjunct is evaluated in a local context which contains not only the information in the global context, but also whatever information was given by the first conjunct. Karttunen (1974) defined local contexts of evaluation for a range of constructions, and suggested the following requirement: presuppositions always need to be entailed (or "satisfied", as he puts it) in the local context in which the trigger is evaluated. Given this requirement, the overall presuppositions of a sentence will just be whatever propositions must be in a context of an utterance in order to guarantee that the presuppositions associated with presupposition triggers are satisfied in their local contexts of interpretation.

Karttunen spelled out how local satisfaction should be calculated separately for each connective and operator he considered. However, recent developments in Schlenker (2008) provide a general way of calculating what the local context should be. In the following reformulation of Karttunen's model we incorporate Schlenker's insights along the lines proposed by Beaver (2008).

Let us say that some clause in a complex sentence is redundant relative to some context of utterance if you can replace that clause by a tautology without affecting the amount of factual information conveyed by the sentence in that context. For example, in (21), the first conjunct is redundant in any context of utterance. Here, the same factual information would be conveyed by "Mary is Mary and Mary owns a sheep", where the first conjunct is replaced by the tautology "Mary is Mary".

(21) Mary owns an animal and Mary owns a sheep

Now let us say that a clause is left-redundant if it is possible to tell by looking at the material in the sentence to the left of the clause that the clause is redundant. So "Mary owns an animal" is not left-redundant in (21) (except if the context of utterance already entails that Mary owns an animal), because there is no material before that clause, implying that it is impossible to tell by looking at material to the left of the clause that the clause is redundant. On the other hand, "Mary owns an animal" is left-redundant in (22) and also in (23):

- (22) Mary owns a sheep and Mary owns an animal.  
 (23) If Mary owns a sheep then Mary owns an animal.

Now we can put this to use to define the crucial notion in Karttunen's (1974) account.

**Definition 7 (Karttunen/Schlenker: Presupposition via satisfaction)** *A presupposition  $P$  is satisfied at point  $X$  in  $S$  iff  $P$  would be left-redundant if added at that point. A sentence presupposes whatever propositions must hold in global contexts of utterance such that each locally triggered presupposition is satisfied where its trigger occurs.*

As an example, let us consider the presuppositions predicted for (20), repeated below:

- (20) Either Geraldine is not a mormon or she has given up wearing her holy underwear.

Note first that for all sentences of the form "A or B", the negation of A is satisfied within the right disjunct. So "Geraldine is a mormon" is satisfied in the right disjunct of (20). And more generally, anything entailed by a combination of propositions in the context and the negation of the left disjunct will be satisfied in the right disjunct. Now, let us consider the clause "she has given up wearing her holy underwear": we take this to trigger the presupposition that Geraldine has had holy underwear that she wore. This presupposition will be satisfied provided the global context of utterance, combined with the negation of the left disjunct, entails that she has had holy underwear that she wore. And classically this will be the case if and only if the context supports the conditional "if Geraldine is a mormon, then she has had holy underwear that she wore." Hence, this conditional is the presupposition Karttunen (1974) predicts for (20).

One notable property of the Karttunen (1974) treatment of examples like (20), a property not found in his 1973 model, is that the presupposition predicted is conditionalized. That is, (20) is not predicted to presuppose that Geraldine has had holy underwear that she wore, but that if she is a mormon then she has had such underwear. We already encountered such conditionalized presuppositions in our discussion of Strong Kleene; in fact, Strong Kleene predicts exactly the same conditionalized presupposition in this case. Karttunen's 1974 model also predicts conditionalized presuppositions when the presupposition trigger is in the right conjunct of a conjunction, or in the consequent of a conditional. Thus in (15-a), repeated below, the presuppositions predicted are that there is a king (since presuppositions triggered in the antecedent are not conditionalized), and that if the king is angry, then there is a knave. In (15-b), the conditional presupposition (that if there is a knave, then there is a knave) is trivial, so in effect there is no net presupposition. (Note that if in (15-b) we took the presupposition of the definite "the knave" to include a uniqueness or maximality requirement, i.e. that there was no more than one knave, then the overall presupposition of the example as predicted by the Karttunen (1974) model, and indeed by Strong Kleene, would no longer be trivial. The presupposition would be that if there was a knave then there was only one knave. More generally, the conditionalized presuppositions predicted by Karttunen came under withering attack by Gazdar 1979a, and have been a subject of controversy ever since.)

- (15) a. If the king is angry then the knave stole the tarts.  
       b. If there is a knave, then the knave stole the tarts.

Although Karttunen’s (1974) model seems quite distinct from any of its predecessors, we have already noted that it shares at least some predictions with Strong Kleene. An observation made by Peters (1979) showed that the 1974 model is surprisingly closely related to the semantic accounts of presupposition discussed above. In particular, Peters showed that Karttunen’s way of calculating presuppositions for the truth conditional connectives is equivalent to what would be obtained within a three-valued logic, but with special non-symmetric connectives. Here is a general way of defining the Peters Connectives, inspired both by Schlenker (2008, 2009) and George (2008):

**Definition 8 (Middle Kleene/Peters connectives)** *Go from left to right through the sentence. For each argument  $X$  that takes a non-classical value, check whether on the basis of material on its left, assigning an arbitrary classical value to  $X$  could conceivably have an effect on the overall value. If so, the sentence as a whole lacks a classical truth value. If not, just assign  $X$  an arbitrary value, and carry on. If this procedure allows all non-classical values to be filled in classically, then the sentence can be assigned a classical value.*

For example, this procedure makes a conjunction classical if both its arguments are classical, false if the left conjunct is false, and undefined otherwise. Thus undefinedness of the left conjunct forces undefinedness of the entire conjunction, whereas undefinedness of the right conjunct only sometimes yields undefinedness of the entire conjunct, as seen in the following comparison of truth tables in various systems. The net effect is that presuppositions of the left conjunct project in the Middle Kleene system, just as in the Weak Kleene system, but presuppositions of the right conjunct are conditionalized, just as in the Strong Kleene system. The net effect is behavior that precisely mirrors that of the Karttunen (1974) model.

**Definition 9 (Trivalent truth tables for conjunction)**

Tab. 91.3.

| Weak Kleene:       |     |     |     | Middle Kleene/Peters: |     |     |     | Strong Kleene:          |     |     |     |
|--------------------|-----|-----|-----|-----------------------|-----|-----|-----|-------------------------|-----|-----|-----|
| $\phi \wedge \psi$ | $t$ | $f$ | $*$ | $\phi \vee \psi$      | $t$ | $f$ | $*$ | $\phi \rightarrow \psi$ | $t$ | $f$ | $*$ |
| $t$                | $t$ | $f$ | $*$ | $t$                   | $t$ | $f$ | $*$ | $t$                     | $t$ | $f$ | $*$ |
| $f$                | $f$ | $f$ | $*$ | $f$                   | $f$ | $f$ | $f$ | $f$                     | $f$ | $f$ | $f$ |
| $*$                | $*$ | $f$ | $*$ | $*$                   | $*$ | $*$ | $*$ | $*$                     | $*$ | $f$ | $*$ |

The equivalence between Peters’ connectives and Karttunen’s model paved the way for a more complete reformulation of the Karttunen model in Karttunen & Peters (1977, 1979), where certain types of presupposition (which Karttunen & Peters regard as conventional implicatures rather than presuppositions) are treated in a compositional grammar fragment. This fragment uses two dimensions of meaning, one for presupposition and one for assertion, and is effectively an implementation of the Peters connectives in a four-valued logic; see Krahmer (1994, 1998), Beaver (2001), and Beaver & Krahmer (2001) for discussion, and the latter for a fragment that mirrors that of Karttunen and Peters, but allows for a better treatment of the interaction between presuppositions and quantifiers.

### 4.3.2. Satisfaction theories

Although Karttunen's (1974) model turned out to be equivalent to a system which, from a purely technical point of view, is in the Frege-Strawson tradition, Karttunen (1974) was one of the seminal papers of the dynamic zeitgeist that swept through semantics and pragmatics in the last decades of the twentieth century. Also relevant here are Hamblin (1970), Stalnaker (1972, 1974) and Lewis (1979), all of whom advanced dynamic models of pragmatics in which the (joint) commitments of speakers and hearers evolve as new assertions are made and their content becomes part of the linguistic context available for future utterances (see also article 88 (Jaszczolt) *Semantics and pragmatics*). It is against this background that Heim (1982, 1983) offered the first dynamic semantic account of presupposition. Heim's model utilizes Stalnaker's notion of a context as a set of all possible worlds compatible with what has been established at that point in a conversation, but involves a crucial twist adapted from Karttunen. In Stalnaker's model, a single *global* context is updated each time new information is asserted, but in Heim's model the context is updated *locally* in the process of computing the meanings of subparts of a complex expression. We can define a simplified version of Heim's system as follows:

**Definition 10 (Dynamic Semantics)** *Assuming that the context set  $C$  is a set of possible worlds and  $S$  and  $S'$  are sentences:*

- i.  $C + S$  = the subset of worlds in  $C$  that are compatible with  $S$ , but this is defined iff  $S$ 's presuppositions (if any) are true in all worlds in  $C$ .
- ii.  $C + \neg S = C - (C + S)$
- iii.  $C + S \wedge S' = (C + S) + S'$
- iv.  $C + S \circ S'$ , where  $\circ$  is some truth functional operator, is given by the simplest classical definition of  $\circ$  in terms of  $\neg$  and  $\wedge$  that preserves the order of the two sub-clauses.
- v.  $S$  is satisfied in a context  $C$  iff  $C + S = C$  (i.e., updating  $C$  with  $S$  has no effect).
- vi.  $S$  presupposes  $S'$  iff  $S'$  is satisfied in all contexts where update with  $S$  is defined.

Clause (iv) entails that update with a conditional is defined via the equivalence  $A \rightarrow B \equiv \neg(A \wedge \neg B)$ . To see how this will work, let's reconsider (15-a), repeated once again below:

- (15) a. If the king is angry, then the knave stole the tarts.
- (24) a. It's not the case that [the king is angry and the knave didn't steal the tarts].
  - b. The king is angry and the knave didn't steal the tarts.
  - c. The king is angry.
  - d. The knave didn't steal the tarts.
  - e. The knave stole the tarts.

In order to update a context with (23), we must do the equivalent of updating with (24-a). Now clause (ii) says that to update a context with (24-a), we must first try updating with (24-b), and subtract the result from the original context (so as to leave behind whichever worlds are *not* compatible with (24-a)). But (24-b) is a conjunction, so we must first update with the left conjunct (24-c), and then with the right (24-d). Updating with (24-c) is only defined if the presupposition that there is a king is satisfied in all worlds



in the context set. We immediately see that (24-c), (24-b), (24-a), and (23) all have this requirement, i.e. they presuppose that there is a king. Provided this presupposition is satisfied, updating with (24-c) produces a subset of worlds where the king is angry. We use this reduced context set for update with (24-d). But update with (24-d) again uses the negation clause (ii) of the above definition. So we started off with a set of worlds where there is a king, we reduced it to a set of worlds where the king is angry, and now we must update that context with (24-e). But this update will only be defined if there is a knave. So it turns out that update of a context with (23) is only defined for contexts where (a) there is a king, and (b) where all the worlds where the king is angry are worlds where there is a knave. Following the definitions through, it turns out that, once again, the original sentence carries both a non-conditionalized presupposition, that there is a king, and the conditionalized presupposition that if the king is angry, then there is a knave.

The satisfaction based model has seen considerable further development – see e.g. Beaver (1992, 2001), Chierchia (1995), Heim (1992), Zeevat (1992), and, for a rather different formalization of a dynamic semantic approach, van Eijck (1993). (See also article 38 (Dekker) *Dynamic semantics*. Note that Definition 10 does not cover modals or attitude verbs: for discussion see the Beaver, Heim and Zeevat references, and section 5., below.)

The most important feature of the satisfaction model not covered in the description above is *accommodation*. For Heim (1982), following Lewis (1979), this is a process whereby contexts are adjusted so as to make update possible when presuppositions are not satisfied. In terms of her treatment of accommodation, Heim's major innovation over Lewis was to allow this process to take place not only in the global context of utterance, but also on local contexts found midway through an update. However, Heim (1982) was not explicit about exactly how accommodation should work and what should be accommodated.

Beaver's model of accommodation, first published in Beaver (1992), was the first to make explicit how accommodation might operate in the satisfaction framework, and on this model accommodation is a type of filtering operation. Beaver suggests that due to uncertainty about what the speaker takes the common ground to be, the hearer has to entertain multiple alternative context sets, with some ranking of which is the most plausible. All these alternative contexts are updated simultaneously. Accommodation is then what happens when the update is not defined on what was previously considered to be the most plausible context, in which case the hearer drops that context from contention. What remains is a new set of contexts in which the most plausible one is a context that has been successfully updated. For example, a hearer who was not certain about whether the speaker took there to be a king would represent contexts where there was a king, and contexts where there was not. Regardless of which the hearer took initially to be more plausible, updating with (23) would then cause contexts in which there was no king to be thrown out, leaving only contexts in which there was a king.

Though we will not go into detail here, we should note that Beaver's proposal is one of several attempts to deal with the conditionalized presuppositions that arise in satisfaction accounts and other theories (such as Strong and Middle Kleene). See the discussion in Beaver (2001), the earlier solution to the problem of conditionalized presuppositions offered by Karttunen & Peters (1979), the criticisms by Geurts (1996, 1999a), and recent discussion of van Rooij (2007), Singh (2007) and Rothschild (2008).

### 4.3.3. Presupposition and anaphora

While a number of authors have noted that presuppositions behave in some respects like anaphors (e.g. Kripke 2009 and Soames 1989), it was van der Sandt (1989, 1992) who brought out the connection the most forcefully. He noted that for every case where a pronoun is interpreted anaphorically (see article 75 (Geurts) *Accessibility and anaphora*), but is not interpretable as a bound variable, a similar configuration is possible with presuppositions. Thus in each of the following pairs, the (a) example includes an anaphoric pronoun (“it”), and the (b) example includes the factive verb “knows”, triggering a presupposition that its propositional complement is true (i.e. that Fred left).

(25) *Inter-sentential (discourse) anaphora*

- a. There was a storm. It was fierce.
- b. Fred left. Mary knows that Fred left.

(26) *Donkey anaphora*

- a. If a farmer owns a donkey then he beats it.
- b. If Fred left then Mary knows that Fred left.

(27) *Modal subordination*

- a. A wolf might come to the door. It would eat you.
- b. Fred might leave. Mary would know that Fred left.

(28) *Bathroom anaphora*

- a. Either there’s no bathroom in this house, or else it’s in a funny place.
- b. Either Fred didn’t leave, or else Mary knows that he left.

In order to account for these parallels, van der Sandt proposed a unified treatment of presupposition and anaphora, extending Discourse Representation Theory so as to deal with both phenomena (see article 37 (Kamp & Reyle) *Discourse Representation Theory*). Presupposed information is information that is presented as given, and in van der Sandt’s theory this means that presuppositions want to have discourse referents to bind to. However, whereas anaphoric pronouns are rarely interpretable in the absence of a suitable antecedent, the same does not hold for all presupposition-inducing expressions. For instance, a speaker may felicitously assert that he met “Fred’s sister” even if he knows full well that his audience wasn’t aware that Fred has a sister. In such cases, Stalnaker (1974) suggested, presuppositions are generally accommodated, which is to say that the hearer accepts the information as given, and revises his representation of the context accordingly. Accommodation, thus understood, is a form of exploitation in Grice’s sense: the purpose of presuppositional expressions is to signal that this or that information is given, and if some information is new but not particularly interesting or controversial (like the fact that somebody has a sister) the speaker may choose to “get it out of the way” by presuppositional means.

Van der Sandt’s theory incorporates the notion of accommodation as follows. Presuppositions, according van der Sandt, introduce information that prefers to be linked to

discourse referents that are already available in the hearer's representation of the discourse, and in this respect they are like pronouns. Van der Sandt in fact uses the term *binding* to refer to configurations in which presuppositions have antecedents in the Discourse Representation Structure, thus generalizing the standard notion of a *bound pronoun* to cases involving multiple discourse referents. However, if a suitable discourse antecedent is not available, a new one will be accommodated, and the presupposition is linked to that. Generally speaking, accommodation is not an option in the interpretation of pronouns, and one reason that has been suggested for this is that a pronoun's descriptive content is relatively poor (see Section 5.1 for discussion). Being told that "she" is wonderful is not particularly helpful if it isn't clear who the pronoun is meant to refer to. By contrast, if the speaker refers to "Pedro's sister" there is more to go on, and accommodation becomes feasible. Hence, van der Sandt hypothesizes that pronouns are a special class of presuppositional expressions: while all presupposition triggers prefer to be linked to antecedents, pronouns almost always must be linked to antecedents, because they are descriptively attenuate, and therefore cannot be construed by way of accommodation (see below for further discussion of the last point).

To get a better idea how this is supposed to work, let us consider an example with several presupposition triggers:

(29) If Fred is gay, then his son is gay, too.

This sentence contains the definite NP "his son", which in its turn contains the pronoun "his", and the focus particle "too". Assuming the pronoun's antecedent is "Fred", the definite NP triggers the presupposition that Fred has a son, while the focus particle triggers the presupposition that someone other than Fred's son is gay. Note that in this example the presupposition triggered by the definite NP is "inherited" by the sentence as a whole, while the one triggered by "too" is not: normally speaking, an utterance of (29) would license the inference that (according to the speaker) Fred has a son, but not that someone else besides Fred's son is gay.

Van der Sandt's theory accounts for these observations as follows. We suppose that the grammar assigns (29) the intermediate semantic representation in (30-a). Here  $[u_1, \dots, u_m; \phi_1, \dots, \phi_n]$  is a simple Discourse Representation Structure in linear form, with  $u_1, \dots, u_m$  a list of discourse markers, and  $\phi_1, \dots, \phi_n$  a list of conditions on those markers; connectives like  $\Rightarrow$  are used to build up complex conditions. We assume for convenience that most interpretative problems have been cleared out of the way already, and that the only thing that remains to be done is resolve the presuppositions triggered by "his", "his son" and "too", which are flagged by Beaver's (1992) trigger symbol,  $\partial$ .

- (30) a.  $[x: \text{Fred}(x),$   
            $[: \text{gay}(x)] \Rightarrow [: \partial[z: \partial[y: z \text{ is } y\text{'s son}], \text{gay}(z), \partial[u: u \neq z, \text{gay}(u)]]]$   
       b.  $[x: \text{Fred}(x),$  (binding  $y$  to  $x$ )  
            $[: \text{gay}(x)] \Rightarrow [: \partial[z: z \text{ is } x\text{'s son}], \text{gay}(z), \partial[u: u \neq z, \text{gay}(u)]]]$   
       c.  $[x, z: \text{Fred}(x), z \text{ is } x\text{'s son},$  (accommodating  $z$ )  
            $[: \text{gay}(x)] \Rightarrow [: \text{gay}(z), \partial[u: u \neq z, \text{gay}(u)]]]$   
       d.  $[x, z: \text{Fred}(x), z \text{ is } x\text{'s son},$  (binding  $u$  to  $x$ )  
            $[: \text{gay}(x)] \Rightarrow [: \text{gay}(z), x \neq z]]]$

(30-a) is the initial semantic representation associated with (29), in which three presuppositions remain to be resolved. The first of these, triggered by the pronoun “his”, is bound to the discourse referent representing Fred, which results in (30-b). The second presupposition, that Fred has a son, cannot be bound, and therefore must be interpreted by way of accommodation. Van der Sandt’s theory, like Heim’s (1983), stipulates that accommodation at the global level, as shown in (30-c), is preferred to accommodation at other sites, as will be discussed in section 5, below. Finally, the presupposition triggered by the focus particle can be bound in the antecedent of the conditional; after simplification, this results in (30-d), which represents the most natural way of interpreting (29).

## 5. Current issues in presupposition theory

### 5.1. Accommodation

Accommodation was first discussed by Karttunen (1974) and Stalnaker (1974), though only named as such by Lewis (1979). Karttunen introduces the concept as follows:

[. . .] ordinary conversation does not always proceed in the ideal orderly fashion described earlier. People do make leaps and shortcuts by using sentences whose presuppositions are not satisfied in the conversational context. This is the rule rather than the exception [. . .] I think we can maintain that a sentence is always taken to be an increment to a context that satisfies its presuppositions. If the current conversational context does not suffice, the listener is entitled and expected to extend it as required. (Karttunen 1974: 191)

If this looks reasonably straightforward, the reader should be warned that accommodation is among the more contentious topics in presupposition theory.

To begin with, there are various notions of accommodation, some of which are stricter than others. To explain, consider the following example by Heim (1982):

(31) John read a book about Schubert and wrote to the author.

In order to determine the intended meaning of “the author”, the hearer has to infer (i) that there is an author and (ii) that the said author wrote the book read by John. Whereas on a broad understanding of accommodation, all of this is accommodated, on a strict construal only (i) is, and (ii) is a bridging inference. This is not just a matter of terminology. If we choose to be strict, we can argue that there is something like an “accommodation module”, which as such has nothing to do with world knowledge; whereas if the notion is construed more broadly, accommodation is of a piece with bridging. To facilitate the following discussion, we will adopt a strict notion of accommodation, and take the naive view that what is accommodated is the presupposition as triggered by, e.g., a definite NP or factive verb.

With these preliminaries out of the way, we turn to the first major question: *Where* are presuppositions accommodated? Though it may seem odd at first, this question is inescapable if we assume, as is standard in dynamic semantics, that an expression may occur in several contexts at the same time (cf. Section 4.3.2.). To illustrate, consider the following:

- (32) a. (c<sub>0</sub>) Maybe (c<sub>1</sub>) Betty is trying to give up drinking.  
       b. (c<sub>0</sub>) Maybe (c<sub>1</sub>) Wilma thinks that (c<sub>2</sub>) her husband is having an affair.

Here  $c_0$  refers to the global context in which a given sentence is uttered, and  $c_1$  and  $c_2$  are auxiliary, or local, contexts. In (32-a), the modal “maybe” creates an auxiliary context of possible states of affairs in which Betty is trying to give up drinking; the same, *mutatis mutandis*, for (32-b). Now, the presupposition triggered in (32-a), that Betty used to drink, can be accommodated *globally*, i.e. in  $c_0$ , or *locally*, in  $c_1$ . In the former case, the utterance is construed as meaning that Betty used to drink and may be trying to kick the habit; in the latter, it conveys that, possibly, Betty used to drink and is trying to give up drinking. Likewise, in (32-b), the presupposition that Wilma is married may be accommodated globally, or locally in the most deeply embedded context. But here there is a third option, as well: if the presupposition is accommodated in  $c_1$ , the sentence is read as “Maybe Wilma is married and she thinks that her husband is having an affair”, and we speak of *intermediate* accommodation.

It is widely agreed that the following empirical generalization, made explicit by Heim (1983), is correct:

(PGA) Global accommodation is preferred to non-global accommodation.

In the examples in (32) the PGA clearly holds: non-global interpretations may be possible, but they require special contexts. One such context may be that the presupposition contains a variable which is bound by a quantifier:

(33) Most Germans wash their cars on Saturday.

The most natural interpretation of this sentence surely is that most Germans who own a car wash it on Saturday. So in this case intermediate accommodation seems to be the preferred option, and this might be explained, following van der Sandt (1992), by supposing that the possessive pronoun contains a variable bound by the quantifier.

There are other cases where intermediate accommodation is virtually impossible:

(34) If Fred is coming to the reception, he may bring his wife.

It is quite unlikely that this may be construed as, “If Fred is married and is coming to the reception, he may bring his wife.” More generally, we don’t know of any clear-cut cases (i.e. cases in which accommodation is not forced by independent contextual factors) in which a presupposition triggered in the consequent of a conditional is accommodated in the antecedent.

The picture is rather confusing. While in some cases, e.g. (32-b) or (33), intermediate accommodation seems possible and sometimes even preferred, in other cases it doesn’t seem possible at all. And things get even more confused than this. Thus far, we have taken our examples at face value, but some authors have argued that we shouldn’t because, as a matter of fact, intermediate accommodation doesn’t exist. For instance, according to Beaver (2001), the presupposition in (33) is taken as evidence that the topic of conversation is car-owning Germans, and it is this topic that restricts the domain of the quantifier, making intermediate accommodation redundant. See von Stechow (1995), Geurts & van der Sandt (1999) and the full version of this article (Beaver & Geurts 2010), and article 72 (Roberts) *Topics* for related issues.

## 5.2. Presupposition failure

What happens when a presupposition is false? The textbook story goes as follows. According to Frege (1892), if an expression *A* suffers from presupposition failure, then any sentence containing *A* will lack a truth value; Russell (1905) famously denied this, holding that such a sentence will always be true or false; and then Strawson (1950) reaffirmed Frege's position, more or less. What is less well known is that in subsequent work, Strawson partly recanted his initial view and came to doubt that presupposition failure invariably entails lack of truth value.

Taking a closer look at how speakers actually assess a sentence, Strawson's 1964 paper argues that presupposition failure may but need not cause a sentence to be infelicitous. Two of his examples are the following:

- (35) a. Jones spent the morning at the local swimming pool.  
       b. The exhibition was visited yesterday by the king of France.

If there is no swimming pool locally, it is "natural enough", according to Strawson, to say that (35-a) is false, and since the king of France doesn't exist, the same applies to (35-b). And if these sentences are false, their negations must be true. So, if these subtle judgments are accepted, then these are cases in which presupposition failure does not prevent us from saying that a sentence is true or false. But Strawson hasn't changed his mind about Russell's example:

Confronted with the classical example, "The king of France is bald", we may well feel it natural to say, straight off, that the question whether the statement is true or false doesn't arise because there is no king of France. (Strawson 1964: 90)

Strawson goes on to observe, however, that speakers who subscribe to this judgment may want to reconsider their verdict if the context is set up the right way. For instance, if Russell's sentence is used to answer the question, "What examples, if any, are there of famous contemporary figures who are bald?", we may be more inclined to say that the answer is simply false.

Strawson's explanation for these facts is given in terms of topicality. The most likely purpose of a sentence like (35-a) is to describe what Jones has been doing in the morning, rather than, say, who the local swimming pool was visited by. That is, in the absence of further information about the context in which this sentence is uttered, its topic will be Jones's exploits. Similarly, a sentence like (35-b) will normally be used to convey information about the exhibition. If so, although the sentence purports to refer to the king of France, it is not about him; the king of France is not the topic of discourse, nor part of it. Strawson's suggestion is that this circumstance influences the way presupposition failure is dealt with. Not to put too fine a point on it, presupposition failure results in infelicity only if it affects the topic of a sentence; otherwise the sentence will be judged true or false, as appropriate.

One of the appealing features of this analysis is that it takes into account the context dependence of speakers' intuitions. As Strawson notes, Russell's sentence (36) will by default be construed as being about the king of France, whence a strong tendency to judge the sentence infelicitous.

(36) The king of France is bald.

If, however, the discourse is about royal baldness in general, for instance, the grammatical subject of (36) is used to say something about that topic, and Strawson's account predicts that the sentence is more likely to be judged false, which seems correct. Another observation that neatly falls into place is that word order may have an effect on speakers' intuitions about presupposition failure. As Strawson observes, if we compare (35-b) with (37), where the defective description is in subject position, we would be "a shade more squeamish" to say that the sentence is simply false (p. 91). This is precisely what one should expect if speakers' intuitions were topic-dependent.

(37) The king of France visited the exhibition yesterday.

Assuming that Strawson's observations are correct, should we say (a) that non-topical definites are non-presuppositional, or (b) that they do have presuppositions, whose failure happens not to affect speakers' truth-value judgments? Some authors argue for the former (e.g. Reinhart 1982, Horn 1989); this is Strawson's view, as well. Von Stechow (2004) argues for the latter: topical or non-topical, "the king of France" always triggers the presupposition that there is a king of France; it's just our truth-value judgments that fluctuate.

### 5.3. Presuppositions and attitudes

For nearly four decades, the Holy Grail of presupposition research has been to explain the behavior of presuppositional expressions occurring in embedded positions. Given that the theoretically most challenging mode of embedding is within the scope of an attitude verb, one might expect that the interaction between presuppositions and attitude verbs should have received a lot of attention. But it hasn't. And it can't be because this topic doesn't pose any problems – on the contrary.

Already the data are problematic. If we embed a presupposition trigger under, e.g., "believe", we observe two types of inference. This is seen in the following examples, where "∼" indicates that there is an inference, but of unspecified type:

(38) Barney believes that *his sister* is drunk.

∼ (a) Barney has a sister.

∼ (b) Barney believes he has a sister.

(39) Wilma believes that Barney *knows* that his sister is drunk.

∼ (a) Barney's sister is drunk.

∼ (b) Wilma believes that Barney's sister is drunk.

Both inferences are fairly robust, and both seem to exhibit projection behavior, as we illustrate here by applying various embedding tests to (38):

(40) a. Barney doesn't believe that his sister is drunk.

b. Perhaps Barney believes that his sister is drunk.

- (41) a. If Barney has a sister, then he believes that his sister is drunk.  
 b. If Barney believes that he has a sister, then he also believes that his sister is drunk.

It is natural to infer from both sentences in (40-a) that Barney has a sister and that he believes that he has a sister, and these inferences can be blocked in sentences such as those in (41), where “his sister” occurs in the consequent of conditional whose antecedent makes one or the other inference explicit. It may seem odd at first that (41-a) should block the inference that Barney believes that he has a sister, while (41-b) blocks the inference that Barney has a sister. Note however that, generally speaking, Barney has a sister *iff* he believes that he has a sister. We’ll return to this theme below.

Interestingly, literally the same pattern of observations holds for other attitude verbs, like “want” for example:

- (42) Barney wants to phone his sister.  
 ~ (a) Barney has a sister.  
 ~ (b) Barney believes he has a sister.

The puzzling thing is that (42) does not license the inference that Barney *wants* to have a sister, but rather that he believes that he has one.

So, in many cases at least, a presupposition  $\phi$  triggered within the scope of “ $x V_A \dots$ ”, where  $V_A$  is an attitude verb, gives rise to two inferences with a candidature for presuppositional status: (a) that  $\phi$  and (b) that  $x$  believes  $\phi$ . Hence, we have three possible ways of proceeding, all of which have been defended in the literature:

- i. Both inferences are presuppositions (Zeevat 1992, at least for certain triggers).
- ii. Only  $\phi$  is a presupposition (Gazdar 1979a, van der Sandt 1988, Geurts 1998).
- iii. Only “ $x$  believes that  $\phi$ ” is a presupposition (Karttunen 1974, Heim 1992).

The first strategy seems to require a stipulation that certain presuppositions have to be accommodated twice, once inside a belief context, and once outside, and such a strategy is difficult to motivate. On the other hand, for (ii) and (iii), there is the obvious problem that if we adopt either one of them, we only account for half of the observed inferences. How to explain the other half? Three possible answers to this question have been discussed in the literature, mainly by Heim (1992):

- i. *De re construal* (Heim 1992) What at first looks like a presupposition projecting to the global context may in fact be due to a *de re* construal of the presupposition trigger. This solution has several serious drawbacks. In particular, it is hard to see how this proposal can give us both inferences at the same time, rather than one (*de re*) or the other (presupposition). For this and other reasons (see Geurts 1998), we will not consider it any further.
- ii. *Exportation* (Karttunen 1974, Heim 1992, Kay 1992) If Barney believes that he has a sister, then it may plausibly be inferred that he has a sister. Therefore, if it is presupposed that Barney believes that he has a sister, then it may plausibly be inferred that he has a sister.



iii. *Importation* (Heim 1992, Geurts 1998) If Barney has a sister, then it may plausibly be inferred that he believes that he has a sister. Therefore, if it is presupposed that Barney has a sister, then it may plausibly be inferred that he believes that he has a sister.

If our presupposition theory predicts that the inferences projected from “ $x V_A \dots$ ” are of the form “ $x$  believes that  $\phi$ ”, then we can appeal to exportation to explain why  $\phi$  is inferable, as well. Vice versa, a theory which predicts that  $\phi$  is presupposed can use importation for deriving “ $x$  believes that  $\phi$ ”. So we have two options:

Tab. 91.4

|          | $x$ believes that $\phi$ | $\phi$         |
|----------|--------------------------|----------------|
| Option A | importation              | presupposition |
| Option B | presupposition           | exportation    |

Which is it going to be? That’s a hard question, which raises various issues, only some of which we can mention here. It should be noted that, whereas for theories of the satisfaction family it is hard, if not impossible, to *avoid* making the prediction that presuppositions projected from attitude contexts are of the form “ $x$  believes that  $\phi$ ”, DRT-style theories are more flexible, and can predict either this or that the presupposition is simply  $\phi$ . In other words, satisfaction theories are more constrained (which is good), but therefore practically forced to resort to Option B. (See Beaver & Geurts 2010 for further discussion of these issues, and article 60 (Swanson) *Propositional attitudes* for general discussion.)

6. Concluding remarks

We have presented an overview of the major strands of work on presupposition. But we have not considered the question of whether presupposition triggers form a natural class in the first place: maybe all presupposition triggers are not alike. Like the topics discussed in the last section, this is a possibility that has only just begun to be explored in detail, with several authors proposing to dichotomize presupposition triggers in some way or other (e.g. Zeevat 1992, Geurts 1999b, Abusch 2002).

Our own suspicion, if we may end on an opinionated note, is that these first attempts to separate presupposition types from each other may turn out to be too cautious. There are several philosophically and linguistically interesting dimensions along which the set of presupposition triggers can be partitioned, such as referentiality, anaphoricity, ease of accommodation, ease of cancellation, and maintenance of truth under presupposition failure. So perhaps what will eventually emerge is not a straightforward dichotomy, but a more complex taxonomy of different types of trigger. And at that point, perhaps we may re-ask the question of whether the things that the different so-called “presupposition triggers” are triggering are in fact presuppositions, in any of the theoretical senses of the term “presupposition” that we have considered in this article.

(Note: this article is an abridged version of Beaver & Geurts 2010, which includes more extensive references. We wish to thank the reviewers and editors at both the Stanford

*Encyclopedia of Philosophy and The Handbook of Semantics, and Noor van Leusen for commentary and for assistance in helping us meet the publisher's exacting specifications.)*

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David Beaver, Austin, TX (USA)

Bart Geurts, Nijmegen (The Netherlands)

## 92. Implicature

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2. The Gricean conception of conversational implicature
3. A case study: scalar implicature
4. Embedded implicature
5. Alternate models and competing conceptions
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### Abstract

*This article reviews in detail Grice's conception of conversational implicature, then surveys the major literature on scalar implicature from early work to the present. Embedded implicature is illustrated, and it is explained why this phenomenon poses a challenge to the Gricean view. Some alternate views of conversational implicature are then presented. The article concludes with a brief look at formal approaches to the study of implicature.*

### 1. Introduction

Conversational implicature is the phenomenon whereby a speaker says one thing and thereby conveys (typically, in addition) something else. For example, in (1) below, Harold says that Sally should bring her umbrella, but further conveys that (he believes that) it is likely to rain. This is a standard case of the phenomenon under examination.

- (1) Sally: What's the weather going to be like today?  
 Harold: You should bring your umbrella.

Conversational implicature was identified and named by the philosopher Paul Grice in his paper "Logic and Conversation", originally presented at Harvard in 1969. Much of today's linguistic pragmatics has its origins in the insights of that paper, and concerns itself in some fashion with some aspect of conversational implicature.

## 2. The Gricean conception of conversational implicature

### 2.1. Implicature as part of what is meant

For Grice, what a speaker *means* by an utterance is the total content which she thereby intends to communicate (see also article 2 (Jacob) *Meaning, intentionality and communication* and article 5 (Green) *Meaning in language use*). One component of what is *meant* is what is *said*: roughly, the truth conditional content linguistically encoded in the utterance. The remainder – what is meant but not said – is what Grice calls *implicature*. Implicature itself subdivides into two major categories: conventional and conversational. Conventional implicature is content which is conventionally encoded but non-truth-conditional (cf. article 94 (Potts) *Conventional implicature*). In this article, we will be concerned with *conversational implicature*: implicatures that arise by virtue of general principles governing linguistic behavior. In “Logic and Conversation” (henceforward, *L&C*; Grice 1975) and “Further Notes on Logic and Conversation” (hence, *FN*; Grice 1978), Grice introduces the phenomenon of conversational implicature and lays out the principles which allow speakers to systematically mean more than they say.

### 2.2. The theory of conversational implicature

To account for the phenomenon of conversational implicature, Grice proposes that there are certain norms of conversational behavior, norms which are mutually known and typically adhered to by conversational participants. These norms prevent conversation from consisting of “a succession of disconnected remarks,” and, at each stage in a conversation, render certain possible conversational contributions “unsuitable” (*L&C*; Grice 1975: 26). Grice summarizes the effect of these norms as a single overarching principle, which he calls the Cooperative Principle:

Make your conversational contribution such as is required, at the stage at which it occurs, by the accepted purpose or direction of the talk exchange in which you are engaged.

This principle has little force without further clarification of what is in fact required of conversational contributions. Grice specifies this further in what he calls *Maxims of Conversation*, formulated as rules governing allowable conversational moves. Grice organizes these maxims into four categories: Quality, Quantity, Relation and Manner. In current usage, these terms are used to designate the specific maxims Grice proposed. Grice himself, however, gives these specifically as *categories* of maxims “under one or another of which will fall certain more specific maxims and submaxims” (Grice 1975: 26), apparently envisaging the possibility of substantial lists of conversational rules. The maxims which Grice proposes are listed below, in some cases slightly reformulated from the original:

#### Conversational Maxims

##### *Quality*

Supermaxim: Try to make your contribution one that is true

1. Do not say what you believe to be false.
2. Do not say that for which you lack adequate evidence.

*Quantity*

1. Make your contribution as informative as is required (for the current purposes of the exchange).
2. Do not make your contribution more informative than is required.

*Relation*

Be relevant

*Manner*

Supermaxim: Be perspicuous

1. Avoid obscurity of expression
2. Avoid ambiguity
3. Be brief (avoid unnecessary prolixity)
4. Be orderly

The view that conversation is a norm-governed activity provides the basis for Grice's account of how conversational implicatures arise. The general structure of the account is this: There is a standing presumption that speakers produce utterances which are in accord with the Cooperative Principle and its maxims. Interpreters will assign to an utterance an interpretation in accord with this presumption. In some cases, this will require the interpreter to attribute to the speaker the intention to communicate something more than, or different from, what she has actually said. In identifying what the speaker intends, the interpreter will rely on three things: first, her observation about what the speaker *said* (i.e., the truth conditional content expressed) and the form in which it was expressed; second, the presumption of cooperativity; and third, any world knowledge that might be relevant. Speakers can anticipate this behavior of interpreters, and thus can predict that particular utterances will be understood as conveying something more than or different from what is literally said. The fact that it is common knowledge that the CP is in effect thus allows speakers to implicate, and interpreters to identify implicatures.

Grice characterizes conversational implicature in the following way (slightly simplified from the original):

A man who, by saying . . . that *p* has implicated that *q*, may be said to have conversationally implicated that *q*, provided that:

1. he is to be presumed to be observing the conversational maxims or at least the Cooperative Principle
2. the supposition that he thinks that *q* is required in order to make his saying *p* (or doing so in *those* terms) consistent with this presumption and
3. the speaker thinks (and would expect the hearer to think that the speaker thinks) that it is within the competence of the hearer to work out, or grasp intuitively, that the supposition mentioned in 2. is required.

Grice's presumption here is that such suppositions of the speaker, when recognized by the hearer, will be understood to be meant.

Clause 2 of this definition is quite problematic, as it makes it a condition on implicature that the implicature (the "required supposition") be uniquely adequate to maintain the

presumption of cooperativity. This is typically too strong: in almost any case of conversational implicature, there are multiple candidate suppositions, any of which might render the utterance cooperative. This point is noted by Grice (see the final paragraph of *L&C*; Grice 1975). Davis (1998) considers this (along with some other difficulties) to completely undermine the Gricean construction. The issue is worth further exploration, but I will not attempt it here.

Let's now make things clearer by examining some specific cases. Consider again the sample discourse from above, repeated here as (2):

- (2) Sally: What's the weather going to be like today?  
Harold: You should bring your umbrella.

Observation: Sally is likely to conclude that Harold means to inform her that it is likely to rain. How so? First, Sally presumes that Harold is speaking in accord with the CP. Among other things, this means that she presumes that he intends his answer to be relevant. Now, strictly speaking, Harold's instruction is not an answer to the question Sally has asked: it says nothing about the weather. But *because* of her presumption, Sally presumes that what Harold says *is* relevant in some way to her question. It immediately occurs to her that one uses an umbrella when it rains; and that Harold is likely to tell her to bring an umbrella if he believes that it is going to rain. If she attributes this belief to Harold, and assumes that he intends, via his utterance, to communicate this belief to her, then she has successfully interpreted his utterance in a way which renders his behavior consistent with her presumption of his cooperativity. As Harold can, moreover, plausibly assume that Sally will reason in this way, he implicates that (he believes that) it is going to rain.

Note that this case illustrates the failure of the uniqueness condition on implicature (Clause 2 of the definition above). Suppose it is common knowledge between Sally and Harold that Sally uses her umbrella as a sunshade when the weather is hot. Then Sally might just as well have attributed to Harold the belief that it would be hot and sunny, and take him to intend to communicate this. So there are (at least) two candidate suppositions that would render Harold's utterance cooperative. On the other hand, contextual factors (such as the interlocutors' common knowledge of recent weather) might well render one of these suppositions far more likely or reasonable. This line of thought might offer a resolution of the difficulty.

The example in (2) involves a Relevance implicature. Implicatures can be generated via any of the maxims (or combinations thereof). Here is one which relies on the first Maxim of Quantity:

- (3) Harold: Which of Bobby's teachers did you talk to at the picnic?  
Sally: Mrs. Smith and Mr. Jones.

Here, Sally implicates that Mrs. Smith and Mr. Jones were the *only* teachers that she talked to. This is by virtue of the first Maxim of Quantity. Given the assumption that Sally is abiding by this maxim, Harold must assume that she will provide all the information relevant to his question. If (she believed that) she had talked to additional teachers, then it would constitute a violation of the maxim to fail to mention them. So, to maintain the premise that Sally *is* abiding by the maxim, Harold must assume that Sally (believes that she) spoke to no other teachers. As Sally, moreover, can assume that Harold will



recognize the required assumption, she implicates that she talked to no other of Bobby's teachers.

### 2.2.1. Characteristics of conversational implicature

In the final pages of *L&C* (Grice 1975: 57–58), Grice identifies certain characteristic features of conversational implicatures. The central ones are these:

1. **Calculability:** if some element of content is a conversational implicature, then it should be possible to provide an account of how it is calculated on the basis of what is said plus the maxims.
2. **Nondetachability:** On Grice's view, implicatures other than Manner implicatures are calculated on the basis of what is said – roughly, on the basis of the truth conditional content expressed. Hence, other ways of expressing the same truth conditional content in the given context should give rise to the same implicature. That is, implicatures are *nondetachable* from a particular truth conditional content.
3. **Cancelability** (of generalized conversational implicature): Because conversational implicatures are not part of the encoded or conventional content of any linguistic item, and because their presence is dependent on (more or less) specific assumptions, including the assumption of the cooperativity of the speaker, then it should be possible for an expected implicature to be contextually canceled.

These features, particularly cancelability, are sometimes taken as diagnostics of conversational implicature. However, Grice did not intend them this way, as he clarifies in *FN* (Grice 1978: 43). Sadock (1976) provides thorough arguments showing that none of these features, either separately or together, can serve as robust diagnostics of conversational implicature, as none are either necessary or sufficient conditions. The arguments are too lengthy to rehearse here in detail, but a couple of points are worth mentioning. With respect to calculability, Grice and Sadock agree that it is not sufficient to establish the presence of a conversational implicature, because what starts life as a conversational implicature may become conventionalized. Nondetachability is neither a necessary nor a sufficient condition. It is not necessary, because it is not a feature of Manner implicatures. It is not sufficient for the identification of conversational implicatures, because it is also a feature of entailments.

Sadock gives a second argument against the necessity of nondetachability, observing that there are cases of truth conditionally equivalent sentences whose utterance does not give rise to the same implicatures. Consider sentences (4) and (5) as answers to the question: *Did you eat any of the cake?*

- (4) I ate some of the cake.
- (5) I ate some and possibly all of the cake.

Obviously, (4) implicates that the speaker did not eat all of the cake, while (5) just as obviously does not so implicate. Yet the two sentences (by assumption) have the same truth conditional content i.e., in both cases the same thing is said. Hence, the implicature is *not*

nondetachable: utterances of truth conditionally identical S and S' do not both produce the implicature.

One possible response to this argument is simply that the definition of nondetachability requires refinement: it should exclude candidates which are truth conditionally equivalent to the original but include an explicit denial of the potential implicature. Other reformulations of (4) do preserve the implicature. Consider *I ate part of the cake* or *I ate a bit of the cake*.

A second response is that the input to conversational implicature calculation is not simple truth conditional content, but some more structured entity. Arguments for this position are given by Gazdar (1979) and Atlas & Levinson (1981).

Finally, we turn to cancelability. First, note that the type of cancelability Grice has in mind involves the speaker being explicit that she is opting out of the observation of the CP, or the context being one which makes clear that the speaker is opting out. In *FN* (Grice 1978), he gives the example of a speaker who is giving a clue in the course of a treasure hunt saying:

- (6) The prize is either in the garden or the attic, but I'm not telling you which.

In this context, the typical implication from a disjunction, that the speaker does not know which disjunct is true, is suppressed.

Sadock discusses a different type of cancelation, where the speaker explicitly denies the usual implicature, as in:

- (7) Some philosophers are crabby, and I don't mean to say that some aren't.

In the current literature, when people discuss implicature cancelation, the latter is usually what is intended.

Grice seems to consider that cancelability can only apply to *generalized* conversational implicatures. What he seems to have in mind is that we make observations about what is normally or typically implicated by the use of a particular expression, and compare it with what (if anything) is actually implicated by the use of that expression in some specific situation. We clearly cannot make the same sort of comparison in the case of *particularized* implicatures. For example, no-one would claim that the sentence *I have to cook dinner* normally or typically implicates *I am not going to read you a story*, but certainly an utterance of that sentence might well so implicate if I say it in response to my six year old's request in easily imaginable circumstances. Nonetheless, we sometimes find cases like these:

- (8) C: Mommy, will you read to me?

M: I have to cook dinner. So if I read to you now, will you play by yourself for a while afterwards, so I can get dinner done?

The first sentence, if uttered alone in this context, might well be used to implicate "no". The entire string, however, makes clear that this is intended to launch a "yes, but . . ." response. So, there is some temptation to say that the second sentence cancels the implicature arising from the first. This is similar to a second way of understanding implicature cancelation in the generalized case. In cases like (7), one might say that the use of the first

clause *does* generate the implicature, but that the implicature is canceled – that is, the initial clause is reinterpreted – in light of the content of the second.

Which way we should see it depends in part on our assumptions about when implicature calculation takes place. It is clear that Grice assumes throughout most of his writing on the subject that the input is at least a complete proposition. The examples used typically involve a single sentence generating an implicature. But it is perfectly consistent with the Gricean model that the semantic content of a multi-sentence conversational contribution – presumed to be several propositions – could be the basis for a process of implicature calculation. If implicatures are calculated in this way, example (7) could only be said to involve cancellation in the sense that an implicature that typically arises fails to do so; and in the case of (8) it would not be sensible to talk about cancellation at all.

Cancelability remains an important diagnostic for distinguishing between conventional content and inferred content (although see again Sadock's arguments concerning ambiguity). However, it is important, in making use of this notion, to be clear just what we mean by it in any particular case.

## 2.2.2. Subtypes of conversational implicature

The Quantity implicature in (3) above straightforwardly fits Grice's own characterization of conversational implicature. But the Relevance implicature in (2) fits it rather awkwardly. Although I formulated it this way above, it is somewhat odd to say that Sally recognizes that Harold *presumes* that it will rain, and therefore takes him to intend to communicate this. It seems more natural to say that Sally recognizes that Harold *presumes* that she would want to have her umbrella with her if it rains, and thus infers, from his recommendation that she bring her umbrella, his intention to communicate that it might rain. Let's call the identified presumption a *background implicature*, and the communicated proposition, that it might rain, a *foreground implicature*.

Sally's recognition of the background implicature seems to make use of standard Gricean reasoning: searching for a way to interpret Harold's utterance as cooperative, she looks for a presumption he might be making which would render what he said relevant to her question. However, the background implicature is nonetheless not a true implicature in Grice's sense; for recall that for Grice, implicature is a subcategory of speaker meaning; and what a speaker means is what he intends to communicate. In the kind of conversation we are imagining between Sally and Harold, it would not typically be Harold's intention to communicate that Sally likes to have her umbrella with her when it rains.

Here we reach the first of many choice points, where we will have to decide: is our goal to follow Grice's conception as closely as possible? Or to use his proposal as a jumping off point from which to develop an empirically adequate and explanatory theory of pragmatics? For linguists, the answer is typically the latter. As a first departure from Grice, we might propose using the term *conversational implicature* for any inference the speaker intends the addressee to make on the basis of the assumption that he is being cooperative. The distinction made above between background and foreground implicature can be further explicated by distinguishing between implicatures which are not meant (in Grice's sense) and those that are. (For further discussion, and identification of background implicatures with presuppositions, see Simons 2004, 2008.)

One additional Gricean distinction remains to be made: that between *particularized* and *generalized* conversational implicature. Example (2) involves a particularized implicature. Here the implicature relies to a high degree on the conversational context and on specific background assumptions attributed to the interlocutors. Changes in the context or in these assumptions easily change the implicature or eliminate it. For example, if Harold had uttered the same sentence in a conversation in which the interlocutors were trying to figure out how to knock a ball out of a tree, it would give rise to no implicatures at all about the weather. There is thus “no room for the idea” (to use Grice’s phrase) that the implicature is associated with this particular form of words or with the expression of this content.

In contrast, in the case of Generalized Conversational Implicatures, exactly this claim is warranted. GCIs are implicatures which normally arise when a particular form of words is used. The only example Grice gives of a GCI in *L&C* (Grice 1975) involves the interpretation of indefinite NPs, which turns out to be a rather complex case. In *FN* (Grice 1978), he discusses the implicature associated with the use of *or* that the speaker does not know which disjunct is true. Grice notes that “noncontroversial examples [of GCIs] are perhaps hard to find, since it is all too easy to treat a generalized conversational implicature as if it were a conventional implicature” (*L&C*; Grice 1975: 37).

In the post-Gricean literature, an element of content is identified as a GCI if, on the one hand, it can be explained as a Gricean implicature and is cancelable; but, on the other hand, its occurrence is not dependent on irregular features of context, but only on the basic assumption that the speaker is speaking in accord with the CP. Some authors deny that there is any theoretically significant distinction between generalized and particularized implicatures (e.g., Hirschberg 1991); while others hold the opposite view (see Levinson 2000, discussed below in section 5).

Presuppositions are also considered by some authors to be a subtype of implicature, although this view is far from widespread. The bulk of linguistic work on presupposition since the 1970’s has focused on the projection problem: assuming the association of presuppositions with particular atomic sentences, how do we account properly for the presuppositions of complex sentences in which the atomic sentences are embedded? The possible relationship between implicature and presupposition becomes salient when we focus on a different question, namely, how do presuppositions arise in the first place? Many authors have suggested that some or all presuppositions arise via the workings of Gricean conversational principles: see among others Stalnaker (1974), Kempson (1975), Wilson (1975), Boër & Lycan (1976), Atlas (1977, 1978, 2005), Atlas & Levinson (1981), Grice (1981), Simons (2001, 2004). The idea underlying all of these proposals is formulated succinctly by Stalnaker: “one can explain many presupposition constraints in terms of general conversational rules without building anything about presuppositions into the meanings of particular words or constructions” (1974: 212). For a discussion of this issue in the broader context of the literature on presupposition, see article 91 (Beaver & Geurts) *Presupposition*.

### 2.2.3. Rational underpinnings of the Maxims

After laying out the CP and the maxims in *L&C*, Grice (1975: 28) raises “a fundamental question about the Cooperative Principle and its attendant maxims, namely, what the basis is for the assumption which we seem to make, that talkers will in general . . . proceed

in the manner that these principles prescribe.” He goes on to say: “I would like to be able to think of the standard type of conversational practice ... as something that it is *reasonable* for us to follow,” and sets out the following as a set of claims to be explored:

1. There are certain goals that are fundamental to conversational exchange.
2. These goals can be accomplished only in conversational exchanges conducted in accordance with the CP.
3. Therefore rational speakers will behave in accord with the CP.

Claim 2 in this list seems unnecessarily strong. We might do better with 2':

- 2'. These goals can be best accomplished (i.e., most efficiently, with least effort of both speaker and hearer) in conversational exchanges conducted in accordance with the CP.

As part of the effort to establish these rationalist foundations for the account, Grice demonstrates that each of the Maxims has an analog in the non-linguistic domain, in other types of goal-oriented interactions. The effort, however, does not go much beyond this, and Grice leaves as an open question whether his conversational principles can be independently motivated. But this proposal sets a particular foundational project for pragmatics, namely, to determine the rational underpinnings of pragmatic principles.

Perhaps because of the label *Cooperative Principle*, it is standard to suppose that observation of the CP and maxims is tied to a certain amount of explicit cooperativity between the discourse participants. What is clearly not required is alignment of practical goals: Grice was clear that the CP must be construed as in effect even in cases like quarreling. The degree of cooperativity envisioned by Grice seems to go no further than a mutual desire on the part of the interlocutors to use language in a way that facilitates communication between them.

Nonetheless, there are some difficult cases: what account is to be given of apparent implicatures in cases where the misaligned goals of interlocutors should lead them to expect their discourse partners to be, for example, intentionally underinformative? (For discussion within a game theoretic framework, see Franke, de Jager & van Rooij 2009.) Both empirical and theoretical questions concerning such issues remain open.

### 2.3. A friendly amendment: Horn's Q- and R-principles

As noted, Grice seems to envision a long, open ended list of specific submaxims falling under each of his four categories. Horn (1984) develops Grice's view in a different direction. Setting aside Quality as having a special status, Horn proposes a reduction of the remaining Gricean principles to just two: Q (“to evoke Quantity”) and R (Relation).

#### *Horn's Principles*

- (Q) Make your contribution sufficient; say as much as you can (given R).
- (R) Make your contribution necessary; say no more than you must (given Q).

The Q-principle corresponds to the first maxim of Quantity. R is intended to encompass Relation, the second maxim of Quantity, and Manner.

The precise wording of the principles is perhaps less important than the underlying idea, which Horn attributes to Zipf (1949) and Martinet (1962). The idea is that there are two basic and conflicting forces at work in the linguistic domain, representing the interests of the speaker and the distinct interests of the hearer. It is in the interest of the hearer/interpreter to receive maximum (relevant) information and to receive it in the clearest formulation available. The Q-principle encapsulates this as a hearer-oriented requirement imposed on the speaker. However, it is in the interest of the speaker to minimise the effort involved in producing her message; this interest underlies the R principle.

Horn emphasizes two points: first, that his two principles together do the work of Grice's categories of Quantity, Relation and Manner; second, that the two principles are in conflict. This latter observation provides the basis of an explanation of certain cases of miscommunication, where different parties may be exploiting or emphasizing different principles. But it also raises an empirical question, namely, in cases of successful communication involving implicature, on what grounds do speakers/hearers determine which principle takes precedence? Consider for example the following cases discussed by Horn:

(9) I broke a finger last week.

(10) I slept on a boat last night.

At issue is the natural interpretation of the indefinite. We are inclined to understand the speaker of (9) as saying that she broke one of her own fingers. This would be, in Horn's view, an application of the R-principle: what is meant is something informationally richer than what is said; the speaker has provided the minimum information necessary to convey the total intended message. In contrast, it is natural to understand the speaker of (10) as saying that she slept on a boat not belonging to her. This, Horn takes to involve an application of the Q-principle: as the speaker has provided no more specific information about the boat, we take it that no additional information is available or relevant. (It is not entirely transparent how the principles are to apply in each case to produce the specific interpretations. What is important here is that interpretation goes in two different directions with two superficially similar sentences.)

Horn's brief discussion suggests that there may be many different, and differently weighted, considerations involved in resolving a maxim-clash. The considerations may be specific to the construction involved, and hence it is likely that there is no global answer to the question of which maxim or principle applies; the question may well require a case-by-case answer.

The problem of clashes between maxims had received prior attention in Atlas & Levinson (1981). They offer a Principle of Informativeness to account for example (9) and a host of additional cases where the speaker is understood as conveying something more specific than what is literally said, noting that in many cases, a conflict exists between this principle and Grice's maxim of Quantity.

### 3. A case study: scalar implicature

So far, we have reviewed Grice's foundational proposal and some proposed extensions. In this section, we look in detail at one particular linguistic phenomenon – scalar implicature – which has commonly been analyzed in Gricean terms.

### 3.1. The basic phenomenon and the Gricean account

The following are standard examples of scalar implicature. In each case, the b. sentence represents an implication that would normally arise if the a. sentence was uttered in ordinary discourse:

- (11) a. Some of my friends are Jewish.  $\sim$   
b. It is not the case that more than some of my friends are Jewish.
- (12) a. Their new house is large.  $\sim$   
b. Their new house is not enormous.
- (13) a. It's possible that I'll get funding for next year.  $\sim$   
b. It's not probable that I'll get funding for next year.

That the content of the b. sentences is an implication and not an entailment can be demonstrated by the possibility of cancelation, as in:

- (14) Some of my friends are Jewish; in fact, most of them are.
- (15) Their new house is large; indeed, it's enormous.

We will assume for now without argument that these implications are implicatures.

The implicatures in question are clearly generalized, not particularized. This is evident, first, from the fact that we can identify them in the absence of any particular information about a context of utterance. Second, the implicatures seem to arise by virtue of the presence of particular expressions, or at least, expressions with particular content: *some*, *large* and *possible*. It does indeed seem that it is the content that is relevant and not the particular lexical item: the same implicatures would arise from utterances of the sentences below:

- (16) A few of my friends are Jewish.
- (17) Their new house is big.
- (18) I might get funding for next year.

These implicatures are amenable to what seems a very straightforward Gricean explanation, based on the first Maxim of Quantity. Recall that this Maxim says:

Make your contribution as informative as is required (for the current purposes of the exchange).

It is crucial for the analysis we are about to give to remember that Quantity is circumscribed not only by Relevance but also by Quality: while you should give all the information that is required, you should only give reliable information.

Now, consider a speaker who utters (11a). Assume that it is relevant to the current conversation roughly what proportion of her friends are Jewish. Then Quantity<sup>1</sup> enjoins her to be fully informative with respect to this question.

One natural way (although by no means the only way) to quantify informativity is in terms of entailment: If  $p$  asymmetrically entails  $q$ , then  $p$  is more informative than  $q$ . Now consider again the speaker who utters (11a), and assume that she is being fully informative in the sense just described. With respect to the (presumed) question at hand, her utterance rules out the possibility that none of her friends are Jewish, but leaves open the possibility that some, many, most or all of her friends are. She could have ruled out these possibilities by making a more informative statement, e.g., by saying:

(19) Many/most/all of my friends are Jewish.

But we presume that the speaker has made the most informative utterance she can given the requirements of Quality. So this leads to the conclusion that she is not in a position to utter any of the variants of (19). But she is presumably in a position to know (more or less) what proportion of her friends are Jewish. Therefore, we conclude further that she is not in a position to make the stronger assertions because they are not true. That is, we conclude that (11a) was the most informative true sentence the speaker could utter relative to the question at hand, and thus conclude from the utterance that some of the speaker's friends are Jewish, and no more than some are.

Parallel derivations can be given for the implicatures in (12) and (13). In each case, the implicature is the negation of a sentence (proposition) which entails (i.e., is informationally stronger than) the actual utterance. The negated proposition in each case represents a stronger alternative which (in some sense) the speaker "could have said" instead of what she actually said.

### 3.2. The scalar solution

In the account just sketched, I carefully avoided any reference to the presence of particular expressions. The account makes reference only to propositions ordered by entailment. But it is not really feasible to maintain so pure an account. Reference to expressions seems necessary to identify the alternative "possible utterances" relative to which these implicatures are calculated. For there are of course all sorts of other, stronger utterances which the speaker could have made whose content is potentially relevant to the same conversation. The speaker of (11a) could have said:

(20) Some of my friends are Jewish and they eat kosher.

(21) Some of my friends are Jewish and some of my friends are Muslim.

or any of an infinity of other possibilities.

In fact, there are imaginable conversational contexts in which utterance of (11a) *would* implicate the negation of some such other stronger sentence. For example, suppose that (11a) were uttered in response to the question:

(22) Do you know anyone who isn't a Christian?

In this context, utterance of (11a) would plausibly give rise to the implicature that the speaker has no friends who are neither Christian nor Jewish e.g., has no Muslim friends;



and this could be explained by reference to the speaker's failure to utter this particular stronger alternative to her actual utterance. So it is not that random stronger alternatives do not give rise to implicatures based on the same kind of reasoning. Rather, they only do so when licensed by special features of the context, that is, they are particularized implicatures. What this tells us is that to fully explain the cases in (11)–(13), we need to say what allows for a context *independent* judgment about the relevant alternatives.

The solution offered by Horn (1972), now the standard account, invokes the notion of a scalar term. These are terms which cluster with other semantically related terms on a scale of informational strength, with relative informativity being measured, as above, in terms of entailment relations. The standard formalization of such Horn scales comes from Gazdar (1979): If  $Q$  is a Horn scale of form  $\langle \alpha_1, \alpha_2, \alpha_3 \dots \alpha_n \rangle$ , then each element in  $Q$  is logically weaker than any element to its left in the following sense: given a pair of sentences  $S, S'$  identical except that where  $S$  contains  $\alpha_i$ ,  $S'$  contains  $\alpha_j$  and  $i > j$ , then, if  $\alpha_i/\alpha_j$  are not embedded under any operator,  $S$  entails  $S'$ . Let's call the relation between elements in such a scale *asymmetric lexical entailment*.

The basic Horn/Gazdar account of generalized scalar implicatures then runs like this: Utterance of a sentence containing an element in a Horn scale renders salient the set of stronger scalar alternatives to the original utterance (i.e., for the unembedded case, sentences identical to the original but with the scalar term replaced by a scale-mate to its left in the scale), regardless of the particular conversational context. A Quantity-based inference generates scalar implicatures based on these alternatives.

We'll see shortly that entailment-based scales do not give us a complete account of scalar implicature. But first, let's review two questions that arise even given this fairly simple model. First question: how many implicatures do scales generate? For example, given the scale  $\langle all, most, many, some \rangle$ , does utterance of sentence  $S$  containing *some* implicate the negations of all of the scalar alternatives to  $S$  based on this scale? Does it implicate just the negation of the next strongest, which in turn entails the negations of the remainder? Does it implicate just the strongest? Hirschberg (1985) argues that the answer may depend on the context. Consider for example the pair of discourses below:

- (23) a. A: Are all mushrooms poisonous?  
       B: Some are.
- b. A: Are many mushrooms poisonous?  
       B: Some are.

Each question makes salient a different sub-part of the relevant scale, changing the implicature generated.

A second question raised by scalar implicatures concerns what Hirschberg calls their epistemic force. (In fact this question arises for all cases of Quantity implicature, but has been discussed in particular in the context of scalar implicatures.) This issue is discussed in almost all of the early research on scalar implicature (Horn 1972, 1989; Gazdar 1979; Hirschberg 1985; see also Soames 1982: 520–521 Levinson 1983: 135; Groenendijk & Stokhof 1984; Sauerland 2004). Soames, Horn (1989) and Sauerland each adopt more or less the following position: Consider again example (11a) above. The Maxim of Quantity, bounded as it is by the maxim of Quality, supports only the weak inference that the speaker *does not know* any stronger assertion to be true. However, in some cases, like that of (11a), we can assume that the speaker has complete knowledge of the situation

she is describing. In such cases, the weak inference supported by the Maxim can be strengthened: the interpreter can infer that the speaker *knows* the stronger alternative *not* to be true. In our example, the interpreter can infer that the speaker knows that it is not the case that many, most or all of her friends are Jewish. Then, by the factivity of knowledge, it is inferrable that it is not the case that many, most or all of her friends are Jewish.

This Gricean prediction does not, though, quite match up to intuition. Weak scalar implicatures are rather unusual, typically arising only when the speaker has explicitly acknowledged the incompleteness of her information, as in:

- (24) I've only looked at a few pages of the manuscript, but I can already tell you that some of the pages require corrections.

It is much more typical for scalar implicatures to be epistemically unmodified, even in circumstances where, on reflection, the interpreter might have less than complete confidence in the speaker's authority or evidence. (For more detailed discussion of this topic, see Sauerland 2004 and van Rooij & Schultz 2004.)

Now we come to two questions much more central to the notion of scale. The first: what precisely are the elements of the scale? The discussion so far suggests that scales consist of lexical items. But Gazdar (1979) proposes that the elements should be semantic values or expressions in a formal language used to represent the semantic content of sentences. Gazdar argues for this on the basis of simplicity. For one thing, a language might contain multiple lexical items with similar content (e.g., *large* and *big*) which occupy the same location in a scale (e.g., relative to *huge*).

The second core question raised by scales themselves is this: Where do scales come from? Or where do they reside? The ideal answer (from a Gricean perspective) would be that scales are merely a formal construct capturing relations between lexical items (or semantic values of items) which are fully reconstructible just on the basis of lexical content. That is, we do not need to stipulate that, for example, *<all, most, many, some>* is a scale, and a language user does not need to learn that it is. Any speaker who knows the meanings of these terms will recognize that they form a scale by virtue of the lexical entailment relations which hold between them.

But additional observations have led many to conclude that such an answer is not available. The additional observation is that not every entailment scale is a Horn scale i.e., a scale supporting scalar implicature. Gazdar (1979) gives a simple example to illustrate this: *regret* asymmetrically entails *know*, but use of *know* does not implicate *not regret*. The example shows that asymmetric lexical entailment is not a sufficient property to qualify a pair of words (or their meanings) as Horn scale-mates.

There is a second type of case where asymmetric lexical entailment is insufficient for Horn scale membership, giving rise to what has recently been dubbed the Symmetry Problem. Consider the pair: *some but not all, some*. The first asymmetrically entails the latter; but clearly, an utterance of (25a) does not implicate (25b):

- (25) a. I ate some of the cookies.  
b. It is not the case that I ate some but not all of the cookies

for the conjunction of a. and b. is equivalent to "I ate all of the cookies" – and this is the negation of what (25a) is actually observed to implicate!

Horn (1972) addresses problem cases of this sort by positing a requirement that elements in scales have the same degree of lexicalization. As English contains no single word which means “some but not all,” the semantic content of this expression cannot be a scale-mate with the content of *some*. This constraint can perhaps be given a Gricean motivation in terms of the Maxim of Manner, the idea being that the alternatives to be considered should only be those which do not increase the complexity of the utterance. (See also Matsumoto 1995; Katzir 2007.)

In light of these difficulties, many researchers adopt the position that Horn scales are linguistically given. So, although we can make certain general observations about the relations which hold between members of a Horn scale, we cannot predict merely on the basis of the linguistic properties of an item whether or not it will occur on a scale, or what its scale-mates will be. It is simply a contingent fact about a language what scales it contains, and what the members of those scales are.

### 3.3. Beyond scales

So, we reach the following position: We posit Horn scales as linguistic elements. Because of the existence of these scales, an utterance U of sentence S containing a scalar term makes salient a set of alternative sentences. We can then apply basic Gricean reasoning utilizing Quantity<sup>1</sup> to give an account of scalar implicatures.

But that basic Gricean reasoning relied on cashing out informativity in terms of asymmetric entailment. Yet there appear to be cases of scalar implicature which don't rely on scales ordered by this relation. Horn (1989) observes several cases where lexical items within a particular domain are intuitively rankable (to borrow a term from Hirschberg 1985), but are not related by lexical entailment. Horn's examples include military rank (*private, corporal, sergeant . . .*), life stages (*newborn, infant, toddler, preschooler . . .*), and legal violations (*tort, misdemeanor, felony, capital crime*). These, Horn suggests, give rise to implicatures following the same pattern as entailment based scalar implicatures, as illustrated by the examples below:

- (26) A: Do they have any pre-schoolers in the program?  
B: They have toddlers. [~ toddlers but no older pre-schoolers]
- (27) A: Have you worked on any capital cases?  
B: I've worked on several felony cases. [~ felony cases but no capital cases]

Hirschberg (1985) goes further in her observations. She points out that scalar implicature-like phenomena arise with a variety of non-linear rankings including whole/part relationships, type/subtype, and prerequisite orderings. Examples of implicatures based on these relations (all borrowed from Hirschberg 1985: Ch. 5) are given below:

- (28) A: Did you read that section I gave you?  
B: I read the first few pages.
- (29) A: Do you have a pet?  
B: We have a turtle.

- (30) A: Is she married?  
B: She's engaged.

Similarly, scalar implicatures can be produced wherever context makes salient some set of alternatives. Here, affirmation of one alternative gives rise to an implicature that no other alternative can be affirmed. So consider:

- (31) A: Do you have apple juice?  
B: I have grape or tomato or bloody mary mix.

On the basis of such observations, Hirschberg (1985: 125) concludes that scalar implicatures are supported by the class of partially ordered sets, i.e., any relation which is reflexive, antisymmetric and transitive. Any set of lexical items referring to entities or processes which stand in such a relation may provide the basis for a scalar implicature.

In order for a scalar implicature to be generated, the ordering which underlies it must be somehow salient. But context can render all kinds of ad-hoc orderings salient, given adequate background. If the Hirschberg-type examples really are cases of scalar implicature, then an account of this phenomenon in terms of conventional, linguistically pre-given scales seems highly implausible. On the other hand, one might argue that these examples are simply cases of particularized quantity implicatures, whose explanation requires reference to the conversational context and goals.

What makes it unlikely that the Hirschberg-type cases are unrelated to standard cases of generalized scalar implicature is that both cases clearly involve the construction of alternative possible utterances. It seems likely that an account of the construction or identification of the alternatives in these context dependent cases will be extendable to the classic scalar cases.

A promising candidate for a more general account comes from work on exhaustivity, originating in Groenendijk & Stokhof (1984). These authors were concerned with the derivation of exhaustive answers to questions, as in the following case:

- (32) A: Which students were late today?  
B: Francine was late.

It is natural to understand the question as requiring, and the response as providing, an exhaustive answer. That is, the response is taken as indicating that, of the relevant set of students, *only* Francine was late (for the event in question). The example is much like many of Hirschberg's, which typically involve question/answer pairs, and could similarly be accounted for on the basis of Quantity. Groenendijk & Stokhof, however, take exhaustification to be a semantic effect, the result of applying to the semantic content of the answer an exhaustivization operator, roughly equivalent to *only* in meaning. This account nonetheless requires, like Hirschberg's, positing a salient set of students who are potential alternatives to Francine.

G&S's proposal is extended and applied directly to the scalar case in van Rooij & Schulz (2004, 2006). The 2006 paper offers several revisions to G&S's original formalization of the semantics of exhaustivization, extending the scope of the account and improving on some of the original predictions. More importantly for our interests, van Rooij & Schulz attempt to derive exhaustivization explicitly as a Gricean effect, and

explicitly connect exhaustivity to scalar implicature, suggesting (van Rooij & Schulz 2006: 245) that many scalar implicatures simply involve exhaustive interpretation. By extension, this suggests that the notion of scale may be dispensable for a large class of cases.

For Groenendijk & Stokhof, exhaustivization is a semantic effect. For van Rooij & Schulz, it is a pragmatic one. Fox (2007) argues for exhaustivization as a syntactic effect, resulting from the interpretation of a covert syntactic element. In terms of its interpretation, Fox's *exh* operator is essentially the same as G&S's, although its occurrence is much less constrained than in their theory. Fox uses his operator specifically to derive scalar implicature effects, unmooring these effects from their Gricean foundations and transplanting them into the grammatical system.

Fox's proposal is one of several in which scalar implicature is derived as a grammatical effect. Landman (1998, 2000) and Chierchia (2004, 2006) propose treatments in which scalar implicature is calculated by the compositional semantic component of the grammar, while remaining sensitive to general contextual factors in some ways. The primary motivation for this "grammatical turn" in the treatment of scalars comes from the phenomenon of embedded implicature, to be discussed briefly in the next section; but is further motivated by the apparent robustness of these implicatures. (But see Geurts 2009 and work cited therein for a challenge to the robustness claim.) What is of particular interest from a foundational perspective is that this one phenomenon is amenable to analysis in such widely differing ways, facing us with a paradox observed by Grice in *Further Notes*:

If we, as speakers, have the requisite knowledge of the conventional meaning of sentences we employ to implicate, when uttering them, something the implication of which depends on the conventional meaning in question, how can we, as theorists, have difficulty with respect to just those cases in deciding where conventional meaning ends and implicature begins?

#### 4. Embedded implicature

Cohen (1971) is one of the earliest published critiques of Grice's theory of conversational implicature. Cohen raises a number of problems for Grice, but his paper is best known for this pair of examples:

- (33) The old king has died of a heart attack and a republic has been declared.
- (34) If the old king has died of a heart attack and a republic has been declared, then Tom will be quite content.

Sentence (33) implies that the king died first, and the republic was subsequently declared. Cohen (1971: 58) points out that this ordering implication is present also when the conjunction occurs in the antecedent of the conditional in (34). In fact, this implication seems to be part of the *content* of the antecedent; for it is natural to judge the conditional true even if we believe that Tom would be unhappy if the republic had been declared first, and the king had subsequently died. But this implication, according to Grice, is supposed to be a conversational implicature. This thus appears to be a case where a purported conversational implicature falls under the scope of a semantic operator, a phenomenon now dubbed *embedded implicature*. (See also article 87 (Chierchia, Fox & Spector) *Grammatical view of scalar implicatures*.)

Since Cohen's work, many additional types of embedded implicature have been identified. So why exactly are these examples problematic for Grice? They are problematic for two reasons, which I call *the calculation problem* and *the compositionality problem* (see Simons 2011).

The calculation problem is this: Grice's account of the calculation of conversational implicatures does not provide a means for the calculation of implicatures from non-asserted clauses. Anscombe & Ducrot (cited by Recanati 2003) provide a succinct argument to this conclusion:

- (a) Conversational implicatures are pragmatic consequences of an act of saying something.
- (b) An act of saying something can be performed only by means of a complete utterance, not by means of an unasserted clause such as a disjunct or the antecedent of a conditional.
- (c) Hence, no implicature can be generated at the level of an unasserted clause.

Now, perhaps it is to be expected that exceptions will be found for the case of Manner implicatures, which involve attention to the form in which something has been said. But apparent implicatures attaching to embedded clauses are of all kinds. Consider the examples in (35) and (36) below, both involving scalar implicatures:

- (35) Either Kai ate the broccoli or he ate some of the peas. (Sauerland 2004)  
     ~ Either Kai ate the broccoli or he ate **some but not all** of the peas.
- (36) Bill thinks that Harriet wants to read some of his papers. (Cf. Chierchia 2004)  
     ~ Bill thinks that Harriet wants to read **some but not all** of his papers.

In neither case can the observed implicatures be derived via standard Gricean reasoning from the entire asserted content. (For details, see the cited papers). Suppose then that we want to allow the implicatures to be generated *in situ*. The standard Gricean machinery simply does not provide a means to do this, as the clauses which give rise to the implicatures are not themselves said. The calculation problem, then, is the problem that the Gricean picture provides no means for calculating implicatures on the basis of content which is not said; but intuitively, syntactically embedded clauses do sometimes seem to give rise to implicatures in their own right.

The second problem, the compositionality problem, can be characterized in two different ways, depending on whether one is interested solely in the consequences of embedded implicatures for Grice's views, or for the theory of interpretation more generally. (For a more general discussion of compositionality, see article 6 (Pagin & Westerståhl) *Compositionality*.) Starting with the Gricean perspective, the compositionality problem is this: According to Grice, what is said is supposed to be determined by conventional content (in addition to reference fixing and disambiguation). But in examples like (34)–(36), the implicatures apparently generated by embedded clauses seem to fall under the scope of the embedding operators, and thus to contribute to the truth conditional content expressed: that is, to what is said. But the compositionality problem is not merely a problem for Grice's conception of what is said. It is more broadly a problem for standard models of the interaction between conventionally encoded content and inferentially derived

content. Translated into the language of current semantic theory, Grice's model of what we now call the semantics/pragmatics interface tells us that processes of semantic composition are independent of (and are analytically prior to) processes of pragmatic inferencing. But cases of embedded implicature suggest that the correct model is one in which, for example, a linguistic operator can apply to a proposition consisting of both encoded and inferentially derived content.

It is for this reason that local pragmatic effects are viewed by non-Gricean pragmaticists as being of central importance (see Sperber & Wilson 1986; Bach 1994; Recanati 1989, 2004; Levinson 2000). These effects do not merely require a rethinking of the mechanism whereby pragmatic effects are derived, but of the entire model of interpretation. The authors just mentioned all hold that such effects – what Levinson (2000) calls *pragmatic intrusion* – are ubiquitous, going well beyond the types of examples illustrated here. For such theorists, a central goal of any theory of pragmatic inference should be to provide an account of local effects, and on this ground the standard Gricean model is rejected.

## 5. Alternate models and competing conceptions

In this section, we will discuss the views of theorists who, while fully embracing the idea that what is conveyed by an utterance includes both encoded content and inferentially derived content, differ from Grice in various ways. There are three principal parameters of difference:

- (i) the rules or principles involved in inference
- (ii) the nature of the input to inference and the interaction between encoded content and inferential content
- (iii) the appropriate analysis of “what is said” or “literal meaning”

### 5.1. Explicature and implicature in Relevance Theory

Relevance Theory (RT), first formulated in Sperber & Wilson (1986), is billed as a cognitive theory of communication. Conversational inference is a central feature of this theory. But Sperber & Wilson differ from the Gricean conception along all three of the parameters set out above.

On the RT view, inference is driven by a deep cognitive principle: the impulse to extract maximal useful information from a stimulus, balanced by the impulse to expend no more effort than seems justified by the anticipated benefits. (Here, we hear echoes of the Zipfian principles underlying Horn's Q- and R-principles.) RT uses the term *Relevance* (rather non-standardly) to characterize this balance between effort and pay-off: the more cognitive benefits – that is, useful information – a stimulus provides, the more Relevant it is; but this is offset by the processing effort required to derive the information. A stimulus has *optimal Relevance* just in case the cognitive benefits derived fully justify the cognitive effort required to derive them.

According to RT, linguistic communication is governed by the following principle:

*Communicative Principle of Relevance*

Every utterance conveys a presumption of its own optimal relevance.

The goal of interpretation is to identify a speaker meaning consistent with this presumption. This one over-arching principle is argued to do all the work which, in Grice's theory, is done by all the maxims combined.

So, one major difference between Grice and RT is the conception of what underlies conversational inference. A second is the specific principle which launches the process. The third major difference concerns the input to conversational inference and the interaction between encoded and inferential content.

On the RT conception, linguistic decoding produces an impoverished semantic object, a propositional radical or propositionally incomplete logical form. The first task of Relevance-driven inference is to fill out this skeletal object into a complete proposition. As noted above, Grice recognized that in order to identify the proposition expressed, an interpreter must fix the referents of referential expressions and resolve ambiguities, but said nothing as to the nature of the processes involved. RT argues, first, that what is required to construct a complete proposition from what is linguistically encoded goes well beyond reference fixing and disambiguation. Second, RT argues that there is no principled distinction to be made between processes involved in "filling out" a proposition and processes involved in deriving further inferences from the proposition so retrieved. All are driven by the same presumption of Relevance.

Inferentially derived content which goes towards "filling out" encoded content into a complete proposition is called *explicature*. Some aspects of content which Griceans treat as generalized conversational implicatures are analyzed in RT as explicatures, with a corresponding shift in the semantic analysis of the items in question. The interpretation of scalars is a central case.

Once all necessary explicatures have been derived, and the utterance has been associated with a proposition, Relevance-driven inference may continue. RT preserves the term *implicature* for these additional inferences, but makes a further subdivision within this class. In RT, the interpretation of an utterance is taken to proceed relative to a context, a context being simply some set of propositions retrievable by the addressee. The relevance of an utterance is partially determined by the number and utility of conclusions which can be deductively drawn from the context in conjunction with the proposition derived from the utterance. Part of the process of interpretation is the construction of an appropriate context. In RT, the term *implicature* is used both for propositions which are inferred to be part of the context for interpretation, and for deductive conclusions drawn on the basis of the constructed context. The former type of implicature is called an *implicated assumption* or *implicated premise*, the latter, an *implicated conclusion*. This distinction (not coincidentally) maps onto the distinction made above between background and foreground implicature.

In introducing the background/foreground distinction, we noted that the extension of the term *implicature* to background implicatures involved a departure from the Gricean conception of implicatures as part of speaker meaning. RT's implicated conclusions are also not necessarily part of Gricean speaker meaning. Suppose a speaker produces an utterance U, knowing that there are multiple contexts relative to which the interpreter might find U relevant, and knowing that U would give rise to different implicated conclusions in different contexts. Then there is no *particular* implicature which the speaker intends to be drawn, and perhaps not even a determinate set of candidates. For Grice, these inferences could not count as implicatures; for RT, they do. In fact, RT recognizes a



continuum of implicatures, from those clearly meant by the speaker, to cases where the speaker expects *some* implicated conclusions to be drawn but does not know what they will be. However, inferences drawn by the interpreter but not driven by the requirements of Relevance lie beyond the limits of implicature.

## 5.2. Bach's Conversational Implicature

Kent Bach's (1994) "Conversational Implicature" does not present any revised theory of what underlies implicature derivation. The purpose of the paper is to demonstrate that "the distinction between what is said and what is implicated is not exhaustive" (Bach 1994: 124). Between the two lies a level which Bach calls *implicature*.

Like the Relevance theorists, Bach takes it that the output of semantic decoding may be propositionally incomplete. Propositional incompleteness drives a process which he calls *completion*: the filling in of "conceptual gaps" in a "semantically underdeterminate" sentence content. Completion is semantically or conceptually mandated. An interpreter, merely by virtue of their knowledge of the language, will be able to identify semantic incompleteness; and linguistic rules or forms will determine what sorts of completions are required.

But even after completion, we may not have arrived at the level of implicature. In some cases, a further process called *expansion* takes place. This is best explained by illustration. Consider one of Bach's central examples: A mother says (unsympathetically) to her child who is complaining of a cut finger:

(37) You're not going to die.

She is not telling her son that he is immortal – the literal meaning of the sentence – but merely that he will not die from the cut on his finger. A proper understanding of her utterance requires expanding the proposition literally expressed to one which is "conceptually more elaborate than the one that is strictly expressed." (Bach 1994: 135) This process of expansion is driven by the interpreter's recognition that the speaker could not reasonably mean what she has literally said. So, like ordinary implicature, expansion is driven by the assumption of the general cooperativity of the speaker.

So, why are these not simply cases of implicature? Here is how Bach distinguishes the two notions:

In implicature one says and communicates one thing and thereby communicates something else in addition. Implicature, however, is a matter of saying something but communicating something else instead, something closely related to what is said (Bach 1994: 126) . . . Implicatures are, as the name suggests, implicit in what is said, whereas implicatures are implied by (the saying of) what is said. (Bach 1994: 140)

Recanati (1989, 2004 and elsewhere) offers a model of linguistic interpretation similar in many respects to that of Bach. Like Bach, Recanati distinguishes conversational implicature from other types of pragmatic inference which operate locally and which do not utilize "full blown" Gricean reasoning. Like Bach, Recanati recognizes two distinct

sub-types of lower-level pragmatic processes, which he calls *saturation* and *modulation*: these are roughly equivalent to Bach's *completion* and *expansion*. Only after these are completed can anything akin to Gricean implicature generation begin.

### 5.3. Levinson: Generalized conversational implicature as default interpretation

Like Bach, Levinson is essentially a Gricean, but considers that Gricean theory requires modification to allow for the fact of "pragmatic intrusion:" inferential contributions to what is said. These contributions are what he identifies as Generalized Conversational Implicatures in Levinson (2000). The specific aspects of interpretation which he identifies as GCIs more or less overlap with those identified by Relevance theorists, Bach and Recanati as local pragmatic effects. Unlike them, Levinson proposes that GCIs can be derived on the basis of (elaborated versions of) the standard Gricean maxims of Quantity, Relation and Manner. In his formulation, these become the Q-, I-, and M-Maxims, respectively ("I" for informativity: Cf. Atlas & Levinson 1981).

Two aspects of the revised maxims are noteworthy. First, for each principle, Levinson gives both a Speaker's Maxim and a Recipient's Corollary. The latter articulates in some detail what sort of inferences are derivable given the interpretation rule. This detail is the second noteworthy aspect of the formulation. Unlike Horn's proposal, discussed above, which aims for maximum generality, Levinson incorporates into the speaker corollaries specific inference rules which produce the central GCI types with which he is concerned. Readers are referred to the original for the full principles.

As presented so far, Levinson's view looks like nothing more than a reformulation of Grice's. What distinguishes his position is his view as to how his principles apply. The central notion for Levinson is that of a *default*: the principles are claimed to be default "inferential heuristics" (Atlas & Levinson 1981: 35) which produce default interpretations. Levinson proposes that the GCI-generating principles apply automatically in the interpretation of any utterance, unless some contextual factor over-rides their application. The inference underlying GCIs is supposed to be "based *not* on direct computations about speaker-intentions but rather on general expectations about how language is normally used" (Atlas & Levinson 1981: 22). Application of default interpretation principles thus lies somewhere in between decoding of linguistically encoded content and the calculation of true implicatures.

The notion of default occurs in two ways in Levinson's view. First, there is the claim that the interpretative principles apply by default. Second, Levinson describes the output of these principles as "default interpretations". Yet as pointed out by Bezuidenhout & Morris (2004), the interpretations which arise are not defaults in the sense that their selection requires no choice among alternatives. Levinson himself, throughout the book, presents multiple options for GCIs which may be associated with particular words or constructions. And it is clear, as emphasized by Bezuidenhout (2002), that the choice among these options often requires reference to wide context – and very likely, reference to considerations of speaker intention and standard Gricean principles.

As noted, a major motivation for Levinson's theory of GCIs is that these implicatures can attach to subordinate clauses, and contribute to what is said. Levinson claims that the

nature of his rules is such that “the inference can be made without complete access to the logical form of the whole utterance . . . Procedurally, the expression *some of the boys G’d* can be immediately associated with the default assumption *some but not all of the boys G’d* even when some indeterminate aspect of the predicate G has not yet been resolved” (Levinson 2000: 259). Applications of the I-principle, which for Levinson include enrichment of lexical content, might similarly be triggered as soon as a particular word is encountered e.g., the interpretation of “drink” as “alcoholic drink” in *I went out for a drink last night*. This local triggering of GCIs is crucial to Levinson’s account of pragmatic intrusion. However, Bezuidenhout 2002 argues rather convincingly against this view of GCIs.

Levinson clearly holds that standard Gricean implicatures also arise, but gives no indication as to whether they are generated by the same principles which produce GCIs, applying in a global, non-default manner; or whether PCIs are assumed to be generated by the standard (but almost identical) Gricean principles.

## 6. Formal and experimental approaches

In this article, we have reviewed the foundations of the analysis of conversational implicature. To conclude, I will briefly introduce two formal approaches to the study of implicature: Optimality Theoretic Pragmatics, and Game Theoretic approaches.

The Optimality Theoretic approach to interpretation is presented as a new take on the Radical Pragmatics program, adopting the view that linguistic form underdetermines the propositional content of utterances. In this respect, OT pragmatics shares underlying assumptions with Relevance Theory, which is cited in some presentations. It is proposed that OT can provide a framework both for the processes involved in filling out a full propositional content (e.g., pronoun resolution, fixing domain restrictions for quantifiers) and in further elaboration of the content expressed, that is, the generation of implicatures. OT pragmatics has so far focussed principally on generalized implicatures involving standard but defeasible interpretations of particular forms: for example, scalar implicatures, and the association of stereotypical situations with unmarked syntactic forms (e.g., the interpretation of *stop the car* vs. *cause the car to stop*) – Horn’s “division of pragmatic labor”. So far, highly particularized implicatures lie outside of the purview of the theory.

OT pragmatics take much of its inspiration from Horn’s (1984) pragmatic taxonomy (see section 2.3 above), which posits the two conflicting principles, Q and R. Horn’s proposal is interpreted within OT pragmatics as claiming that pragmatic interpretation is a matter of achieving an optimal balance in the pairing of forms and interpretations: a given form *f*’ should be assigned an interpretation *m* which enriches the linguistic content of *f*, but not so much that some alternate form *f*’ would be a better candidate for the expression of *m*; while a desired meaning *m* should be expressed in a form *f* which is adequately economical, but not so much so that some other meaning *m*’ would be a better candidate to be expressed by it. This balancing of competing requirements is captured by a modification of standard OT called Bidirectional OT (Blutner 2000).

Clearly what this conception requires is a theory of what renders one candidate form-interpretation pair better than another. Identifying a set of pragmatic constraints relative to which to formulate a metric for evaluating the “goodness” of such pairs is one of the central tasks of OT pragmatics. (For some contributions to this project, see Blutner & Zeevat (2004). The introduction to that volume gives a useful overview of the

framework.) A second task of the theory is to fix the definition of optimization, i.e., what counts as an “adequately good” pairing. See again the aforementioned volume, and also Blutner (2000). For a book length presentation of the OT approach to interpretation, integrating syntax, semantics and pragmatics, see Blutner, de Hoop & Hendriks (2006).

Decision theory is a mathematical framework used to model rational decision making, in particular in situations of incomplete knowledge about the world. The decisions in question are typically choices among some fixed set of options. Game theory, an extension of decision theory utilizing the same set of formal tools, is used to model decisions in situations where two agents interact, and where each agent’s choices impact on the decision of the other, a so-called *game*. Decision theory and, more extensively, game theory have been applied to various aspects of linguistic analysis since Lewis’s pioneering (1969) work. More recently, some theorists have begun to use game theory to model pragmatic inference, including the calculation of some types of implicature. (For a useful introduction to the basic mathematical machinery and its application to pragmatics, see chapter one of Benz, Jäger & van Rooij (2006); the rest of the book provides a good survey of central topics in the application of game theory to pragmatics. See also article 93 (Jäger) *Game theory*.)

There are two (not entirely distinct) lines of work in this domain. One line of work attempts to formalize fundamental pragmatic concepts or principles using game theoretic tools. Particular attention has been given to the concept of Relevance (see e.g., Merin 1999; van Rooij 2001 and elsewhere). A second line of work attempts to replicate the effects of particular Gricean or neo-Gricean principles using Game Theory. Work in this line is generally presented as friendly to the Gricean framework, intended as a precise formulation of it rather than as an alternative.

Like OT, game theory is set up to model choices among a fixed set of alternative utterances/interpretations, and hence finds applications in attempts to model generalized implicatures involving choices among competing expressions. As with OT, particularized implicatures lie (at least so far) outside of the domain of the theory. Again, scalar implicature and Horn’s “division of pragmatic labor” have been targeted for analysis (see van Rooij 2008 and article 93 (Jäger) *Game theory*). The overlap between game theory and OT is not accidental. Dekker & van Rooij (2000) demonstrate that optimality theoretic models can be given a game theoretic interpretation, and that optimal interpretations represent Nash equilibria.

These are only samples of the formal approaches that have been utilized to develop robust accounts of conversational inference in general and conversational implicature in particular. A very different line of work, mainly pursued by computer scientists modelling discourse utilizes Planning Theory (for a starting point, see Grosz & Sidner 1986).

The developing area of experimental pragmatics offers another kind of enrichment of traditional Gricean pragmatics, applying the methods of experimental cognitive psychology to derive data for pragmatic theorizing. Some work in this area simply tries to apply proper methodology to elicit judgments from untutored informants, rather than using the standard informal (and, it is argued, often misleading) methods traditional in pragmatics: see for example Geurts & Pouscoulous (2009). Other work is aimed at testing the adequacy of particular pragmatic theories or claims by evaluating their implications for processing. The approach is to formulate a specific claim about processing which is implied by the pragmatic theory under investigation, and then to test that claim empirically. This approach has been applied recently to the debate about the status of generalized

conversational implicatures, with a variety of experimental techniques being applied to the question of whether or not these implicatures are “defaults” of some kind. Techniques range from the use of measures of reading or response time (e.g., Breheny, Katsos & Williams 2005), eye-tracking over visually presented examples (e.g., Bezuidenhout & Morris 2004) and even over real world tasks (e.g., Grodner & Sedivy 2004; Storto & Tanenhaus 2005). Noveck & Sperber (2004) offers a useful introduction to this area of research.

While an understanding of the conceptual foundations of the theory of implicature is crucial for meaningful work in this domain, it is only through the development of formal models that a substantive, predictive theory of conversational implicature can be provided.

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Mandy Simons, Pittsburgh, PA (USA)

## 93. Game theory in semantics and pragmatics

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### Abstract

*Game theory is a mathematical framework that is being used in economics and biology, but also in philosophy, political science and computer science, to study the behavior of multiple agents that are engaged in strategic interaction. It has manifold applications in linguistics as well. In particular, it has been utilized to investigate stability conditions of linguistic features in a large speech community, and to explore the strategic aspects of single speech acts.*

*The following chapter gives an introduction into a particular incarnation of this research paradigm, the Iterated Best Response model of game-theoretic pragmatics. It can be seen as a formalization of the neo-Gricean program of pragmatics. Empirical issues touched upon include exhaustification, free choice readings, ignorance implicatures, embedded implicatures and the pragmatics of measure terms.*

### 1. Introduction

The interpretation of linguistic utterances is determined by the words involved and the way they are combined, but not exclusively so. Establishing the content that is communicated by an utterance is inextricably intertwined with the communicative context where the utterance is made, including the expectations of the interlocutors about each other. Clark & Marshall (1981) make a good case that even the reference of a definite description depends on the reasoning of the speaker and hearer about each other's knowledge state. Likewise, computing the implicatures of a sentence requires reasoning about the knowledge states and intentions of the communication partners. To use a worn-out example, Grice (1975) points out that a sentence such as (1b), if uttered to the owner of an immobilized car by a passerby, carries much more information than what is literally said.

- (1) a. *car owner:* I am out of petrol.  
       b. *passerby:* There is a garage round the corner.

The listener will legitimately infer from this exchange that the garage is open and sells petrol (or at least so the passerby believes). This follows from his expectations that the passerby understands his situation and is cooperative. But this is not sufficient. The



passerby must be aware of these expectations, and he must believe that the car owner is capable to make the required inference, the car owner must be able to assign these epistemic qualities to the passerby etc.

The standard tool to model this kind of inferences about mutual belief states is epistemic logic, and it has been extensively used to model the interface between semantics and pragmatics (see for instance Stone 1998; Gerbrandy 1999). *Game Theory* is another intellectual tradition that aims at a mathematical model of the inferences that are involved in the interaction of rational agents. Unlike epistemic logic, game theory puts its focus on the decisions and preferences of the interacting agents, rather than on explicit models of their internal states and reasoning processes. As communicative goals and decisions play a crucial role for pragmatics, the use of game theoretic methods in pragmatics suggests itself.

The application of game theory to linguistic issues traces back to David Lewis' dissertation (Lewis 1969), where he showed that the game theoretic notion of a *Nash equilibrium* is apt to explain how a linguistic convention can be self-sustaining in a community. While the game theoretic investigation of communication was mostly pursued by economists and biologists in the quarter century after Lewis' work (see for instance Spence 1973; Crawford & Sobel 1982; Maynard Smith 1991), since the mid-nineties formal linguists and philosophers of language have paid increasing attention to the potential of game theory to the analysis of language use and language evolution (see for instance Dekker & van Rooij 2000; Parikh 2001; van Rooij 2004; Skyrms 2010 or the papers in Benz, Jäger & van Rooij 2005; Pietarinen 2007).

In this article, I will not even attempt to give a comprehensive overview on the various applications of game theory to semantics and pragmatics that have emerged in recent years. Rather, I will describe a particular approach in some detail. The *Iterated Best Response* Model (IBR Model for short) of game theoretic pragmatics is an implementation of the neo-Gricean program of pragmatics to derive the mapping from *what is said* to *what is meant* from first principles of rational communication. Various incarnations of it have been proposed in recent years (cf. Jäger 2007c; Franke 2008; Jäger & Ebert 2009; Franke 2009; see also Benz & van Rooij 2007 for a related approach), drawing on earlier work in economics such as Rabin (1990) that was not specifically directed at the analysis of natural language. In this article I will largely follow the version from Franke (2009). In particular, the analyses of disjunction, free choice permissions and embedded implicatures given below are taken from there.

## 2. Game construction I: Interpretation games

Following the lead of Lewis (1969), the present approach models linguistic communication as a *signaling game*. This is a class of dynamic games involving two players, a *sender* and a *receiver*. The game proceeds in three stages:

1. The sender is assigned some piece of private information, its *type*, that is not revealed to the receiver.
2. The sender transmits a *signal* to the receiver. The choice of the signal may depend on the type.
3. The receiver chooses a certain *action*, possibly dependent on the observed signal.

To keep the mathematical analysis manageable, I will assume that the number of possible types, signals and actions are finite. The type of the sender is assigned according to a certain *prior* probability distribution that is common knowledge between the players.

A *history* of such a game is a type-signal-action triple. Both players have certain preferences over histories. These preferences are modeled as numerical *utilities*. It is important to keep in mind that the numerical values used are to some degree arbitrary. What is important is only the relative preferences between histories (or probability distributions over histories) that are captured by such a utility function. Unless otherwise noted, it is always tacitly assumed that both players are *rational*. This entails that they have a consistent epistemic state, and that they make their choices in a way that maximizes their *expected utilities*, given their epistemic state.

Unlike Lewis (1969) and much subsequent work, the IBR model is not concerned with the question how signals acquire meaning in a signaling game. Instead it is presupposed that signals already have a conventionalized meaning that is common knowledge between the players, and the model serves to study how the conventionalized meaning affects the way signals are used in particular strategic situations. Therefore we augment signaling games with a relation of truth that holds between types and signals.

Let us make the model formally precise. A signaling game consists of the following components:

- a finite set  $S$  of *signals* that the sender has at her disposal,
- a finite set  $T$  of *types* (information states) the sender might be in,
- a *prior probability distribution*  $p^*$  over  $T$ ,
- a *truth* relation  $\models$  between  $T$  and  $S$ ,
- a set  $A$  of *actions* that the receiver may take, and
- utility functions  $u_s$  and  $u_r$  for the sender and the receiver respectively that both map triples from  $T \times S \times A$  to real numbers.

Intuitively, a type  $t \in T$  specifies the information that the sender wants to communicate in a given situation, and  $S$  is the set of linguistic expressions that she could, in principle, utter. It would be unwieldy though to identify  $S$  with all well-formed expressions of English (or some other natural language), and to pin down the set of possible information states of the sender seems to be outright hopeless. To analyze a particular linguistic example, we have to construct a local game that captures the relevant alternatives that the interlocutors take into consideration. In the sequel, I will present a recipe how to construct such a game. It closely follows the proposal from Franke (2009).

To illustrate the recipe, I will use the standard example for a scalar implicature:

(2) Some boys came to the party.

If the listener is interested in the question how many boys came to the party, (2.) carries the implicature that not all boys came to the party. Neo-Gricean pragmaticists usually assume (cf. for instance Horn 1984) that this effect arises because the word *some* in (2.) is element of a scale  $\{no, some, all\}$ . When interpreting (2.), the listener takes into consideration that the speaker could have uttered (3a) or (b):

- (3) a. No boy came to the party.  
 b. All boys came to the party.

When constructing a game for a particular expression  $s$  that is uttered in a particular context  $c$ , the set of signals  $\mathcal{S}$  is simply  $ALT_c(s)$ , the set of expression alternatives to  $s$  in  $c$ . This set may be determined by lexical properties of the linguistic material involved (as in the case of scalar expressions), by information structure (cf. Rooth 1985; Büring 1995) by an explicit or implicit question and perhaps by other factors. The issue has been discussed extensively in the literature and I will not dwell further on it here – see for instance Fox (2007); Katzir (2007) for some recent discussion. For the running example,  $\mathcal{S} = \{(2.), (3a), (3b)\}$ , mnemonically named  $\{\text{SOME}, \text{NO}, \text{ALL}\}$  in the sequel.

The set of  $\mathcal{T}$  of *types* or information states that the sender may have can be identified with the set of answers to the current *question under discussion* that – according to the listener – the speaker might know. For the time being, I will assume the *strong competence assumption*, i.e. the idea that the speaker is perfectly informed about the issue at hand. (The name “competence assumption” is due to van Rooij & Schulz 2004, but the notion has been used by many neo-Gricean researchers under varying names. I call it “strong competence assumption” here because I will later introduce a weaker variant thereof.) This means that the speaker is assumed to know the truth value of all elements of  $\mathcal{S}$ . (It is actually sufficient to assume that the speaker has a definite opinion about these truth values. I will continue to pretend that the speaker only has correct information, but nothing hinges on this.) The consequences of lifting this assumptions are explored in Section 6.

If the speaker is also rational, we can identify her possible information states with the set of maximally consistent sets of the elements of  $\mathcal{S}$  and their negations that are consistent with the context and contain at least one non-negated element. To avoid the formal complication of defining an appropriate negation for whatever representation language we use, information states are defined as non-empty sets of sentences that are deductively closed within  $\mathcal{S}$ , with the implicit assumption that a sentence which is not a member of an information state is false in this state (the so-called *closed world assumption*).

In the example at hand, these would be (under the assumptions that  $\{\text{NO}, \text{SOME}\}$  is inconsistent and  $\text{ALL} \vdash \text{SOME}$ , where  $\vdash$  indicates entailment):

$$\mathcal{T} = \{\{\text{NO}\}, \{\text{SOME}\}, \{\text{SOME}, \text{ALL}\}\}.$$

Types are thus essentially *possible worlds* (provided the competence assumption holds). In our running example, I will denote the three types with  $w_{\neg\exists}$ ,  $w_{\exists\neg\forall}$ , and  $w_{\forall}$  respectively.

The *prior probability distribution*  $p^*$  over  $\mathcal{T}$  captures the subjective probabilities that the receiver assigns to the possible states of the sender. It has no obvious counterparts in the epistemic models that are commonly used in formal semantics and pragmatics. Unless any specific information is given, we have no reason to assume that the receiver considers a certain type as being more likely than any other type. In such a situation the *principle of insufficient reason* (cf. Jaynes 2003) applies: If two possibilities  $a$  and  $b$  are indistinguishable except for their names, they have the same subjective probability. This entails that  $p^*(t) = 1/|\mathcal{T}|$  for all types  $t$ . In our example, this means:

$$p^*(w_{\neg\exists}) = p^*(w_{\exists\neg\forall}) = p^*(w_{\forall}) = \frac{1}{3}.$$

A signal  $s$  is *true* in a type  $t$  if  $s \in t$ . We thus have:

$$\begin{array}{lcl} w_{\neg\exists} & \models & \text{NO} \\ w_{\exists\rightarrow\forall} & \models & \text{SOME} \\ w_{\forall} & \models & \text{SOME, ALL} \end{array}$$

In an interpretation game, the receiver's task is to figure out which type the sender has. The set  $\mathcal{A}$  of receiver *actions* can thus be identified with  $\mathcal{T}$ . (I will continue to use the letters  $a$  and  $\mathcal{A}$  when talking about receiver's options, and  $t/\mathcal{T}$  when referring to information states.)

It is furthermore assumed that both players have an overarching interest in succesful communication. Formally this cashes out as the postulate that

$$t' \neq t \Rightarrow \forall s. u_{s/r}(t, s, t) > u_{s/r}(t, s, t').$$

Players have a secondary interest in avoiding complexity. For the sender this means that she prefers short or otherwise unmarked expressions over long and marked ones. I will refrain from spelling this out in more detail. The fact that there is differential signal complexity should be uncontroversial; it underlies Grice's Maxim of Manner as well as more recent implementations such as Bidirectional Optimality Theory (cf. Blutner 2001). Pinning it down in a general way is not trivial, but I will confine myself to clear examples. Formally this is captured by a cost function  $c_s$  that maps type-signal pairs to real numbers. The assumption to make signal costs dependent on types is motivated by regularities such as TOPIC PRECEDES COMMENT that indicate that preferences over expressions may depend on the meaning that the speaker wants to express.

Likewise, the receiver may have, *ceteris paribus*, differential preferences between different interpretations of an expression – such as a dispreference for coercion or type shift, a preference for presupposition binding over accommodation etc. (cf. van der Sandt 1992). This is implemented by a cost function  $c_r$  that maps signal-action pairs to real numbers. (To my knowledge, receiver's costs as well as type-dependent sender's costs were first introduced in Franke & Jäger 2012.) In all examples discussed in this chapter, receiver costs do not properly depend on signals but only on actions.

These assumptions are implemented by the following utility functions:

$$\begin{aligned} u_s(t, s, a) &= -c_s(t, s) + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else,} \end{cases} \\ u_r(t, s, a) &= -c_r(s, a) + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else.} \end{cases} \end{aligned}$$

Unless otherwise noted, it is always assumed that costs are *nominal*. This means that costs are extremely low in comparison to the payoff that is to be gained from getting the type across correctly. They only ever play a role when comparing options that are otherwise equally successful for communication. Formally this can be ensured by the following postulate (The reason for this particular definition is the following: It will be motivated in the next section that we only need to consider strategies where the probability that a sender has to achieve succesful information transmission with a certain signal  $s$  is either

0 or  $1/n$ , for some positive integer  $n \leq |\mathcal{A}|$ . The latter occurs if the receiver maps  $s$  to one out of  $n$  different actions. The minimal difference between the success chance of two different signals is thus  $1/n - 1/(n-1)$ , which is always larger than  $|\mathcal{A}|^{-2}$ . The argument for the receiver is analogous.):

(4) NOMINAL COSTS

$$0 \leq c_s(t, s) < |\mathcal{A}|^{-2},$$

$$0 \leq c_r(s, a) < |\mathcal{S}|^{-2}.$$

In our running example differential costs play no role, and we thus assume that all costs are 0.

The game construction for an example sentence, represented as signal  $s$ , is summarized in the following definition. (An inference relation is assumed to be given, and a set of sentences is consistent if not everything can be inferred from it.)

**Definition 1 ((Strong) Interpretation Game)** *Let  $s$  be an expression that is uttered in a context  $ct$  (where a context is a set of sentences the truth of which is common knowledge between the interlocutors), and that has a set of alternatives  $ALT(s)$  such that each element thereof is consistent with  $ct$ . The strong interpretation game  $G_s^* = (\mathcal{T}, p^*, \mathcal{S}, \mathcal{A}, u_s, u_r)$  for  $s$  is constructed as follows, where  $c_s$  and  $c_r$  are nominal cost functions:*

$$\begin{aligned} \mathcal{T} &= \{t \subseteq \mathcal{S} \mid t \neq \emptyset \wedge t \cap ct \text{ is consistent} \wedge \\ &\quad \forall s' \in \mathcal{S}. t \vdash s \Rightarrow s' \in t\}, \\ p^*(t) &= \frac{1}{|\mathcal{T}|}, \\ \mathcal{S} &= ALT(s), \\ t \models s' &\Leftrightarrow s' \in t, \\ \mathcal{A} &= \mathcal{T}, \\ u_s(t, s', a) &= -c_s(t, s') + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else,} \end{cases} \\ u_r(t, s', a) &= -c_r(s', a) + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else.} \end{cases} \end{aligned}$$

### 3. Strategies and best responses

A (behavioral) strategy for the sender is a probabilistic function from types to signals. Formally, the set of sender strategies  $\Sigma$  is defined as

$$\Sigma = \mathcal{T} \mapsto \Delta(\mathcal{S}),$$

(where  $\Delta(X)$  is the set of probability distributions over the set  $X$ , i.e.  $p \in \Delta(X) \Leftrightarrow p \in X \mapsto [0, 1] \wedge \sum_{x \in X} p(x) = 1$ ). We write  $\sigma(s|t)$  rather than  $\sigma(t, s)$  to stress the intuition that this is the probability that the sender uses signal  $s$  provided she is in type  $t$ .

Likewise, the set  $P$  (speak: *Rho*) of receiver strategies consists of the probabilistic functions from  $\mathcal{S}$  to  $\mathcal{A}$ :

$$P = \mathcal{S} \mapsto \Delta(\mathcal{A})$$

where  $\rho(a|s)$  is the probability that, upon observing signal  $s$ , the receiver will perform action  $a$ .

It is important to note that these probabilities are again subjective probabilities.  $\sigma \in \Sigma$  does not model the plan of the sender, but rather the expectations the receiver has about the sender's behavioral dispositions (and likewise for  $\rho \in P$ ).

If the sender is in type  $t$  and has a model  $\rho$  of the receiver, she can estimate the utility that she can expect for each signal. This is captured by the notion of *expected utility*:

$$EU_s(s|t; \rho) = \sum_{a \in \mathcal{A}} \rho(a|s) u_s(t, s, a).$$

For the utility function defined above, this simplifies to

$$EU_s(s|t; \rho) = \rho(t|s) - c_s(t, s).$$

To estimate the receiver's expected utility upon observing a signal  $s$  given a model  $\sigma$  of the sender, one needs the probability of the types in  $\mathcal{T}$  conditional on observing  $s$ .  $\sigma$  provides the exact opposite, the conditional probability of signals given types. These two conditional probabilities are related via *Bayes' Rule*:

$$\sigma(t|s) = \frac{\sigma(s|t) p^*(t)}{\sum_{t' \in \mathcal{T}} \sigma(s|t') p^*(t')}.$$

If  $p^*$  is a uniform distribution, this simplifies to

$$\sigma(t|s) = \frac{\sigma(s|t)}{\sum_{t' \in \mathcal{T}} \sigma(s|t')}.$$

This is only defined if the denominator is  $> 0$ . If it does equal 0,  $\sigma$  assigns probability 0 to the signal  $s$  in all types  $t'$ . This would be a scenario where the receiver observes a signal that contradicts his model of the sender's behavior. Such signals are called *surprise signals*. They force the receiver to *revise his beliefs* in a way that accommodates the unexpected observation. The issue of the appropriate belief revision policy is a major issue in epistemic game theory, and I will not discuss it here at any length (see for instance Battigalli & Siniscalchi 2002). In the context of this chapter, I will adopt a rather simple version. If the receiver observes a surprise signal, he gives up all his assumptions about the sender's behavior and about costs of signals. He does preserve his knowledge about the literal interpretation of signals and about prior probabilities though. This is implemented in the following way:

$$\sigma(t|s) = \begin{cases} \frac{\sigma(s|t)}{\sum_{t' \in \mathcal{T}} \sigma(s|t')} & \text{if } \sum_{t' \in \mathcal{T}} \sigma(s|t') > 0 \\ \text{undefined} & \text{else.} \end{cases}$$

The receiver's expected utility given a model  $\sigma$  of the sender thus comes out as

$$EU_r(a | s; \sigma) = \begin{cases} \sum_{t \in T} \sigma(t | s) u_r(t, s, a) & \text{if defined} \\ \text{undefined} & \text{else.} \end{cases}$$

For the utility function given above, this simplifies to

$$EU_r(a | s; \sigma) = \begin{cases} \sigma(a | s) - c_r(s, a) & \text{if defined,} \\ \text{undefined} & \text{else.} \end{cases}$$

Rational players will play a *best response* to their model of the other player, i.e. they will always choose an option that maximizes their expected utility. If the expected utility is not defined (i.e. if the receiver observes a surprise signal), the receiver takes resort to hypothesizing that the observed signal is true. This taken into account, best responses are defined as:

$$br_r(t, \rho) = \{s \mid EU_s(s | t; \rho) = \max_{s' \in S} EU_s(s' | t; \rho)\}$$

$$br_r(s, \sigma) = \begin{cases} \{a \mid EU_r(a | s; \sigma) = \max_{a' \in A} EU_r(a' | s; \sigma)\} & \text{if } EU_r(\cdot | s; \sigma) \text{ is defined,} \\ \{a \mid a \models s\} & \text{else.} \end{cases}$$

The *best response* (singular definite) of a player to a model of the other player is the behavioral strategy that assigns equal probabilities to all best responses (due to the principle of insufficient reason), and 0 to all sub-optimal responses.

$$BR_S(\rho) = \sigma \quad \text{iff} \quad \sigma(s | t) = \begin{cases} \frac{1}{|br_S(t, \rho)|} & \text{if } s \in br_S(t, \rho), \\ 0 & \text{else} \end{cases}$$

$$BR_r(\sigma) = \rho \quad \text{iff} \quad \rho(a | s) = \begin{cases} \frac{1}{|br_r(s, \sigma)|} & \text{if } a \in br_r(s, \sigma), \\ 0 & \text{else} \end{cases}$$

Let me illustrate these notions with the running example. Suppose the receiver assumes the sender to be absolutely honest, and this is the only assumption he makes about her. A model of such a sender would be  $\sigma_0$ , who sends some true signal in each state. Applying the principle of insufficient reason again, a receiver who expects the sender to be honest but makes no further assumptions about her will assign her the following strategy:

$$\sigma_0(s | t) = \begin{cases} \frac{1}{|\{s \mid t \models s\}|} & \text{if } t \models s, \\ 0 & \text{else.} \end{cases}$$

In our little example,  $\sigma_0$  would look as in tab. 93.1.

Tab. 93.1: Honest sender  $\sigma_0$

|                          | NO | SOME          | ALL           |
|--------------------------|----|---------------|---------------|
| $w_{\neg\exists}$        | 1  | 0             | 0             |
| $w_{\exists\neg\forall}$ | 0  | 1             | 0             |
| $w_{\forall}$            | 0  | $\frac{1}{2}$ | $\frac{1}{2}$ |

The *expected utilities* of the receiver against the honest sender's strategy  $\sigma_0$  come out as given in tab. 93.2 (which is the result of flipping tab. 93.1 along the diagonal and normalizing rowwise).

Tab. 93.2:  $EU_r(\cdot | \cdot; \sigma_0)$

|      | $w_{\neg\exists}$ | $w_{\exists\neg\forall}$ | $w_{\forall}$ |
|------|-------------------|--------------------------|---------------|
| NO   | 1                 | 0                        | 0             |
| SOME | 0                 | $\frac{2}{3}$            | $\frac{1}{3}$ |
| ALL  | 0                 | 0                        | 1             |

Consider  $\rho_0 = BR_r(\sigma_0)$ , the best response of the receiver against  $\sigma_0$  from tab. 93.1. In each type, the receiver will maximize his expected utility. So in each row in tab. 93.2, he will choose a cell that is maximal within this row. If there were several such cells,  $\rho_0$  would put equal probability to each of it. In the example, the maxima are unique and thus receive a probability 1, as shown in tab. 93.3.

Tab. 93.3:  $\rho_0 = BR_r(\sigma_0)$

|      | $w_{\neg\exists}$ | $w_{\exists\neg\forall}$ | $w_{\forall}$ |
|------|-------------------|--------------------------|---------------|
| NO   | 1                 | 0                        | 0             |
| SOME | 0                 | 1                        | 0             |
| ALL  | 0                 | 0                        | 1             |

Computing the sender's expected utility against  $\rho_0$  also amounts to simply flipping the tab. along the diagonal, and the best response to  $\rho_0$  puts all probability mass into the cells with a maximal expected utility within its row (see tab. 93.4).

It is easy to see that  $BR_r(BR_s(\rho_0)) = \rho_0$ , so iterating the best response operation will not alter the strategies anymore.

Tab. 93.4:  $EU_s(\cdot | \cdot; \rho_0), BR_s(\rho_0)$

|                          | NO | SOME | ALL |
|--------------------------|----|------|-----|
| $w_{\neg\exists}$        | 1  | 0    | 0   |
| $w_{\exists\neg\forall}$ | 0  | 1    | 0   |
| $w_{\forall}$            | 0  | 0    | 1   |

|                          | NO | SOME | ALL |
|--------------------------|----|------|-----|
| $w_{\neg\exists}$        | 1  | 0    | 0   |
| $w_{\exists\neg\forall}$ | 0  | 1    | 0   |
| $w_{\forall}$            | 0  | 0    | 1   |



#### 4. Iterated Best Response

The notion of a best response models the behavior of rational players, given certain (perhaps probabilistic) assumptions about the behavior of the other player. But how are these assumptions formed? It might seem reasonable to assume that one's opponents are also rational. This means that they play a best response to their model of one's own behavior. This answer apparently only shifts the problem one step further, and this could be repeated *ad infinitum*.

The standard solution concept in classical game theory is agnostic with regard to the question where beliefs about other players come from. It is only required that beliefs are consistent with the assumption that everybody is rational (and that this fact is common knowledge). If I believe that my opponent has a correct model of my behavior and is rational, I will ascribe to them a best response to my behavior and they ascribe to me a best response to my behavior. Such a state is self-reinforcing. It is called a *Nash equilibrium*. There is no simple answer to the question though how players find such an equilibrium in the first place. This problem is aggravated by the fact that many games have many equilibria. In our example, the 1–1 map between types and signals from tab. 93.3 (together with the best response to it) constitutes an equilibrium, but so do the other five 1–1 maps, plus an infinity of properly stochastic strategy pairs.

In the present context the equilibrium concept is thus problematic because it disregards the literal meaning of signals – any 1–1 map between meanings and signals is as good as any other. Also, results from behavioral experiments suggest that people are actually not very good at finding Nash equilibria, even if there is only one. This can be illustrated with the game “*p*-beauty contest”. In this game, each of  $n$  test persons is asked to pick a (real) number between 0 and 100. The winner is the one whose choice is closest to  $p$  times the average of all numbers from the group, where  $p$  is some number that is announced in advance. Suppose  $p = 0.7$ . Then the only Nash equilibrium of the game is that everybody picks 0 (because for any other average, one could benefit by undercutting this average). This game has been tested experimentally many times, with very revealing results. For instance, Camerer & Fehr (2006) report that participants chose numbers from the entire interval  $[0, 100]$ , with peaks around 50, 35 and 25. Their interpretation is that the participants fall into three groups. The irrational players simply choose a random number without any strategic thinking. (The authors do not interpret the peak at 50, but it seems to me that this is just a variant of irrational behavior were 50 is chosen because it is located nicely in the center of the interval.) Then there are *level-1 players*. They anticipate that many people are irrational, and that their average choice is 50. The best response to this is to pick  $50 \times 0.7 = 35$ . Finally, *level-2 players* expect there to be level-1 players and play a best response to their choice. This would be  $35 \times 0.7 = 24.5$  and corresponds to the peak at 25.

Similar results have been found time and again by other researchers. (See Camerer 2003 for further information and references.) It is also interesting that the average choice quickly converges towards 0 if the game is repeated and the players get feedback about the average outcome after each round (as reported in Slonim 2005). So repeated playing seems to foster level- $k$  thinking for levels  $> 2$ .

These considerations lead to the following model: There is a default strategy that people follow if they do not deliberate. In the beauty contest game, this is the strategy to pick

randomly from the available numbers. Furthermore, there is a *cognitive hierarchy* of rational player types of ever higher sophistication. *Level-1* players play a best response to the default strategy, *level-2* players a best response to *level-1* players and so on. (Note that the level of a player does not necessarily measure their ability to perform nested reasoning. It is also bounded by their assumption about the level of their opponent.)

This architecture is readily applicable to interpretation games. The default strategy of a non-deliberating player is the honest sender  $\sigma_0$  that sends each true signal with the same probability in each type. (Jäger & Ebert 2009 and Franke 2009 also consider a default strategy for the receiver where each signal is assigned a uniform distribution over types where this signal is true. This version of the model leads to unwelcome predictions in connection with I-implicatures though. In example (7), starting with the receiver would lead to a fixed point where the I-implicature does not emerge.) A *level-0 receiver* plays the best response  $\rho_0$  to  $\sigma_0$ , a *level-1 sender* plays the best response to  $\rho_0$  and so on. This is captured by the notion of an *IBR sequence* (where *IBR* abbreviates *Iterated Best Response*).

### Definition 2 (IBR sequence)

$$\sigma_0(s | t) = \begin{cases} \frac{1}{|\{s | t \models s\}|} & \text{if } t \models s, \\ 0 & \text{else,} \end{cases}$$

$$\rho_n = BR_r(\sigma_n),$$

$$\sigma_{n+1} = BR_s(\rho_n)$$

In the running example  $\sigma_1$  is given in the left panel of tab. 93.4. For all  $n > 1$ ,  $\sigma_n = \sigma_1$  and  $\rho_n = \rho_0$ . The strategy pair  $(\sigma_1, \rho_0)$  is a fixed point of the IBR sequence and thus a Nash equilibrium. It can be shown that with a utility function as given in Equation (1) and nominal costs, the IBR sequence always reaches a fixed point (see Appendix).

Let  $s$  be an expression and  $\mathcal{G}(s)$  the interpretation game constructed for  $s$ . Let  $(\sigma^*, \rho^*)$  be the fixed point of the IBR sequence. The IBR model then predicts that  $s$  receives as possible readings the set  $\{a | \rho^*(a|s) > 0\}$ . For the running example, the prediction is thus that *Some boys came to the party* will be interpreted as entailing that not all boys came to the party. As this game is constructed from expression (2.), it does not serve to make predictions about the interpretation of the alternative expressions (even though in this example these predictions would be correct). Also, the model is not designed to make predictions about speaker behavior, so it is not claimed that a speaker who wants to express that some but not all boys came will use expression (2.).

## 5. Examples

The previous example illustrated how scalar implicatures are derived in the IBR model. Here is another example of a quantity implicature:

- (5) (Who of Ann and Bert came to the party?) Ann came to the party.

The question defines a set of alternative answers:

- (6) a. Ann came to the party. (= ANN)  
 b. Bert came to the party. (= BERT)  
 c. Neither came to the party. (= NEITHER)  
 d. Both came to the party. (= BOTH)

They define four possible worlds (i.e. maximally consistent sets of alternatives or their negations): Only Ann came ( $w_a$ ), only Bert came ( $w_b$ ), neither came ( $w_\emptyset$ ) or both came ( $w_{a,b}$ ).  $\sigma_0$  is constructed in the following way:

- Draw a table with types as rows and expressions as columns.
- Put a 1 in each cell where the column-expression is true in the row-world, and 0 everywhere else.
- Divide each row by its sum.

The result is shown in tab. 93.5.

Tab. 93.5:  $\sigma_0$

|               | ANN           | BERT          | NEITHER | BOTH          |
|---------------|---------------|---------------|---------|---------------|
| $w_a$         | 1             | 0             | 0       | 0             |
| $w_b$         | 0             | 1             | 0       | 0             |
| $w_\emptyset$ | 0             | 0             | 1       | 0             |
| $w_{ab}$      | $\frac{1}{3}$ | $\frac{1}{3}$ | 0       | $\frac{1}{3}$ |

The table for the best response  $BR_r(\sigma)$  to some sender strategy  $\sigma$  can be constructed by the following operations:

- Flip the table for  $\sigma$  along the main diagonal.
- If a row consists only of 0s, replace each cell corresponding to a true type-signal association with 1.
- Otherwise subtract receiver costs from each cell, replace each cell that is maximal within its row by 1, and every other cell by 0.
- Divide each row by its sum.

Note that the best response to a surprise signal (a column with only 0s in a receiver strategy) only makes use of the literal meaning of that signal and disregards costs. This reflects the fact that surprise signals enforce belief revision. In the present model, speakers only preserve their knowledge about the literal meanings of signals under belief revision and delete all other information.

The table for the best response  $BR_s(\rho)$  to some receiver strategy  $\rho$  can be computed by the following steps:

- Flip the table for  $\rho$  along the main diagonal.
- Subtract sender costs from each cell.

- Replace each cell that is maximal within its row by 1, and all other cells by 0.
- Divide each row by its sum.

The strategy  $\sigma_1 = BR_s(\rho_0)$  is given in tab. 93.6.

Tab. 93.6:

| $\rho_0$ | $w_a$ | $w_b$ | $w_\emptyset$ | $w_{ab}$ | $\sigma_1$    | ANN | BERT | NEITHER | BOTH |
|----------|-------|-------|---------------|----------|---------------|-----|------|---------|------|
| ANN      | 1     | 0     | 0             | 0        | $w_a$         | 1   | 0    | 0       | 0    |
| BERT     | 0     | 1     | 0             | 0        | $w_a$         | 0   | 1    | 0       | 0    |
| NEITHER  | 0     | 0     | 1             | 0        | $w_\emptyset$ | 0   | 0    | 1       | 0    |
| BOTH     | 0     | 0     | 0             | 1        | $w_{ab}$      | 0   | 0    | 0       | 1    |

$(\sigma_1, \rho_0)$  form a fixed point. Hence the model predicts that (5.) is interpreted exhaustively, i.e. in the sense that Ann but not Bert came to the party.

The two examples illustrate the general pattern of *quantity implicatures*. If an expression  $A$  has an alternative  $B$  that is logically stronger than  $A$ , then in the fixed point  $A$  will be interpreted exhaustively, i.e. as entailing “ $A$  and not  $B$ ”.

This inference may be blocked though if the alternative set already contains an expression which literally denotes “ $A$  and not  $B$ ”. This may be illustrated with the next example.

- (7) a. John opened the door. (= OPEN)  
 b. John opened the door using the handle. (= OPEN-H)  
 c. John opened the door with an axe. (= OPEN-A)

Normally (7a) will be interpreted as meaning (7b) rather than (c). This is an instance of an inference type that Levinson (2000) calls *I-implicatures* – underspecified expressions tend to be interpreted as the prototypical elements of their literal denotation.

Suppose (b) and (c) are expression alternatives in the interpretation game for (a), and suppose that the only ways to open a door is with the handle or with an axe. (This example is a bit more abstract than the previous two, first because the set of alternatives along the lines of (7c) is actually open-ended, and second because these alternatives are arguably not activated in the same way when interpreting (a) as for instance the scalar alternatives are in the first example. Nevertheless the example is instructive to illustrate the logic of the IBR model.) Under these assumptions, there are just two possible worlds:  $w_h$  where John opens the door with the handle, and  $w_a$  where he uses an axe. (Recall that the possible worlds are maximally consistent sets of alternatives or negations thereof *that contain at least one non-negated expression*. Therefore the alternatives do not generate a world where John does not open the door at all.)

In this example costs play a role. The implicature arises because (7a) is shorter than both (b) and (c), and because  $w_h$  is more prototypical than  $w_a$ . Let us thus say that the costs are as given in tab. 93.7, where the first number in each cell give the sender’s cost and the second the receiver’s. The actual choice of numbers is inessential for the IBR sequence. As long as costs are sufficiently small, only the relative ranking of the different alternative types and expressions according to their costs matters.

The construction of  $\sigma_0$  follows the same procedure as explained above.

Tab. 93.7: Cost functions

| $c_s, c_r$ | OPEN              | OPEN-H                       | OPEN-A                       |
|------------|-------------------|------------------------------|------------------------------|
| $w_h$      | 0, 0              | $\frac{1}{20}, 0$            | $\frac{1}{20}, 0$            |
| $w_a$      | $0, \frac{1}{20}$ | $\frac{1}{20}, \frac{1}{20}$ | $\frac{1}{20}, \frac{1}{20}$ |

The IBR sequence for example (7) is given in tab. 93.8. The fixed point is  $(\sigma_1, \rho_1)$ . The signal OPEN is interpreted as the proposition  $\{w_h\}$ , i.e. as expressing that John opened the door using the handle.

Tab. 93.8: IBR sequence

| $\sigma_0$ | OPEN          | OPEN-H        | OPEN-A        |
|------------|---------------|---------------|---------------|
| $w_h$      | $\frac{1}{2}$ | $\frac{1}{2}$ | 0             |
| $w_a$      | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ |
| $\sigma_1$ | OPEN          | OPEN-H        | OPEN-A        |
| $w_h$      | 1             | 0             | 0             |
| $w_a$      | 0             | 0             | 1             |

| $\rho_0$ | $w_h$ | $w_a$ |
|----------|-------|-------|
| OPEN     | 1     | 0     |
| OPEN-H   | 1     | 0     |
| OPEN-A   | 0     | 1     |
| $\rho_1$ | $w_h$ | $w_a$ |
| OPEN     | 1     | 0     |
| OPEN-H   | 1     | 0     |
| OPEN-A   | 0     | 1     |

Note that this outcome depends both on differential costs between the different signals and the fact that the more specific signals jointly exhaust the meaning of the more general signal. If OPEN would not entail  $\text{OPEN-H} \vee \text{OPEN-A}$ , there would be a third type  $w^*$  where John opened the door, but neither with the handle nor with an axe, and OPEN would be interpreted as  $\{w^*\}$ , i.e. we would observe a quantity implicature rather than an I-implicature.

A similar but slightly more complex inference pattern has been called *M-implicature* or *division of pragmatic labor* (Horn 1984). An example is given in (8).

- (8)    a. John stopped the car. (= STOP)  
         b. John made the car stop. (= MAKE-STOP)

Normally (8a) is interpreted as referring to an event where John stopped the car in the usual way, i.e. using the foot brake, while (b) rather conveys that he stopped it in a less conventional way, such as using the hand brake or driving into the ditch.

The following game is again more of an illustration of the working of the IBR model than a serious attempt to analyze this particular linguistic example. Suppose there are two possible worlds: in  $w_1$  John stops the car using the foot brake, and in  $w_2$  he drives it into the ditch. These

are the only ways to stop the car. Both STOP and MAKE-STOP are true in both worlds. The receiver has, *ceteris paribus*, a preference for  $w_1$  over  $w_2$ , which is mirrored by the fact the latter has higher receiver costs than the former. Likewise, the sender has a preference for STOP over MAKE-STOP, which is mirrored in the cost function. The cost functions are given in tab. 93.9.

Tab. 93.9: Cost functions

| $c_s, c_r$ | STOP              | MAKE-STOP                    |
|------------|-------------------|------------------------------|
| $w_1$      | 0, 0              | $\frac{1}{10}, 0$            |
| $w_2$      | $0, \frac{1}{10}$ | $\frac{1}{10}, \frac{1}{10}$ |

Tab. 93.10 shows the IBR sequence for this game. In the fixed point  $(\sigma_2, \rho_2)$ , STOP is interpreted as  $\{w_1\}$  and make-stop as  $\{w_2\}$ .

Tab. 93.10: IBR sequence

| $\sigma_0$ | STOP          | MAKE-STOP     |
|------------|---------------|---------------|
| $w_1$      | $\frac{1}{2}$ | $\frac{1}{2}$ |
| $w_2$      | $\frac{1}{2}$ | $\frac{1}{2}$ |

| $\sigma_1$ | STOP | MAKE-STOP |
|------------|------|-----------|
| $w_1$      | 1    | 0         |
| $w_2$      | 1    | 0         |

| $\sigma_2$ | STOP | MAKE-STOP |
|------------|------|-----------|
| $w_1$      | 1    | 0         |
| $w_2$      | 0    | 1         |

| $\rho_0$  | $w_1$ | $w_2$ |
|-----------|-------|-------|
| STOP      | 1     | 0     |
| MAKE-STOP | 1     | 0     |

| $\rho_1$  | $w_1$         | $w_2$         |
|-----------|---------------|---------------|
| STOP      | 1             | 0             |
| MAKE-STOP | $\frac{1}{2}$ | $\frac{1}{2}$ |

| $\rho_2$  | $w_1$ | $w_2$ |
|-----------|-------|-------|
| STOP      | 1     | 0     |
| MAKE-STOP | 0     | 1     |

6. Game construction II: Lifted games

In its present version, our model assumes a very strong version of the competence assumption: it is hard-wired into the model that the speaker knows the complete answer to the question under discussion. This is not just unrealistic, it also leads to unwarranted predictions. Consider (9), the standard example for a quantity implicature.

- (9)   a. Ann or Bert showed up. (= OR)  
      b. Ann showed up. (= A)  
      c. Bert showed up. (= B)  
      d. Ann and Bert showed up. (= AND)

Since Grice (1975) it is a common assumption that *or* literally denotes inclusive disjunction, and that the exclusive interpretation is due to a quantity implicature, arising from the competition with *and*. If we assume that the alternative set to (9) is (9a–d), we end up with a game that is represented by  $\sigma_0$  in tab. 93.11.

Tab. 93.11: IBR sequence

| $\sigma_0$ | OR            | A             | B             | AND           |
|------------|---------------|---------------|---------------|---------------|
| $w_a$      | $\frac{1}{2}$ | $\frac{1}{2}$ | 0             | 0             |
| $w_b$      | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| $w_{ab}$   | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ |
| $\sigma_1$ | OR            | A             | B             | AND           |
| $w_a$      | 0             | 1             | 0             | 0             |
| $w_b$      | 0             | 0             | 1             | 0             |
| $w_{ab}$   | 0             | 0             | 0             | 1             |

| $\rho_0$ | $w_a$         | $w_b$         | $w_{ab}$      |
|----------|---------------|---------------|---------------|
| OR       | $\frac{1}{2}$ | $\frac{1}{2}$ | 0             |
| A        | 1             | 0             | 0             |
| B        | 0             | 1             | 0             |
| AND      | 0             | 0             | 1             |
| $\rho_1$ | $w_a$         | $w_b$         | $w_{ab}$      |
| OR       | $\frac{1}{3}$ | $\frac{1}{3}$ | $\frac{1}{3}$ |
| A        | 1             | 0             | 0             |
| B        | 0             | 1             | 0             |
| AND      | 0             | 0             | 0             |

In the fixed point  $(\sigma_1, \rho_1)$ , OR receives the inclusive interpretation. What is even more odd is that OR is a surprise signal, because it is never used in  $\sigma_1$ . This is a consequence of the strong competence assumption. For each of the three maximally informative information states assumed here, there is a more specific signal, so OR is in fact superfluous in this game.

To adequately deal with examples like this, we have to take the possibility into account that the sender is underinformed. This can be accommodated if we identify information states, i.e. types, with non-empty *sets* of possible worlds (as it is standard practice since Stalnaker 1978). Franke (2009) calls this kind of game *epistemically lifted games*. So if  $W$  is the set of worlds that is constructed from a set of alternative expressions,

$$\mathcal{T} = POW(W) - \{\emptyset\}.$$

An expression is considered true in a state if it is true in all possible worlds in this state, i.e.

$$t \models s \text{ iff } \forall w \in t. w \models s.$$

The competence assumption is not completely given up though. A weaker version of it is implemented via the receiver's cost function. Everything else being equal, the receiver has a preference for more specific interpretations (cf. Dalrymple et al.'s 1994 *Strongest Meaning Hypothesis*). This corresponds to the *weak competence assumption*

$$a_1 \subseteq a_2 \Rightarrow \forall s. c_r(s, a_1) < c_r(s, a_2).$$

For concreteness' sake, let us say that

$$\forall s. c(s, a) \propto |a|.$$

Applied to example (9), this leads to the following cost functions (It is assumed that AND and OR are more complex than A and B for the sender, but nothing hinges on this in this example.):

$$\begin{aligned}\forall t.c_s(t, A) &= c_s(t, B) = 0, \\ \forall t.c_s(t, \text{AND}) &= c_s(t, \text{OR}) = \frac{1}{100}, \\ \forall s.c_r(s, a) &= \frac{|a|}{1000}.\end{aligned}$$

The IBR sequence is given in tab. 93.12.

The fixed point here is  $(\sigma, \rho_0)$ . Two things are noteworthy in this example. First, the construction correctly predicts that or receives an exclusive interpretation. Second, the usage of or triggers an ignorance implicature. In the fixed point strategy, the receiver infers from observing or that the sender does not know a for sure, and she doesn't know b for sure either.

The game construction for lifted interpretation games is summarized in the following definition. These games are called *weak interpretation games* because they implement the *weak competence assumption*. Strong interpretation games emerge as the special case

Tab. 93.12: IBR sequence in the epistemically lifted game

| $\sigma_0$             | OR            | A             | B             | AND           |
|------------------------|---------------|---------------|---------------|---------------|
| $\{w_a\}$              | $\frac{1}{2}$ | $\frac{1}{2}$ | 0             | 0             |
| $\{w_b\}$              | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| $\{w_{ab}\}$           | $\frac{1}{2}$ | 0             | 0             | $\frac{1}{2}$ |
| $\{w_a, w_b\}$         | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ |
| $\{w_a, w_{ab}\}$      | $\frac{1}{2}$ | $\frac{1}{2}$ | 0             | 0             |
| $\{w_b, w_{ab}\}$      | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| $\{w_a, w_b, w_{ab}\}$ | 1             | 0             | 0             | 0             |

| $\sigma_0$ | $\{w_a\}$ | $\{w_b\}$ | $\{w_{ab}\}$ | $\{w_a, w_b\}$ | $\{w_a, w_{ab}\}$ | $\{w_b, w_{ab}\}$ | $\{w, w_b, w_{ab}\}$ |
|------------|-----------|-----------|--------------|----------------|-------------------|-------------------|----------------------|
| OR         | 0         | 0         | 0            | 1              | 0                 | 0                 | 0                    |
| A          | 1         | 0         | 0            | 0              | 0                 | 0                 | 0                    |
| B          | 0         | 1         | 0            | 0              | 0                 | 0                 | 0                    |
| AND        | 0         | 0         | 1            | 0              | 0                 | 0                 | 0                    |



| $\sigma_0$             | OR | A             | B             | AND |
|------------------------|----|---------------|---------------|-----|
| $\{w_a\}$              | 0  | 1             | 0             | 0   |
| $\{w_b\}$              | 0  | 0             | 1             | 0   |
| $\{w_{ab}\}$           | 0  | 0             | 0             | 1   |
| $\{w_a, w_b\}$         | 1  | 0             | 0             | 0   |
| $\{w_a, w_{ab}\}$      | 0  | $\frac{1}{2}$ | $\frac{1}{2}$ | 0   |
| $\{w_b, w_{ab}\}$      | 0  | $\frac{1}{2}$ | $\frac{1}{2}$ | 0   |
| $\{w_a, w_b, w_{ab}\}$ | 0  | $\frac{1}{2}$ | $\frac{1}{2}$ | 0   |

when the context contains the assumption that the speaker knows the complete answer to the question under discussion.

**Definition 3 (Weak Interpretation Game)** Let  $s$  be an expression that is uttered in a context  $ct$  and that has a set of alternatives  $ALT(s)$  such that each element thereof is consistent with  $ct$ . The weak interpretation game  $G_s = (\mathcal{T}, p^*, S, \mathcal{A}, u_s, u_r)$  for  $s$  is constructed as follows, where  $c_s$  and  $c_r$  are nominal cost functions:

$$\begin{aligned}
 \mathcal{W} &= \{w \subseteq S \mid w \neq \emptyset \wedge w \cap ct \text{ is consistent} \wedge \\
 &\quad \forall s' \in S, w \vdash s \Rightarrow s' \in w\}, \\
 \mathcal{T} &= POW(W) - \{\emptyset\} \\
 p^*(t) &= \frac{1}{|\mathcal{T}|}, \\
 S &= ALT(s), \\
 t \vdash s' &\Leftrightarrow \forall w \in \mathcal{T}. s' \in w, \\
 \mathcal{A} &= \mathcal{T} \\
 u_s(t, s', a) &= -c_s(t, s') + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else,} \end{cases} \\
 u_r(t, s', a) &= -c_r(s', a) + \begin{cases} 1 & \text{if } t = a, \\ 0 & \text{else,} \end{cases} \\
 a_1 \subseteq a_2 &\Rightarrow \forall s' \in S. c_r(s', a_1) < c_r(s', a_2).
 \end{aligned}$$

The difference between the strong and the weak competence assumption may be significant. This applies for instance to *free choice permission* sentences such as (10a) (cf. Kamp 1973):

- (10) a You may take an apple or a banana. ( $= \Diamond(A \vee B)$ )  
 b You may take an apple. ( $= \Diamond A$ )

- c. You may take a banana. ( $= \Diamond B$ )
- d. You may take and apple and a banana. ( $= \Diamond(A \wedge B)$ )

Sentence (a) normally receives a *free choice* interpretation: You may take an apple, and you may take a banana. Furthermore the sentence implicates that the addressee is not allowed to take both an apple and a banana.

The free choice interpretation rests on the background assumption that the speaker is the one who grants the permission. This of course entails that the speaker is maximally competent about the permission state of the addressee. If the speaker simply reports the permission that somebody else granted (enforced for instance by the continuation *but I don't know which*), the free choice inference does not emerge. The disjunction still preferably receives an exhaustive interpretation – the addressee is not allowed to take both kinds of fruit simultaneously.

Let us construct an interpretation game for (10a). It seems reasonable to assume that the alternatives to (10a) are (10b-d), which are taken to have the logical forms which are given in brackets. If we assume the standard inference relation for modal logic (system *K*), we have four possible worlds here:

- $w_a = \{\Diamond A, \Diamond(A \vee B)\}$ : You may take an apple but not a banana.
- $w_b = \{\Diamond B, \Diamond(A \vee B)\}$ : You may take a banana but not an apple.
- $w_{a,b} = \{\Diamond A, \Diamond B, \Diamond(A \vee B)\}$ : You may take an apple and you may take a banana, but not both.
- $w_{ab} = \{\Diamond A, \Diamond B, \Diamond(A \vee B), \Diamond(A \wedge B)\}$ : You may take both an apple and a banana.

(10a,d) are longer than (b,c), so it is reasonable to assume that they have higher costs. Let us say that  $c(t, \Diamond(A)) = c(t, \Diamond(B)) = 0$  and  $c(t, \Diamond(A \vee B)) = c(t, \Diamond(A \wedge B)) = \frac{1}{1000}$ .

Under the strong competence assumption, the IBR sequence comes out as in tab. 93.13.

In the fixed point  $(\sigma_2, \rho_2)$ , (10a) correctly comes out as having the exhaustive free choice interpretation “You may take an apple and you may take a banana, but not both.”

Tab. 93.13: IBR sequence

| $\sigma_0$ | $\Diamond(A \vee B)$ | $\Diamond A$  | $\Diamond B$  | $\Diamond(A \wedge B)$ | $\rho_0$               | $w_a$         | $w_b$         | $w_{a,b}$ | $w_{ab}$ |
|------------|----------------------|---------------|---------------|------------------------|------------------------|---------------|---------------|-----------|----------|
| $w_a$      | $\frac{1}{2}$        | $\frac{1}{2}$ | 0             | 0                      | $\Diamond(A \vee B)$   | $\frac{1}{2}$ | $\frac{1}{2}$ | 0         | 0        |
| $w_b$      | $\frac{1}{2}$        | 0             | $\frac{1}{2}$ | 0                      | $\Diamond A$           | 1             | 0             | 0         | 0        |
| $w_{a,b}$  | $\frac{1}{3}$        | $\frac{1}{3}$ | $\frac{1}{3}$ | 0                      | $\Diamond B$           | 0             | 1             | 0         | 0        |
| $w_{ab}$   | $\frac{1}{3}$        | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$          | $\Diamond(A \wedge B)$ | 0             | 0             | 0         | 1        |

| $\sigma_1$ | $\Diamond(A \vee B)$ | $\Diamond A$  | $\Diamond B$  | $\Diamond(A \wedge B)$ |
|------------|----------------------|---------------|---------------|------------------------|
| $w_a$      | 0                    | 1             | 0             | 0                      |
| $w_b$      | 0                    | 0             | 1             | 0                      |
| $w_{a,b}$  | 0                    | $\frac{1}{2}$ | $\frac{1}{2}$ | 0                      |
| $w_{ab}$   | 0                    | 0             | 1             | 1                      |
| $\sigma_2$ | $\Diamond(A \vee B)$ | $\Diamond A$  | $\Diamond B$  | $\Diamond(A \wedge B)$ |
| $w_a$      | 0                    | 1             | 0             | 0                      |
| $w_b$      | 0                    | 0             | 1             | 0                      |
| $w_{a,b}$  | 1                    | 0             | 0             | 0                      |
| $w_{ab}$   | 0                    | 0             | 0             | 1                      |

| $\rho_1$               | $w_a$         | $w_b$         | $w_{a,b}$     | $w_{ab}$      |
|------------------------|---------------|---------------|---------------|---------------|
| $\Diamond(A \vee B)$   | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$ |
| $\Diamond A$           | 1             | 0             | 0             | 0             |
| $\Diamond B$           | 0             | 1             | 0             | 0             |
| $\Diamond(A \wedge B)$ | 0             | 0             | 0             | 1             |
| $\rho_2$               | $w_a$         | $w_b$         | $w_{a,b}$     | $w_{ab}$      |
| $\Diamond(A \vee B)$   | 0             | 0             | 1             | 0             |
| $\Diamond A$           | 1             | 0             | 0             | 0             |
| $\Diamond B$           | 0             | 1             | 0             | 0             |
| $\Diamond(A \wedge B)$ | 0             | 0             | 0             | 1             |

Now suppose the strong competence assumption is replaced by its weak counterpart. This would be a scenario where the sender is not the person granting the permission, but just somebody who has information about the addressee’s permission state. Then we end up with fifteen information states. For reasons of space, I will only show the the five of

Tab. 93.14: IBR sequence

| $\sigma_0$     | $\Diamond(A \vee B)$ | $\Diamond A$  | $\Diamond B$  | $\Diamond(A \wedge B)$ |
|----------------|----------------------|---------------|---------------|------------------------|
| $\{w_a\}$      | $\frac{1}{2}$        | $\frac{1}{2}$ | 0             | 0                      |
| $\{w_b\}$      | $\frac{1}{2}$        | 0             | $\frac{1}{2}$ | 0                      |
| $\{w_{a,b}\}$  | $\frac{1}{3}$        | $\frac{1}{3}$ | $\frac{1}{3}$ | 0                      |
| $\{w_{ab}\}$   | $\frac{1}{4}$        | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$          |
| $\{w_a, w_a\}$ | 1                    | 0             | 0             | 0                      |
| $\vdots$       | $\vdots$             | $\vdots$      | $\vdots$      | $\vdots$               |

| $\rho_0$               | $\{w_a\}$ | $\{w_b\}$ | $\{w_{a,b}\}$ | $\{w_{ab}\}$ | $\{w_a, w_b\}$ | ... |
|------------------------|-----------|-----------|---------------|--------------|----------------|-----|
| $\Diamond(A \vee B)$   | 0         | 0         | 0             | 0            | 1              | ... |
| $\Diamond A$           | 1         | 0         | 0             | 0            | 0              | ... |
| $\Diamond B$           | 0         | 1         | 0             | 0            | 0              | ... |
| $\Diamond(A \wedge B)$ | 0         | 0         | 0             | 1            | 0              | ... |

| $\sigma_1$     | $\Diamond(A \vee B)$ | $\Diamond A$  | $\Diamond B$  | $\Diamond(A \wedge B)$ |
|----------------|----------------------|---------------|---------------|------------------------|
| $\{w_a\}$      | 0                    | 1             | 0             | 0                      |
| $\{w_b\}$      | 0                    | 0             | 1             | 0                      |
| $\{w_{a,b}\}$  | 0                    | $\frac{1}{2}$ | $\frac{1}{2}$ | 0                      |
| $\{w_{ab}\}$   | 0                    | 0             | 0             | 1                      |
| $\{w_a, w_b\}$ | 1                    | 0             | 0             | 0                      |
| $\vdots$       | $\vdots$             | $\vdots$      | $\vdots$      | $\vdots$               |

them which are relevant (see tab. 93.14). Here a fixed point is already reached at  $(\sigma_i, \rho_0)$ . In this fixed point, (10a) is interpreted as  $\Diamond A \leftrightarrow \neg \Diamond B$ , i.e. we get an ordinary exclusive wide scope interpretation for the disjunction plus an ignorance implicature (the speaker does not know whether the addressee may take an apple or whether he may take a banana), rather than a free choice reading.

## 7. Embedded implicatures

Chierchia (2004) makes a case that scalar implicatures are actually not the outcome of a Gricean reasoning procedure that is based on rationality assumptions. Rather, he proposes that these inferences are strictly speaking not implicatures at all, but rather part of the literal meaning of the sentence in question. He motivates this, among other arguments, with examples such as (11).

- (11) a. Kai had broccoli or some of the peas. ( $B \vee \exists xPx$ )  
 b. Kai had broccoli or all of the peas. ( $B \vee \forall xPx$ )

The argument runs as follows. Let  $A$  be an expression which competes with a logically stronger scalar alternative  $B$ . According to the Gricean view, if the speaker would believe that  $B$ , he would have said so. Since she didn't say it, she doesn't believe it. If she is also competent, we can conclude that she does not believe that  $B$ , and thus  $B$  is false. If this is applied to (11a), we have a scalar alternative (11b), which is logically stronger. Hence there should be an implicature to the effect that (11b) is false, i.e. that Kai didn't have broccoli and didn't eat all of the peas.

However, the (a)-sentence does not implicate that Kai didn't have broccoli. What is implicated is much weaker, namely that Kai had broccoli or he had some *but not all* of the peas. The strengthening of *some* to *some but not all* happens within the scope of the disjunction. Chierchia and his followers conclude from this that the information *he did not eat all of the peas* is part of the truth conditions of the second disjunct.

This is not the place to explore the issue whether or not implicatures are computed locally. (An extensive discussion from a neo-Gricean point of view can be found in Geurts

2010.) I will confine myself to showing why Chierchia's argument does not apply to the kind of pragmatic reasoning that is formalized by the IBR model.

As pointed out by Sauerland (2004), the alternatives that have to be taken into consideration when evaluating (11a) also include the sentences in (12).

- (12) a. Kai had broccoli. ( $= B$ )  
 b. Kai had some of the peas. ( $= \exists xPx$ )  
 c. Kai had all of the peas. ( $= \forall xPx$ )  
 d. Kai had broccoli and some of the peas. ( $= B \wedge \exists xPx$ )  
 e. Kai had broccoli and all of the peas. ( $= B \wedge \forall xPx$ )

These seven alternatives give rise to five different possible worlds:

- $w_{B \neg \exists} = \{B, B \vee \exists xPx, B \vee \forall xPx\}$ ,
- $w_{\neg B \exists \neg \forall} = \{\exists xPx, B \vee \exists xPx\}$ ,
- $w_{\neg B \forall} = \{\exists xPx, \forall xPx, B \vee \exists xPx, B \vee \forall xPx\}$ ,
- $w_{B \exists \neg \forall} = \{B, \exists xPx, B \vee \exists xPx, B \vee \forall xPx, B \wedge \exists xPx\}$ ,
- $w_{B \forall} = \{B, \exists xPx, B \vee \exists xPx, B \vee \forall xPx, B \wedge \exists xPx, B \wedge \forall xPx\}$ .

As the strong competence assumption is not warranted in this example, we have to construct a weak interpretation game, which has 31 different types. For reasons of space I will only present the IBR reasoning for the relevant subset thereof, which are seven types in this case. These are the five maximally informative types, plus two types consisting of two possible worlds each. These seven types are the only relevant ones in the sense that all other types have probability 0 for each signal under each  $\rho_n$  in the IBR sequence. The first two steps of the IBR sequence are given in tab. 93.15. The relevant part of  $\sigma_1$  is simply the transpose of the displayed part of  $\rho_{\emptyset'}$  and  $(\sigma_1, \rho_{\emptyset'})$  form a fixed point.

Tab. 93.15: IBR sequence

| $\sigma_0$                                                | $B$           | $\exists xPx$ | $\forall xPx$ | $B \vee \exists xPx$ | $B \wedge \exists xPx$ | $B \vee \forall xPx$ | $B \wedge \forall xPx$ |
|-----------------------------------------------------------|---------------|---------------|---------------|----------------------|------------------------|----------------------|------------------------|
| $\{w_{B \neg \exists}\}$                                  | $\frac{1}{3}$ | 0             | 0             | $\frac{1}{3}$        | 0                      | $\frac{1}{3}$        | 0                      |
| $\{w_{\neg B \exists \neg \forall}\}$                     | 0             | $\frac{1}{2}$ | 0             | $\frac{1}{2}$        | 0                      | 0                    | 0                      |
| $\{w_{\neg B \forall}\}$                                  | 0             | $\frac{1}{4}$ | $\frac{1}{4}$ | $\frac{1}{4}$        | 0                      | $\frac{1}{4}$        | 0                      |
| $\{w_{B \exists \neg \forall}\}$                          | $\frac{1}{5}$ | $\frac{1}{5}$ | 0             | $\frac{1}{5}$        | $\frac{1}{5}$          | $\frac{1}{5}$        | 0                      |
| $\{w_{B \forall}\}$                                       | $\frac{1}{7}$ | $\frac{1}{7}$ | $\frac{1}{7}$ | $\frac{1}{7}$        | $\frac{1}{7}$          | $\frac{1}{7}$        | $\frac{1}{7}$          |
| $\{w_{B \neg \forall}, w_{\neg B \exists \neg \forall}\}$ | 0             | 0             | 0             | 1                    | 0                      | 0                    | 0                      |
| $\{w_{B \neg \exists}, w_{\neg B \forall}\}$              | 0             | 0             | 0             | $\frac{1}{2}$        | 0                      | $\frac{1}{2}$        | 0                      |

| $\rho_0$               | $\{w_{B \neg \exists}\}$ | $\{w_{\neg B \exists \neg \forall}\}$ | $\{w_{\neg B \forall}\}$ | $\{w_{B \exists \neg \forall}\}$ | $\{w_{B \forall}\}$ | $\{w_{B \neg \forall}, w_{\neg B \exists \neg \forall}\}$ | $\{w_{B \neg \exists}, w_{\neg B \forall}\}$ |
|------------------------|--------------------------|---------------------------------------|--------------------------|----------------------------------|---------------------|-----------------------------------------------------------|----------------------------------------------|
| B                      | 1                        | 0                                     | 0                        | 0                                | 0                   | 0                                                         | 0                                            |
| $\exists xPx$          | 0                        | 1                                     | 0                        | 0                                | 0                   | 0                                                         | 0                                            |
| $\forall xPx$          | 0                        | 0                                     | 1                        | 0                                | 0                   | 0                                                         | 0                                            |
| $B \vee \exists xPx$   | 0                        | 0                                     | 0                        | 0                                | 0                   | 1                                                         | 0                                            |
| $B \wedge \exists xPx$ | 0                        | 0                                     | 0                        | 1                                | 0                   | 0                                                         | 0                                            |
| $B \vee \forall xPx$   | 0                        | 0                                     | 0                        | 0                                | 0                   | 0                                                         | 1                                            |
| $B \wedge \forall xPx$ | 0                        | 0                                     | 0                        | 0                                | 1                   | 0                                                         | 0                                            |

As can be seen from the fourth row of  $\rho_0$ , (11a) is interpreted as  $\{w_{B \neg \exists}, w_{\neg B \exists \neg \forall}\}$ . This means that either Kai ate broccoli or some but not all of the peas, but not both, and the speaker does not know which. The IBR model thus predicts a narrow scope exhaustive interpretation of *some*, an exclusive interpretation of *or* and an ignorance implicature, which is empirically correct.

It is illuminating to explore why Chierchia's problem does not apply here. It is true that the sender could have uttered  $B \vee \forall xPx$ , but she did not do so. There may be more than one reason though why she avoided that signal. In  $w_{B \neg \exists}$  she believes it to be true but prefers to utter B, because it is more informative. In  $w_{\neg B \exists \neg \forall}$  she prefers  $\forall xPx$ , for the same reason. In  $w_{B \exists \neg \forall}$  she prefers  $B \wedge \exists xPx$ , again for the same reason. In  $w_{B \forall}$ , finally, she prefers the more informative  $B \wedge \forall xPx$ . So if the speaker is maximally competent, she would never utter (11b). The most plausible explanation for her using that signal would be that she is in state  $\{w_{B \neg \exists}, w_{\neg B \forall}\}$ , i.e. she believes that Kai either had broccoli but no peas or all peas but no broccoli, but not both. The fact that she refrained from using this signal thus only entails that she doesn't hold this belief state, which is consistent with the intuitive interpretation of (11a).

## 8. Beyond nominal costs

In the model presented so far, the main objective of the players is to achieve correct information transmission. If the receiver guesses the sender's type correctly, both score a utility close to 1; otherwise their utility is close to 0. There are various domains where the degree of communicative success is not binary. If the sender wants to communicate that the temperature is 21 degree and the receiver guesses that the temperature is 20 degree, information transmission was not perfect, but much better than in a scenario where the receiver guesses 10 degree. Quite generally, there may be a graded notion of *similarity* between types, and the goal of communication is to maximize the similarity between the sender's type and receiver's action. (This idea has been explored in detail in Jäger & van Rooij 2007; Jäger 2007a; Jäger, Koch-Metzger & Riedel 2011.) If the degree of similarity between types is continuous, there may be scenarios where the expected gain in communicative success for choosing a more costly signal is lower than the increase in costs. This means that costs are not always nominal anymore. The consequences of this approach are explored in the final example of this article.

Krifka (2002) observes that the pragmatic interpretation of number words follows an interesting pattern:

“RN/RI principle:

- a. Short, simple numbers suggest low precision levels.
- b. Long, complex numbers suggest high precision levels.”

(Krifka 2002: 433)

This can be illustrated with the following contrast:

- (13) a. The distance is one hundred meters. (= 100)  
 b. The distance is one hundred and one meter. (= 101)

The sentence (13b) suggests a rather precise interpretation (with a slack of at most 50 cm), while (13a) can be more vague. It may perhaps mean something between 90 and 110 meter. Actually, (13a) is pragmatically ambiguous; depending on context, it can be rather precise or rather vague. The crucial observation here is: A shorter number term such as “one hundred” allows for a larger degree of vagueness than a more complex term such as “one hundred and one.”

Krifka also observes that the degree of vagueness of a short term can be reduced by making it more complex – for instance by modifying it with “exactly”:

- (14) The distance is exactly one hundred meter. (= EX-100)

Krifka (2002) accounts for these facts in terms of bidirectional OT, assuming a general preference for vague over precise interpretation. Krifka (2007) contains a revised analysis which employs game theoretic pragmatics. Space does not permit a detailed discussion of Krifka’s proposals; in the following I will just briefly sketch how the IBR model accounts for Krifka’s observations.

We use (13a,b) and (14) as expression alternatives. If we assume that the literal denotation of 100 and EXACTLY-100 is identical – 100 meter sharp –, we end up with two possible worlds. However, the scenario potentially contains another source of uncertainty of the receiver about the sender’s information state. The sender may or may not consider precision important for the task at hand. (Like in the examples relating to I- and M-implicatures, this game cannot be constructed according to the recipe given above. For the time being, I simply stipulate the parameters of the game and leave the issue how the game is to be extracted from the linguistic information for further research.) This gives us four possible worlds:

- $w_1$ : length is 100 meter; precision is important.
- $w_2$ : length is 101 meter; precision is important.
- $w_3$ : length is 100 meter; precision is not important.
- $w_4$ : length is 101 meter; precision is not important.

If  $\llbracket \cdot \rrbracket$  is the function that maps a signal to the set of types where it is true, we assume

$$\llbracket 100 \rrbracket = \llbracket \text{EXACTLY-100} \rrbracket = \{w_1, w_3\}$$

$$\llbracket 101 \rrbracket = \{w_2, w_4\}$$

The utility functions now depend on the similarity between types. Formally, they are defined as:

$$u_s(t, s, a) = \text{sim}(t, a) - c_s(t, s)$$

$$u_r(t, s, a) = \text{sim}(t, a) - c_r(s, a)$$

The similarity function  $\text{sim}$  is given in tab. 93.16.

Furthermore, I assume that  $c_s(t, 100) = 0$  and  $c_s(t, 101) = c_s(t, \text{EXACTLY-100}) = 0.15$ . The IBR sequence then comes out as shown in tab. 93.17.

Tab. 93.16: Similarity function

| <i>sim</i> | $w_1$ | $w_2$ | $w_3$ | $w_4$ |
|------------|-------|-------|-------|-------|
| $w_1$      | 1     | 0.5   | 1     | 0.5   |
| $w_2$      | 0.5   | 1     | 0.5   | 1     |
| $w_3$      | 1     | 0.9   | 1     | 0.9   |
| $w_4$      | 0.9   | 1     | 0.9   | 1     |

Tab. 93.17: IBR sequence

| $\sigma_0$ | 100           | 101 | EXACTLY-100   |
|------------|---------------|-----|---------------|
| $w_1$      | $\frac{1}{2}$ | 0   | $\frac{1}{2}$ |
| $w_2$      | 0             | 1   | 0             |
| $w_3$      | $\frac{1}{2}$ | 0   | $\frac{1}{2}$ |
| $w_4$      | 0             | 1   | 0             |
| $\sigma_1$ | 100           | 101 | EXACTLY-100   |
| $w_1$      | 1             | 0   | 0             |
| $w_2$      | 0             | 1   | 0             |
| $w_3$      | 1             | 0   | 0             |
| $w_4$      | 1             | 0   | 0             |
| $\sigma_2$ | 100           | 101 | EXACTLY-100   |
| $w_1$      | 0             | 0   | 1             |
| $w_2$      | 0             | 1   | 0             |
| $w_3$      | 1             | 0   | 0             |
| $w_4$      | 1             | 0   | 0             |

| $\rho_0$    | $w_1$         | $w_2$         | $w_3$         | $w_4$         |
|-------------|---------------|---------------|---------------|---------------|
| 100         | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| 101         | 0             | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ |
| EXACTLY-100 | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| $\rho_1$    | $w_1$         | $w_2$         | $w_3$         | $w_4$         |
| 100         | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | $\frac{1}{2}$ |
| 101         | 0             | 1             | 0             | 0             |
| EXACTLY-100 | $\frac{1}{2}$ | 0             | $\frac{1}{2}$ | 0             |
| $\rho_2$    | $w_1$         | $w_2$         | $w_3$         | $w_4$         |
| 100         | 0             | 0             | $\frac{1}{2}$ | $\frac{1}{2}$ |
| 101         | 0             | 1             | 0             | 0             |
| EXACTLY-100 | 1             | 0             | 0             | 0             |



In  $\sigma_0$  and  $\rho_0$  all signals are used/interpreted according to their literal meaning. In  $\sigma_1$  the sender of type  $w_4$  decides that it is better to use the imprecise but more economical expression 100 rather than 101. Note that in type  $w_2$ ,  $\sigma_1$  still uses 101 because for this type precision is sufficiently important to justify the higher expression costs.

As a consequence, 100 receives a vague interpretation in  $\rho_1$ . To avoid this vagueness, type  $w_1$  in  $\sigma_2$  prefers the more costly but also more precise expression EXACTLY-100. As a consequence, the expression 100 does not carry any information anymore about the distinction between the two possible lengths in  $\rho_2$ . It still does convey information though, namely the pragmatic information that the sender is in a state where precision is not important. The two complex expressions only receive a precise information in  $\rho_2$ .  $(\sigma_2, \rho_2)$  are a fixed point.

## 9. Conclusion

Game theoretic methods have received a good deal of attention in the linguistics community in recent years. The aim of this chapter is to illustrate the potential of this approach by showing how the neo-Gricean program of pragmatics can be spelled out in this framework. It is thus representative of one major line of research, which uses rationalistic game theory to model the decision making of language users in specific communicative situations. This is mostly applied to problems of pragmatic interpretation (such as the work by Benz, Parikh, van Rooij and others that has already been mentioned above), but there is also some interest in NLP circles to apply these concepts to language generation (see for instance Golland, Liang & Klein 2010; Klabunde 2009).

Even though game theory has originally been conceived as a tool to make prescriptive claims about the behavior of fully rational agents, since the seminal work of Maynard Smith (1982) it has also become a standard tool in biomathematics. There it is used to model Darwinian evolution in situations where replicative success depends on interactions between different organisms. In this context, evolutionary game theory has been used extensively to study the evolution of animal communication systems, including human language (see for instance Maynard Smith 1991; Nowak & Krakauer 1999).

Since the 1990s it has been recognized by economists that the evolutionary logic can be fruitfully applied to study cultural phenomena in situations where the behavior of humans is governed by imitation and learning. This perspective has been applied to natural language as well to explain the emergence and stability of linguistic conventions in various domains of grammar (see for instance van Rooij 2004; Huttegger 2007; Jäger 2007b).

*Thanks to Michael Franke and Roger Levy for pointing out several mistakes in a draft version of this article, and to Jason Quinley for correcting my English.*

## 10. Appendix

**Theorem 1 (Fixed Point of IBR sequence)** *For each Strong or Weak Interpretation Game, there is a number  $n \geq 0$  such that for all  $m > n$ :  $\sigma_m = \sigma_n$  and  $\rho_m = \rho_n$*

*Proof:* All strategies that are considered in an IBR sequence assign a uniform distribution over a subset of  $\mathcal{S}$  to each type (sender) or a uniform distribution over a subset of  $\mathcal{A}$  to each signal (receiver). Since the games are finite, there are only finitely many such strategies.

Consider a strategy profile  $\langle \sigma, \rho \rangle$ . We define five measures over profiles (average sender utility, measure of entropy of  $\sigma$ , average receiver utility, negative of the number of false interpretations assigned to surprise signals, measure of entropy of  $\rho$ ):

- $m_1(\sigma, \rho) = \sum_{t \in \mathcal{T}} p^*(t) \sum_s \sigma(s|t) \sum_{a \in \mathcal{A}} \rho(a|s) u_s(t, s, a)$ ,
- $m_2(\sigma, \rho) = \sum_{t \in \mathcal{T}} |\{s \mid \sigma(s|t) > 0\}|$ ,
- $m_3(\sigma, \rho) = \sum_{t \in \mathcal{T}} p^*(t) \sum_s \sigma(s|t) \sum_{a \in \mathcal{A}} \rho(a|s) u_r(t, s, a)$ ,
- $m_4(\sigma, \rho) = \sum_{s: \forall t \sigma(s|t)=0} |\{a \mid \rho(a|s) > 0 \wedge a \neq s\}|$ ,
- $m_5(\sigma, \rho) = \sum_{s \in \mathcal{S}} |\{a \mid \rho(a|s) > 0\}|$ .

Next we define a partial order over profiles via a lexicographic order of their  $m_1 - m_5$ -values:

$$(\sigma_1, \rho_1) > (\sigma_2, \rho_2) \text{ iff } \exists i. m_i(\sigma_1, \rho_1) > m_i(\sigma_2, \rho_2) \wedge \forall j < i : m_j(\sigma_1, \rho_1) = m_j(\sigma_2, \rho_2).$$

It is obvious that  $>$  must be acyclic.

Let  $(\sigma_n, \rho_n)$  be an element of an IBR sequence, and let  $\sigma_{n+1} \neq \sigma_n$ . As  $\sigma_{n+1} = BR_s(\rho_n)$ , for each  $t$  and each  $s$  with  $\sigma_{n+1}(s|t) > 0$ ,  $EU_s(s|t; \rho_n) = \max_{s'} EU_s(s'|t; \rho_n)$ . Hence  $m_1(\sigma_{n+1}, \rho_n) = \max_{\sigma} m_1(\sigma, \rho_n)$ . The usage of the principle of insufficient reason in the definition of  $BR_s$  ensures that within the set of sender strategies having this property,  $\sigma_{n+1}$  is the unique strategy that maximizes  $m_2(\cdot, \rho_n)$ . Hence  $\forall \sigma \neq \sigma_{n+1}. \langle \sigma_{n+1}, \rho_n \rangle > \langle \sigma, \rho_n \rangle$ . In particular,  $\langle \sigma_{n+1}, \rho_n \rangle > \langle \sigma_n, \rho_n \rangle$ .

Now suppose  $\rho_{n+1} \neq \rho_n$ . Note that for any  $t, s, a_1, a_2$ , if  $u_r(t, s, a_1) \geq u_r(t, s, a_2)$ , then  $u_s(t, s, a_1) \geq u_s(t, s, a_2)$ . To see why this is so, suppose  $a_1 \neq a_2$ . If  $u_r(t, s, a_1) \geq u_r(t, s, a_2)$ , then either  $a_1 = t$  and  $a_2 \neq t$ , or  $a_1, a_2 \neq t$  and  $c_r(s, a_1) \leq c_r(s, a_2)$ . In both cases,  $u_s(t, s, a_1) \geq u_s(t, s, a_2)$ .

Since  $br_r(s, \sigma)$  gives the set of actions that maximize the expected value of  $u_r$  given  $s$  and  $\sigma$ , it only contains actions that also maximize the expected value of  $u_s$  given  $s$  and  $\sigma$ . Hence  $BR_r(\sigma)$  is a strategy that maximizes  $m_1(\sigma, \cdot)$ .  $m_2$  only depends on  $\sigma$ . Hence  $BR_r(\sigma)$  maximizes  $m_1(\sigma, \cdot)$  and  $m_2(\sigma, \cdot)$ . By definition, it also maximizes  $m_3(\sigma, \cdot)$ . By the belief revision policy that is implemented via the best response to surprise signals in the definition of  $BR_r$ ,  $BR_r(\sigma)$  also maximizes  $m_4(\sigma, \cdot)$ . Finally, the definition of  $BR_r$  ensures that  $BR_r(\sigma)$  is the unique strategy among all strategies that maximize  $m_1, \dots, m_4$  that maximizes  $m_5$ . Therefore  $\langle \sigma_{n+1}, \rho_{n+1} \rangle > \langle \sigma_{n+1}, \rho_n \rangle$ .

The relation  $>$  is acyclic. All elements of the IBR sequence are strategies that map types (signals) to uniform distributions over subsets of  $\mathcal{S}$  ( $\mathcal{A}$ ). There are only finitely many such strategies. Therefore the IBR sequence must have a fixed point. -|

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Gerhard Jäger, Tübingen (Germany)

## 94. Conventional implicature and expressive content

1. Introduction
2. Dimensions of meaning
3. Pragmatic enrichment
4. Conclusion
5. References

### Abstract

*This article presents evidence that individual words and phrases can contribute multiple independent pieces of meaning simultaneously. Such multidimensionality is a unifying theme of the literature on conventional implicatures and expressives. I use phenomena from discourse, semantic composition, and morphosyntax to detect and explore various dimensions of meaning. I also argue that, while the meanings involved are semantically independent, they interact pragmatically to reduce underspecification and fuel pragmatic enrichment. In this article, the central case studies are appositives like Falk, the CEO, and the taboo intensive damn, though discourse particles and connectives like but, even, and still play supporting roles. The primary evidence, both quantitative and qualitative, is drawn from large interview and product-review corpora, which harbor a wealth of information about the importance of these items to discourse.*

### 1. Introduction

Natural language meanings are multifaceted. Even the simplest words, phrases, and sentences can, when uttered, convey a variety of distinct messages. Some derive solely from the conventions of language, others from rich interactions between language and context. Important examples include presuppositions, conversational implicatures, conventional implicatures, connotations, and at-issue (truth-conditional, entailed) content, as well as blends of these. Many of the central issues of semantic and pragmatic theory revolve around how to manage this complex network of interdependent meanings.

The present article focuses on secondary meanings that (i) derive from the conventions of language, albeit with extreme context dependency in many cases, and (ii) are semantically separate from the at-issue content but interact with it pragmatically. Appositives and expressives typify this multidimensionality:

- (1) a. Charlie, *an infamous axe murderer*, is at the door!  
b. Charlie is at the door.
- (2) a. The *damn* dog is on the couch.  
b. The dog is on the couch.

These sentences are information-rich even without contextualization; if uttered, they convey even more. My focus is on the meanings that we can trace, in whole or in part, to the highlighted (italicized) elements.

For example, both (1a) and (1b) convey that Charlie is at the door. However, the appositive in (1a) contributes a second meaning, by ascribing the property of being an infamous axe murderer to Charlie. These two meanings are, in a sense to be made clear below, independent of one another, but they interact pragmatically. In this case, each supports the other's relevance to guide us towards the speaker's intended message. The interaction is quite different if we replace this appositive clause with *the pizza delivery guy*. Thus, we'd like a semantic theory that allows this sentence to denote two propositions, and we'd like a pragmatic theory that explains how those propositions interact to produce a pragmatically-enriched message.

Something similar happens in (2). Whereas (2b) can be a neutral report, (2a) encodes charged information about the speaker's emotional state. The nature of this contribution is context dependent and challenging to specify, but it nonetheless leaps out, helping us to understand why the speaker is offering the content of (2b) at this point in the conversation. Once again, we have semantic independence—we can identify (2b) in (2a), both semantically and morphosyntactically—and once again we have rich pragmatic interactions between the two meanings.

Grice (1975) sketched the notion of conventional implicature (CI) for roughly this class of phenomena, and Bach (1999), Neale (1999), and Horn (2007) find the seeds of that classification in Frege's writings. Both Frege and Grice used expressions like these to probe the limits of their theories of meaning. Ever since, the study of CIs has branched off in numerous directions. The resulting picture appears fragmented; as Horn (2007: 39) says, CIs have had "a long and sometimes difficult history". I've argued, though, that multidimensionality of the sort seen in (1)–(2) unites this research (Potts 2007b). Here, I argue for a unifying pragmatic concept as well: CI items are primarily devices for situating the main clause in the web of information that comprises the discourse. This seems a fitting characterization not only of the above examples, but also of items more standardly regarded as contributing CIs, as in (3)–(5).

- (3) Alfie is a baby, *but* he is quiet.  
a. At-issue = Alfie is a baby, and he is quiet  
b. CI  $\approx$  Babies are not usually quiet
- (4) Isak is *still* swimming.  
a. At-issue = Isak is swimming  
b. CI  $\approx$  Isak was swimming earlier
- (5) *Even* Bart passed the test.  
a. At-issue = Bart passed the test  
b. CI  $\approx$  Bart was among the least likely to pass

The CI paraphrases are very rough, as indicated by the approximation signs. A recurrent theme of CI meanings is that they are hard to specify in propositional terms. I return to this in section 3..

In the next section, I take a closer look at the semantic multidimensionality of these examples, providing diagnostics for identifying secondary dimensions of meaning and isolating them compositionally and pragmatically. Following that, I address how CIs feed pragmatic enrichment. The overall picture reconciles the lexical and constructional origins of CIs with the usual assumption that they belong, in some sense, to pragmatics.

## 2. Dimensions of meaning

Grice (1975) calls upon multiple dimensions of meaning to resolve conflicting intuitions about speaker commitments. The definition proceeds by way of example:

If I say (smugly), *He is an Englishman; he is, therefore, brave*, I have certainly committed myself, by virtue of the meaning of my words, to its being the case that his being brave is a consequence of (follows from) his being an Englishman. But while I have said that he is an Englishman and said that he is brave, I do not want to say that I have *said* (in the favored sense) that it follows from his being an Englishman that he is brave, though I have certainly indicated, and so implicated, that this is so.

On Grice's proposal, the conventional implicature is the proposition denoted by 'its being the case that his being brave is a consequence of (follows from) his being an Englishman', and the at-issue content ('what is said') is the proposition denoted by the conjunction 'he is an Englishman and brave'. One sentence, two propositions. One might dispute whether Grice's analysis of *therefore* is correct, but the logical and linguistic idea is compelling.

Karttunen & Peters (1979) brought this idea to life by fitting it into a standard model-theoretic package. The essence of their idea is captured by the four truth-value combinations in (6).

- (6)  $\langle \mathbf{T}, \mathbf{T} \rangle \langle \mathbf{F}, \mathbf{T} \rangle$   
 $\langle \mathbf{T}, \mathbf{F} \rangle \langle \mathbf{F}, \mathbf{F} \rangle$

Suppose we treat the first value in each pair as modeling at-issue content and the second as modeling CI content. Then we have a nuanced system that includes absolute truth (upper left), absolute falsity (lower right) and blends of the two with an intermediate status. Appositives provide an easy illustration of the promise of this idea:

- (7) Falk, the CEO of Acme Products, gave the keynote address.

Here, we have two propositions expressed. Let's connect them with the meaning tuples in (6) by assuming that the at-issue dimension (that Falk gave the keynote address) is the first coordinate, with the appositive content (that Falk is the CEO of Acme) given by the second coordinate. If both propositions are true, the value is  $\langle \mathbf{T}, \mathbf{T} \rangle$ . If Falk merely consults for Acme, but he did give the keynote, then the value is  $\langle \mathbf{T}, \mathbf{F} \rangle$ . And so forth. This seems to be very close to Grice's (1975) original proposal; the quotation at the start of this section continues with its analysis of *therefore* by saying, "I do not want to say that my utterance

of this sentence would be, *strictly speaking*, false should the consequence in question fail to hold.” Presumably, it wouldn’t be, strictly speaking, true in this situation either:  $\langle \mathbf{T}, \mathbf{F} \rangle$ .

There is no reason to limit ourselves to truth values when dealing with multiple dimensions of meaning. We certainly want to enrich the coordinates to be propositional, for example. If  $W$  is the space of possible worlds, then this gives us all the meanings in  $\wp(W) \times \wp(W)$  to work with. However, if appositives are to be a test case, then mere pairs won’t suffice. A single sentence could have multiple appositives hanging off of it, each contributing in its own way. This might lead us to conclude that the meaning space is  $\wp(W)^n$ , the set of all  $n$ -tuples of propositions, again with the first member corresponding to the at-issue content and the rest corresponding to secondary meanings of whatever kind we discover.

However, the phenomena in question are compositional: they trace to particular words and constructions. This is central to Karttunen & Peters’ theory. For them, not only sentences, but also individual words and phrases, can have multidimensional meanings. Pursuing this idea, we can identify *Falk, the CEO of Acme Products* as a phrase that has two meaning components. Its first dimension picks out Falk, and is thus indistinguishable from the unadorned proper name *Falk*. Its second dimension is the proposition that Falk is the CEO of Acme Products. Since appositives can affix to sentences (*It’s raining, which is unexpected*), verb phrases (*Joan jogs, which Jed does too*), and a host of other constituents, it looks like the space of meanings is at least as broad as  $M \times \wp(W)^n$ , the set of all pairs in which the first coordinate is a member of the set  $M$  of all meanings (whatever that space is like) and the rest of the coordinates are propositional.

I think we want to generalize even more than that to deal with expressive content. Here is Kaplan (1999) drawing a distinction that bears a family resemblance to Grice’s above, but that more directly links semantics and pragmatics:

When I think about my own understanding of the words and phrases of my native language, I find that in some cases I am inclined to say that I know what they *mean*, and in other cases it seems more natural to say that I know how to *use* them.

Kaplan goes on to define *descriptive correctness* and *expressive correctness*, two very different measures of a sentence’s status when uttered in context. The two are independent. If I utter *The damn dog is on the couch*, my utterance is descriptively incorrect if I’m wrong in my claim about the dog, but it’s expressively correct if my emotions are heightened in the way that *damn* indicates. Conversely, my utterance is descriptively correct if I am right about the dog, but it is expressively incorrect if I am, for example, simply confused about the use conditions of this item and thus send an inaccurate or unintended signal about my emotional state. We can reconnect with Karttunen & Peters’ (1979) semantic multidimensionality by treating sentences as denoting  $n$ -tuples of meanings, where our notion of meaning is left broad enough to encompass not only the propositional stuff of appositives but also the more elusive emotionality of expressives.

The above very general logical ideas form the backbone of this article, and versions of them are evident in the quite varied formal approaches of Hawkins (1991), Asher (2000), Barker (2003), Potts (2005), and Corazza (2005), and see Heim (1983), Dekker (2002), Beaver (1997), Simons (2006) for critical discussion of whether presuppositions should be handled in similar terms. I introduce these technical concepts first largely to shift the emphasis off of what I or others believe about how to define ‘conventional implicature’



and ‘expressive’, or how to interpret others’ definitions of these terms. Instead, I’d like to focus on the formal and empirical issues that arise when we move to a theory in which individual words and phrases denote *n*-tuples of meanings. There is a great deal of space, in such a setting, for new empirical investigation and formal innovation. I turn now to the task of identifying dimensions of meaning, using phenomena from discourse (section 2.1.), semantic composition (section 2.2.), and morphosyntax (section 2.3.).

## 2.1. Dimensions in discourse

In the previous section, I used truth-value judgments to acquaint us with the idea that some sentences denote tuples of meanings. If these values are truly independent, then we should expect to see the effects in discourse as well. The present section reviews evidence that this is what we find.

Let’s start with simple, straightforward denials, again using appositives as a test case. In (8), from the Larry King Live TV show (August 9, 2005), King is finishing his show by passing control of the airwaves to Aaron Brown. Brown disputes just the appositive relative’s content; the at-issue content concerns an uncontroversial fact about the network’s schedule.

- (8) King: Right now, it’s time to turn it over to our man in New York, the host of “NEWSNIGHT,” Aaron Brown, who carries on, as all great newsmen do, in that great tradition of, the show must go on.  
Brown: No, that’s what show business people do. [ . . . ] That’s what you do. I do something else.

We also, of course, find cases in which the target of a denial is just the at-issue content of the preceding utterance, with the appositive left unaddressed. This is the dynamic in the following exchange from the TV show *The Situation Room* (September 26, 2008):

- (9) Blitzer: You’re with the House Republicans, who say you know what, not so fast.  
Dobbs: No, no, no, no, no. I’m with the American people [ . . . ]

In both (8)–(9), the first statement is semantically multidimensional, and the reply exploits this fact.

Assent and denial are not the only phenomena that can tease meaning dimensions apart. In the following Switchboard corpus (Godfrey & Holliman 1993) exchange, for example, Speaker A55 acknowledges the truth of the at-issue content of Speaker B54’s assertion but queries the appositive content:

- (10) Speaker B54: Actually I just, put a, uh, little fence around my yard, uh, um, which is I suppose, technically illegal, but I had so many groundhogs last year that I think they’ll let me get by with it, and it, it’s got this one inch mesh and what I’ve noticed it’s kept the cats out and I love it.  
Speaker A55: Um, yeah, yeah, because they, they like to get in and fertilize things too. But, uh, why would it be illegal?

The reverse—querying the at-issue content while accepting the appositive content—is also robustly attested in naturally-occurring dialogue.

It is easy to accumulate additional evidence for the multidimensionality of appositive-containing sentences. For example, sometimes the appositive and at-issue dimensions fuel different speech acts (e.g., *Is Sam, who was in the hospital recently, feeling well enough to attend?*), and they can host distinct speech-act modifiers (e.g., *Please visit Sam, who could, quite frankly, use some cheering up!*). For further discussion, data, and references see Potts (2005: §4) and Horn (2007).

I think the situation does not differ in kind for other CI and expressive items, though many of them contribute in ways that are harder to characterize precisely, which makes them inherently less open to negotiation in dialogue and which can lead to what Horn (2002) calls *assertoric inertia*. However, there are some identifiable techniques for accessing even these more ineffable dimensions. For example, all of the phrases in (11) are robustly attested on the Internet. (Examples marked with ‘G’ were found using Google.)

- (11) a. But? What do you mean, *But*? [G]
- b. Again? What do you mean, *Again*? [G]
- c. Still? What do you mean, *Still*? [G]
- d. Even? What do you mean, *Even*? [G]

More generally, the template *W? What do you mean W?* (i) highlights an element *W* that arguably *makes* multiple meaning contributions, (ii) homes in on the non-at-issue part of that meaning, and (iii) challenges it. This resembles the ‘Hey, wait a minute!’ strategy discussed by Shanon (1976) and von Stechow (2004) in the context of identifying and negotiating presuppositions. Example (12), from a CNN interview between Anderson Cooper and As’ad AbuKhalil (May 14, 2003), illustrates with a very clear case of presupposition-challenging, tracing ultimately to the presuppositions of *make* in the intended sense.

- (12) AbuKhalil: Well, it’s an extremely organized party. And I worry that we may inevitably or willingly make them an enemy of the United States. I did an interview with (CROSSTALK)
- Cooper: Wait a minute. Wait a minute. You’re saying they’re not an enemy of the United States already?

This strategy is also widely used for other kinds of non-at-issue meaning. In (13), for example, basketball coach Bobby Knight recounts an incident in which he hurled a chair onto the court. King calls him on the surprise conversational implicature that the outburst was merely a performance (Larry King Live, March 26, 2001).

- (13) Knight: Yeah. Somebody said, you know, you are really good actor, and —like the chair, I didn’t hit anybody with the chair, pretty good aim, I thought.
- King: Wait a minute! Are you telling me you knew what you were doing there?

Thus, the ‘Hey, wait a minute’ test is useful for identifying a wide range of non-at-issue meanings, especially those that are difficult to articulate and thus difficult to unambiguously query or challenge.

Expressive content is the most reticent of all. It is common for speakers to call upon the ‘Hey, wait a minute!’ strategy to object to the appropriateness of another speaker’s swears, honorifics, and exclamations. This is effective, but it is limiting from an analytic standpoint, since it is rarely clear which aspects of the meaning are being challenged. It

makes sense, then, to turn to subsentential discourse phenomena, where questions about what is asserted and what is accepted are less pressing. Ellipsis is especially useful here (article 70 (Reich) *Ellipsis*). Example (14) shows that verb-phrase ellipsis can reuse an expressive-laden phrase without thereby incorporating the expressivity (Potts et al. 2007):

- (14) Speaker A: I saw your fucking dog in the park.  
 Speaker B: No, you didn't. You couldn't have. The poor thing passed away last week.

In using the strong expressive *fucking*, Speaker A evinces hostility towards Speaker B's dog. Speaker B reuses the verb phrase *see your fucking dog in the park*, but clearly without the expressive coloring. Although indexicals easily shift under ellipsis (Fiengo & May 1994; article 61 (Schlenker) *Indexicality and de se*), as we see with the pronoun *you* in this example, the expressive does not shift for B's utterance. Rather, it is simply factored out. Multidimensionality provides a straightforward analysis of this case: Speaker A's verb phrase denotes a pair consisting of (i) the property of seeing B's dog in the park, and (ii) the expressive associated with *fucking*. Speaker B's ellipsis reuses only (i).

## 2.2. Dimensions in semantic composition

In the previous section, I argued that individual meaning dimensions can lead different lives in discourse. The present section shows that this multidimensionality is felt throughout semantic composition as well. Indeed, the case for dimensions of meaning is even easier to make at the subsentential level; once we move to the discourse level, there is a tendency for all discourse meanings to enter the swirl of the common ground. Karttunen's (1973) *presupposition* holes are a straightforward place to start this investigation. The standard holes are negation, modalization, conditionalization, and questioning (article 91 (Beaver & Geurts) *Presupposition*). They are united in the following sense: if a hole *H* combines semantically with an at-issue proposition *p*, then the result of that combination, *Hp*, does not entail *p*. For example, let's suppose that *p* is the proposition expressed by the sentence in (15a). If this is left unembedded, it yields a commitment to *p* when uttered. However, if embedded as in (15b–e), this commitment disappears.

- (15) a. Sam fed the dog.  
 b. Sam didn't feed the dog.  
 c. We don't have to stop by the house if Sam fed the dog.  
 d. Sam might feed the dog.  
 e. Did Sam feed the dog?

The presupposition holes earn their name because they do not have these expected modulating effects on *presuppositions* that are expressed by constituents in their scope. This is evident already in (15): the basic example (15a) presupposes the existence of a unique, salient dog, in virtue of the phrase *the dog*. Thus, let's say that the content of (15a) is better given by *pq*, where *q* is the proposition that there is a unique, salient dog. Evidently, the values of  $\neg pq$ ,  $(pq \rightarrow r)$ , *might*(*pq*), and *?pq* all still have *q* as a commitment; the presupposition slips past all these operators.

All the meanings discussed in the previous section — appositives, expressives, particles, and so forth — uniformly project out of hole environments, with embedded interpretations typically requiring special discourse conditions or special intonational tunes (Boër & Lycan 1976; Horn 1989). In (16), for example, Pelosi's answer does not target the content of King's appositive; the two are discussing Pelosi's public criticism of the Bush administration's handling of the Iraq War, which Pelosi goes on to defend (Larry King Live, February 27, 2007).

- (16) King: And you don't think at all they have a point when they say you and others like you, who speak out forcefully against it, help al Qaeda?  
Pelosi: No.

Thus, despite being embedded in an interrogative, the appositive itself becomes a commitment of King's (admittedly somewhat biased) question. Conditional antecedents like (17), from the Switchboard corpus, also make the point. Here, if the appositive were interpreted as part of the antecedent, then the antecedent as a whole would be semantically contradictory, which is clearly not the speaker's intent.

- (17) I think it would concern me even more if I had children, which I don't,  
[...]

Karttunen's *plugs* are less uniform in their handling of these meanings. The plugs are non-factive attitude predicates (article 60 (Swanson) *Propositional attitudes*), and perhaps also tense operators. Plugs contrast with holes in that they typically do force presuppositions to be interpreted in their scope: if  $P$  is a plug and  $p_q$  is the meaning of a presupposition-laden sentence, then  $Pp_q$  typically does not presuppose  $q$ .

In the case of appositives, projection out of plug environments is routine. Example (18), from the widely available 20\_newsgroups corpus, is a clear illustration, here centering around the non-factive attitude predicate *report*.

- (18) ESPN *reported* on Sunday, April 11, that *the Lightning, who have been playing in 10,400-seat Expo Hall, are exploring opportunities to move to either Atlanta or Minneapolis*. But Esposito [Lightning general manager — CP] said there was no truth to the report.

The sentential complement of *report*, the constituent we would expect to determine the content of the *report*, is the clause *the Lightning, who have been playing in 10,400-seat Expo Hall, are exploring opportunities to move to either Atlanta or Minneapolis*. This contains the appositive. Yet it is evident from the second sentence that the appositive content must be factored out — it is not part of the argument to *report*, despite its syntactic position.

We expect the embedded constituent to denote the pair of propositions in (19). The first is modified by *report*, whereas the second goes on to become an unqualified discourse-level commitment in this case.

- (19) a. The Lightning are exploring opportunities to move to either Atlanta or Minneapolis  
b. The Lightening have been playing in 10,400-seat Expo Hall

Thus, this example indicates that it needs to be possible for the two dimensions to interact differently with plugs. Similar behavior is widely attested for expressives. In (20), for example, the complaint in question was written by the lawyers for “the idiot”; the attitude that this referential device conveys is clearly that of the author, not part of what the complaint says.

- (20) The complaint says that the idiot filled in a box labeled “default CPC bid” but left blank the box labeled “content CPC bid (optional)”. [G]

These examples show that appositives and other CIs *can* be interpreted outside of syntactically embedding holes and plugs. Whether they *must* be interpreted in this way is controversial. The issues surrounding expressives nicely illustrate the general empirical and theoretical issues that complicate things. Amaral, Roberts & Smith (2007) present examples like (21) as evidence that some expressives do receive embedded readings.

- (21) [Context: We know that Bob loves to do yard work and is very proud of his lawn, but also that he has a son Monty who hates to do yard chores. So Bob could say (perhaps in response to his partner’s suggestion that Monty be asked to mow the lawn while he is away on business):]  
Well, in fact Monty said to me this very morning that he hates to mow the friggin’ lawn.

However, Potts (2007a) argues that examples like this do not involve true embedding, but rather an independently attested form of perspective shifting that is not tied to syntactic configurations or semantic binding and that is closely connected with discourse-bound logophoric reflexives (Kuno 1987; Büring 2005). Such shifting is facilitated by embedded attitude predications (they supply a salient perspective), but it is not dependent upon it. Example (22) illustrates well. The text, from the July 1995 issue of Harper’s Magazine, is by Lewis Lapham, the populist author and editor. The adjective *idiotic* used in the final sentence is not one that Lapham would endorse himself. Rather, he means to connect it with the group he characterizes in the preceding sentence. The perspective involved in this expressive modifier (indeed, in the entire rhetorical question) is thus shifted, not via interaction with other parts of the sentence, *but* rather as a matter of pragmatics.

- (22) I was struck by the willingness of almost everybody in the room—the senators as eagerly as the witnesses—to exchange their civil liberties for an illusory state of perfect security. They seemed to think that democracy was just a fancy word for corporate capitalism, and that the society would be a lot better off if it stopped its futile and unremunerative dithering about constitutional rights. Why humor people, especially poor people, by listening to their idiotic theories of social justice?

For further discussion of these issues, as they relate not only to expressives, but also to appositives and other CI items, see Schlenker (2003); Potts (2005, 2007a); Wang, Reese & McCready (2005); Amaral, Roberts & Smith (2007); Harris & Potts (2009).

For the more typical CI items exemplified in (3)–(5) above, the facts pertaining to presupposition plugs are clearer: they generally take scope inside plug environments. The most extended, detailed case for this position is due to Bach (1999), whose Indirect

Quotation (IQ) Test is designed specifically to see where and how items like *but* take scope with respect to plugs. Bach's central examples have the form of (23).

- (23) Marv: Shaq is huge and agile.  
 a. Marv said that Shaq is huge but agile.  
 b. Marv said that Shaq is huge and agile

The IQ Test concerns what it takes to give a complete and accurate indirect report of Marv's utterance (23). If the contrastive non-at-issue meaning of *but* could take scope out of an embedded speech report, then we might expect (23a) to be fine. However, (23a) seems to imbue Marv's claim with extra content not evident in his original utterance. While Marv might endorse such content, it seems not to be conveyed by (23) alone. Thus, the IQ Test suggests that *but* is plugged by *say*. We can also work in the reverse direction: if Marv had uttered (24), then (23a) would satisfy the demand for a complete paraphrase, because we could freely interpret all aspects of *but*'s content inside the attitude predicate.

- (24) Marv: Shaq is huge but agile.

The projection of meaning from hole and plug environments remains an active area of research. As new lexical items are found and explored, the picture grows ever more complex. In my view, facts like the above suggest that projection patterns are highly lexical and subject to many pragmatic influences. The best strategy, then, seems to be to approach each item with an open mind about how it will project, rather than assuming that an existing classification of it (as a presupposition trigger, CI item, discourse particle, etc.) will determine its meaning contribution in complex sentences. The main conclusion of this section is therefore quite general: multidimensional phenomena provide a window into the semantic composition process, and they also pose deep challenges for how to characterize that process.

### 2.3. Morphosyntactic parochialism

Testing with presupposition holes, plugs, and other complex semantic operators often involves delicate judgments about scope and discourse commitments. Modern semantic theories hew tight to the morphosyntax (Partee 1984; Barker & Jacobson 2007; articles 6 (Pagin & Westerståhl) *Compositionality* and 86 (Kay & Michaelis) *Constructional meaning*), though, so we expect those phenomena to correlate with generalizations concerning forms. This section describes some instances in which meaning dimensions rise to the surface in this way. The general result is that many natural language meanings operate only internal to their own meaning dimensions.

A simple first example is provided by *both*, which modifies only binary coordinated phrases:

- (25) a. \* Jed lamented both that it was raining.  
 b. Jed lamented both that it was raining and that the weather report had been wrong.

If an appositive is affixed to a sentence, the result denotes a pair of propositions, so we might expect *both* to combine with such sentences. This is not the case, though:

- (26) Jed lamented (\*both) that it was raining, which the weather report had gotten wrong.

Example (26) involves a sentential appositive relative clause, adjoined sentence-finally so that it looks superficially very much like a coordinate structure. However, as far as *both* is concerned, its content is not there; *both* is unable to reach beyond the at-issue dimension, even when circumstances would seem to favor that.

The *both* test is useful for detecting that a given meaning is not in the at-issue dimension, but it doesn't tell us much about what kind of non-at-issue meaning we have on our hands. For example, presuppositions are also invisible to *both*; in (27), the predicate *stop* arguably presupposes that Ali ran the marathon before, so we have two propositions expressed, and yet inserting *both* results in ungrammaticality:

- (27) Ali (\*both) ran the marathon again.

However, there are morphosyntactic phenomena that allow us to diagnose CI and expressive content in particular. Potts et al. (2007) report on a number of such phenomena, in English, Hindi, and Japanese, and they reference related cases in Arabic (Aoun & Choueiri 2000) and German (Schwarz 2009). There isn't space to review all that evidence here, but it is worth looking at one case in detail, to convey a sense for how the arguments work. The example builds on Pullum & Rawlins' (2007) findings for the matching construction *X or no X* (e.g., *War or no war*).

The English *as AP as AP can be* construction, illustrated in (28) with examples found using Google, requires matching, in some sense, between the two APs:

- |      |    |                                                      |     |
|------|----|------------------------------------------------------|-----|
| (28) | a. | as sure as sure can be                               | [G] |
|      | b. | as gun nut as gun nut can be                         | [G] |
|      | c. | as washed up as washed up can be                     | [G] |
|      | d. | as average and vanilla as average and vanilla can be | [G] |

If the two APs don't match, the result is often ungrammatical:

- (29) a. \*I'm as sure as certain can be.  
 b. \*I'm as sure as absolutely sure can be.

This might lead one to conclude that the two APs need to be string-identical. However, examples like (30) show that this is incorrect:

- (30) their society is as *secular and religiously neutral* as neutral and secular can be [G]

Here, the APs are *secular and religiously neutral* and *neutral and secular*, which obviously do not match. Once we sort out the ellipsis and arrive at a meaning for these phrases, though, we find that they match in their *at-issue* meanings. This seems, in fact, to be the

right level at which to state the matching requirement: the construction demands identity of at-issue content. This matching requirement encompasses string-identity cases like (28), it properly rules out mismatches like (29), and it leaves enough leeway for (30).

It is important to emphasize, as part of this generalization, that we are restricting attention to *at-issue* content. Mismatches arising from the expressive dimension do not result in ungrammaticality:

- (31) a. I'm as sure as *fucking* sure can be.  
 b. I'm as *fucking* sure as sure can be.  
 c. He's as *fucking* crazy as *motherfucking* crazy can be.

Let  $\phi$  be the meaning contribution of *fucking* in expressive uses like (31), and let  $[[\textit{sure}]]$  be the at-issue content of *sure*. The multidimensional theory of expressives allows us to say that *sure* and *fucking sure* denote  $[[\textit{sure}]]$  and  $\langle [[\textit{sure}]], \phi \rangle$ , respectively, which match in the relevant semantic sense.

Expressives are unique among modifiers in creating a permissible imbalance of this sort. Even emotive items like *absolutely* have at-issue content that violates the matching requirement. Thus, the correct generalization about the form of the *as AP as AP can be* construction crucially depends on a distinct expressive dimension.

This multidimensionality is the key to understanding the famous infixing properties of expressives as well (McCarthy 1982):

- (32) a. o-fucking-kay, fan-friggin-tastic  
 b. \*o-surely-kay, \*fan-stunning-tastic

The infixed expressive cannot possibly combine with, or modify, its syntactic sister, which seems not even to be morphemic. Rather, the expressive operates on a more general level, contributing something about the speaker's emotional state at the time of utterance. Even very emotive at-issue modifiers do not achieve the required independence, as we see in (32b).

## 2.4. Summary of findings

We've now seen a variety of different pieces of evidence that a single constituent can simultaneously contribute multiple independent meanings. It is worth pausing to recap before moving to the pragmatic interactions.

At the discourse level (section 2.1.), we saw speakers responding to individual parts of these multifaceted meanings. Some meanings in secondary dimensions seem less accessible, in this sense, than others. However, we were able to identify techniques (falling broadly under the rubric of 'Hey, wait a minute!' responses) that isolate even these.

In semantic composition (section 2.2.), we leaned on the presupposition holes and plugs to understand how various meanings project, i.e., how they are, or are not, semantically modified by the operators that embed them syntactically. The picture was again one of complex variability. All the items we looked at routinely project out of presupposition hole environments. Presupposition plugs evince more complex behavior, and they are difficult to separate from more discourse-oriented facts concerning perspective.



The morphosyntax is also revealing of the multidimensional semantic foundation (section 2.3.). There, we were able to correlate judgments about grammaticality with semantic generalizations that hinge on being able to have more than one dimension of meaning. This evidence is reassuring, since the semantic and pragmatic facts of section 2.2. can be rather subtle and variable. I turn now to studying how the various dimensions interact to produce rich, coherent pragmatic interpretations.

### 3. Pragmatic enrichment

All the secondary meanings that we've seen so far trace to specific lexical items and constructions. This is not an accident; the 'conventional' part of 'conventional implicature' captures the arbitrary, encoded source of these meanings, contrasting them with those that derive from pragmatic interactions (article 92 (Simons) *Implicature*). Nonetheless, there is an important pragmatic angle on both CIs and expressives; it is arguably the case that the value of having multifaceted meanings is that they deliver richer, more nuanced messages than one could obtain with just a single dimension.

The goal of the present section is to identify and explore some of these pragmatic interactions. We have already seen that individual CI and expressive items differ markedly in their morphosyntax and their semantics, making it hard (or unsatisfying) to study them en masse. The variability is even greater at the pragmatic level. Thus, I do not attempt to provide sweeping generalizations. Instead, I focus on the two items that I opened with and that play a significant role in the preceding discussion: nominal appositives and the expressive *damn*. I take each in turn, beginning with appositives (section 3.1.), then applying those lessons to the trickier case of *damn* (section 3.2.).

#### 3.1. Nominal appositives

Appositives of the sort considered here are prototypically used to *comment* upon the main-clause's content (Asher 2000; Huddleston & Pullum 2002; Potts 2005). They are excellent vehicles for side remarks that would badly interrupt the narrative if expressed as free-standing sentences. For example, (33a) is more natural than (33b) because the digression into the speaker's relationship with Edna intrudes less when expressed appositively than when given the prominence of a free-standing sentence.

- (33) a. I had lunch with Edna, whom I've known since high school. She now works for a design firm.  
 b. I had lunch with Edna. I've known her since high school. She now works for a design firm.

Similarly, in (34), from the Penn Treebank (Marcus et al. 1999), the appositive essentially just satisfies the presupposition of the antecedent verb phrase headed by *cool off*.

- (34) Recovery could be hampered if Britain's major trading partners in Europe, which are enjoying robust economic activity, cool off as expected in late 1990 and 1991.

However, appositives are vital to the overall import of the clauses to which they affix, often in ways that go beyond commentary (Ifantidou-Trouki 1993; Blakemore 1996). The most telling indication of their potential is that that they can answer the immediate

question under discussion, pushing the at-issue content into the background, as in (35), from Larry King Live, June 10, 2003:

- (35) King: Maybe the Harry Potter line was—Michael Beschloss, why are people rushing to buy this book?

Beschloss: I think it's exactly what I was sort of saying earlier, which is they watched her for all those years and wondered what was in her mind and they want to get some idea of what it was.

Can we reconcile the commentary insight with the observation that appositives are often central to the flow of the discourse? I think we can. The crucial insight lies in the fact that natural language sentences are, quite generally, wildly underspecified representations of the meanings that they convey in context (Bach 1994; Levinson 2000; articles 24 (Egg) *Semantic underspecification* and 108 (Pinkal & Koller) *Semantics in computational linguistics*). Appositives allow speakers to strategically resolve this underspecification and thus increase the overall communicative value of the sentences that contain them. Most lexical items have context-dependent aspects of their meanings (article 89 (Zimmermann) *Context dependency*), and appositives often serve to help resolve this. For example, the primary function of the appositive in (36) is to provide information about the scale that is relevant for understanding *even* in this situation.

- (36) Even Gary Kasparov, a world chess champion for 15 years, lost to Deep Blue.

Because the appositive can be niched (Ross 1973) right next to *even Gary Kasparov*, it is superior to a sequence of sentences when it comes to resolving the context dependency. This is also likely a primary function of the appositive in (33a), which helps the listener to contextualize the proper name *Edna*. Indeed, the primary function of definite nominal appositives like the ones in (37), taken from the CNN show *Lou Dobbs Tonight* (July 14 and February 15, 2008) is to help the listener fix the referents of the proper name they adjoin to (Elbourne 2005: §3.3; Potts 2005: §4.5.5):

- (37) a. OTS, the regulator, was asleep at the switch and allowed things to happen without restraint.  
b. Bush, the elder, was not wholly committed [ . . . ]

Even if a sentence's context-dependent features are resolved, an appositive can still play an essential role, by helping the listener to understand why that particular content is being offered at all. My simple example (1b), repeated here, is a good illustration:

- (38) Charlie is at the door.

Even if we know exactly what proposition this expresses, we might still be at a loss to understand *why* it was uttered. Inserting an appositive can help reveal the speaker's intentions:

- (39) a. Charlie, a pizza delivery person, is at the door!  
b. Charlie, an infamous axe murderer, is at the door!

Thinking of discourse as structured by abstract *questions under discussion* or *decision problems* (Roberts 1996; Büring 1999; van Rooy 2004) is revealing of the differences between (38) and (39). With focal prominence on the subject, (38) simply answers the question of who is at the door. The speaker might have richer issues in mind, but whether or not his audience detects this is left to purely pragmatic inferences. In contrast, (39a) and (39b), which naturally make the subject prominent, effectively force enriched interpretations. The question (or decision problem) they address is not merely who is at the door, but rather also, What should we *do* in light of that fact?

Many appositive elements function in similar ways in discourse, including appositive relatives, As-parentheticals (*Ed, as we now know, is a spy*), and speech-act modifiers like *frankly*. While more could be said, both about the ways in which appositives differ from separate main clauses and the ways in which they interact with the at-issue content, I think the above suffices to make the point that, despite separation at the compositional level, at-issue and appositive content interact to flesh out underspecified meanings and enrich them.

### 3.2. The taboo intensive *damn*

The meanings contributed by expressive elements like *damn* are, of course, quite different from those of appositives, but both feed pragmatic enrichment in similar ways. The goal of this section is to begin to build a refined pragmatics for *damn* that relates it, in an abstract sense, to apposition.

One is inclined to start by asking what *damn* means and then build a pragmatic theory from that foundation. However, asking for a traditional semantics here seems to miss the point; the interest of this item lies in its *use conditions*, in Kaplan's (1999) terms (as summarized near the start of section 2.). We want to get a grip on the expectations that *damn* creates in the hearer, and the ways in which a speaker can exploit those expectations when talking.

So, what expectations does *damn* set up? In answering this question, we are apt to think first of negative uses—those that convey agitation, frustration, and the like. These are essential uses of this item, but they tell only part of the story, as we see when we look to naturally occurring cases. The examples in (40)–(41) are drawn from one of the large collections of online product reviews that Constant et al. (2009) use to study a wide variety of expressives. These examples range from the truly negative, as in (40), to the exclaimatively positive, as in (41).

- (40) a. About time someone took a wrecking ball to the whole damn rotten structure.  
b. Trouble is Steyn doesn't know a damn thing about Americans.
- (41) a. I couldn't put the damn thing down.  
b. Chelsea is delightful and so damn funny.  
c. I've read about 3/4th of it ... and I just can't get the damn thing done.

What unifies these uses is *heightened emotion*. Constant et al. (2009) quantify this perspective by studying the distribution of *damn* and other expressives in the corpus from which the above are drawn, which consists of 53,557 reviews by over 40,000 authors, for a

total of about 8.1 million words. Each review in the collection is tagged with a star-rating, one through five stars. Authors writing one or five star reviews are in more heightened emotional states than authors writing reviews in the middle of the rating scale. This emotionality is reflected in their language, which is rich in intensive, exclamatives, and the like. Constant et al. (2009) argue, on the basis of this language and our intuitions about what it conveys, that the star-ratings provide a rough but nonetheless useful approximation of the speaker's emotional state: the extreme ratings (one and five stars) correlate with heightened emotion, and the middle ratings (two to four stars) correlate with more measured outlooks.

The distribution of *damn* in this collection is depicted, on a log-odds scale, in figure 94.1. The empirical points are the black dots; for each rating category  $R$ , we calculate

$$\ln\left(\frac{\text{count}(\text{damn}, R)}{\text{count}(R) - \text{count}(\text{damn}, R)}\right)$$

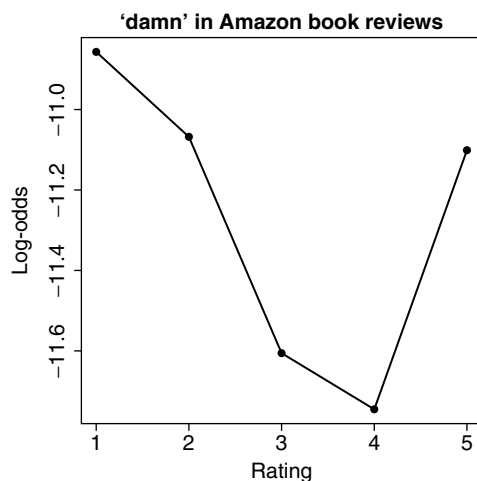


Figure 94.1: The frequency distribution of the taboo intensive *damn* in a large corpus of online product reviews with star ratings attached to them. The empirical points are black. The lines are included to bring out the U shape. The distribution reveals that *damn* is used primarily in the extreme rating categories, where the authors either loved or loathed the product they are writing about.

where  $\ln$  is the natural logarithm,  $\text{count}(\text{damn}, R)$  is the number of occurrences of *damn* in reviews in category  $R$ , and  $\text{count}(R)$  is the total number of words in reviews in category  $R$ . This calculation is similar to a basic frequency distribution obtained by calculating  $\text{count}(\text{damn}, R) / \text{count}(R)$ , but it affords a more powerful and reliable statistical perspective on these distributions.

The distribution is noteworthy for its U shape with respect to the rating categories: *damn* is significantly more frequent at the extreme ends of the rating scale than it is in the middle. Indeed, it is about 66% more likely to appear in a five-star review than in a three-star review. Thus, it is an excellent indicator of an extreme review and, in turn, of heightened emotion. In contrast, by itself, it is a poor signal of the polarity of that emotion: it is

just 27% more likely to appear in a one-star review than in a five-star one. This is the same profile that Constant et al. (2009) report for intensives like *absolutely* (Beaver & Clark 2008) and exclaimatives like *wow*. Setting the mildly taboo qualities of *damn* aside, we can say that it is, like intensives and exclaimatives, a reliable indicator that the speaker is in a heightened emotional state (or at least intends to create such an impression).

The frequency distribution is a rich source of information about what *damn* does to utterances containing it. The subjective/objective corpus of Pang & Lee (2004) is another piece of the puzzle. Pang & Lee classified sentences according to whether they were objective or subjective. The resulting corpus has 5,000 sentences in each of the two categories, and each has around 650,000 words in it. The corpus contains 24 occurrences of *damn*, and 23 of them occur in the subjective corpus. What's more, the single *damn* in the objective corpus is used in the context of objectively describing the subjective mental state of a character in a movie. Thus, we have suggestive evidence that *damn* correlates strongly with subjectivity, and we might even go so far as to say that it can move otherwise objective statements into a subjective realm, an ability that seems in keeping with the perspective dependence of expressives in general (Potts 2007a).

All this corpus evidence paints a rich picture of the contribution of *damn*. The associations between this word and the conceptual categories (the rating scale, the subjective/objective distinction) are representative of our linguistic experiences. As speakers, we have strong expectations that uses of *damn* will correlate with the speaker's being in a heightened emotional state (or wishing to create that impression). In turn, we use it only when we are in such a state (or wish to create that impression). The total effect of these assumptions is that *damn* is a *reliable* signal of emotionality. Knowing its use conditions, in the Kaplanian sense, largely involves being attuned to this information. As a result, whereas an utterance of (43a) might leave you unsure of how the speaker views the situation being described, (43b) creates a window into his underlying emotional state at the time of utterance.

- (43) a. Sam bought that bike.  
b. Sam bought that damn bike.

Even (43b) is indeterminate, though. I noted above that *damn* is about as frequent in positive reviews as it is in negative ones. As Constant et al. (2009) observe, this means that we look to the context to understand the polarity of the emotionality it signals. If Sam's new bike is going to ensure that he beats us in every race, then you'll perceive a resigned solidarity in my utterance of (43b). In contrast, if I'm simply eager to try out his fancy new ride, then exuberance will shine through.

The immediate linguistic environment often provides the strongest indicators of what a given expressive utterance means. Looking back at (40)–(41), we see that the predicates surrounding *damn* guide the emotional polarity of *damn* itself. Predicates like *rotten* tend to take us to negative parts of the emotional spectrum; predicates like *funny* tend to take us to positive parts of it. When Constant et al. (2009) restrict attention to tokens of *damn* that immediately precede positive adjectives, the U shape seen in figure 94.1 becomes a pronounced Reverse L, i.e., a dramatic bias for positivity emerges.

Thus, the expressive imbues the at-issue content with new meaning and importance, and the at-issue content clarifies the meaning of the expressive. The two dimensions shape each other.

### 3.3. Unifying themes

Appositives and expressives are very different in form and content, and this is reflected in the ways in which they contribute to utterance interpretation. However, both often play the role of contextualizing the at-issue content that surrounds them. Appositives resolve underspecification and enhance relevance; expressives color with subjectivity and emotionality.

## 4. Conclusion

This article builds a case for a theory of meaning in which individual words and phrases denote tuples of independent meanings. Section 2. describes a framework for modeling such meanings and goes on to present evidence that the effects of multidimensionality are felt in discourse (section 2.1.), in semantic composition (section 2.2.), and in morphosyntax (section 2.3.).

Appositives and expressives provide the primary empirical evidence in this article, with various connectives and particles playing supporting roles. Though multidimensionality arguably unities these morphosyntactically disparate items, we should take care not to overstate the unity; many differences emerge, suggesting that we need to study each item on its own terms, with the known diagnostics and generalizations guiding investigation rather pressuring us to pack phenomena into rigid categories.

In section 3, the emphasis shifts from semantic denotations to the role that conventional implicatures and expressives play in pragmatic inference. The case studies are appositives and the taboo intensive *damn*. These investigations highlight a few ways in which secondary dimensions of meaning can play primary roles in shaping the overall message of an utterance.

*My thanks to Christopher Davis, Jesse Harris, and Florian Schwarz for their comments on an earlier draft of this paper. Thanks also to Ash Asudeh, David Beaver, Craige Roberts, Aynat Rubinstein, and the participants in LSA.314 at the 2007 Linguistic Institute, Stanford University, for stimulating these ideas.*

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Christopher Potts, Stanford, CA (USA)





# XIX. Typology and crosslinguistic semantics

## 95. Semantic types across languages

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### Abstract

*A semantic perspective on language universals deals with absolute universals of meaning and the semantic import of syntactic and inflectional categories, and lexical items. This paper takes a model-theoretical basis as primary and looks both at the independent semantics and at the mappings from syntax to semantics and from semantics to syntax. Denotational semantics is contrasted with conceptual semantics. The grammatical side of the discussion works mainly with categorial and cartographic approaches. The general approach is hypothetico-deductive and at every point in a description it is necessary to ask whether we are dealing with a universal property of human language or with a property or distinction that is limited to one or several languages. In the latter case we need to ask about the space of variation and about dependencies across such spaces. Looking from grammar to meaning, the paper takes up nominal, verbal, and clausal constructions as well as sub-topics: mass and count nouns, numbers and number, adjectival modification, kinds of verbs and verbal complexes.*

### 1. Introduction

Languages can be compared as to the semantic types they invoke *per se* and as to the reflections of these types in other aspects of language, for example, syntactic categories, syntactic and morphological features, word-building, and so on. We are interested in universals in both perspectives.

There are two main approaches to semantics, sometimes placed in opposition: (i) Denotational semantics and (ii) Conceptual semantics. The two may, however, be considered complementary: Denotational semantics assigns denotations “in the world” to the expressions of the language being interpreted. Conceptual semantics links expressions of the language to concepts considered as psychological entities “in the head”. In practice, people who follow the two modes or traditions mostly do so independently of each other. In this sketch, we will mainly follow the first approach. In both approaches questions about universals loom large. At every point when we investigate a particular language or build

and test a general theory about human languages we face this question: *Is this piece of our description something that is limited to a single language, or is it something that is common to many or all languages?*

Two moves are possible and both have been and still are popular:

- A. Assume parochial until licensed to say otherwise!
- B. Assume universal unless forced to say otherwise!

Here we find in practice a parting of the ways on methodological grounds. On the one side we have the empiricist stance epitomized by Leonard Bloomfield's dictum: "The only useful generalizations about language are inductive generalizations" (Bloomfield 1933: 20); on the other, we have the hypothetico-deductive procedure of most generative linguists. With these two approaches, the notion of a universal takes on quite different meanings. For one side, saying that something is a universal means that you have investigated all languages and found that every language instantiates the universal. Of course no one has done or ever will investigate all languages, so we must be content with looking at representative samples. On the other side, a universal is just an element in a theoretical structure that can be supported by looking at the consequences of the general theory. (Lewis 1972 is a classic defense of the denotational view. Ray Jackendoff (in many writings, for example 1972 is a prominent advocate of the conceptual position. Zwarts & Verkuyl 1994 is a valuable study, which in effect provides a model-theoretic interpretation for one version of conceptual semantics.)

The first approach was characterized like this by William Croft:

One of the features that distinguishes the typological method of discovering constraints on possible language type is the empirical method applied to the problem. If a typologist wants to find restrictions on possible relative clause structures, for example, he or she gathers a large sample of languages and simply observes which of the possible relative clause types are present and which are absent. That is, the restrictions on logically possible language types are motivated by the actually attested language types. If there is a gap in the attested language types, then it is provisionally assumed that the gap represents a constraint on what is a possible language, and explanations are sought for the gap. This is the inductive method, which must be used in constructing generalizations from empirical data. (Croft 2003: 49)

Here is a representative defense of the second position by Guglielmo Cinque, writing about the cartographic approach to syntactic structures (see section 6.2.2 below):

What makes the enterprise all the more interesting is the mounting evidence of the last several years that the distinct hierarchies of functional projections may be universal in the inventory of the heads they involve, in their number, and in their relative order (despite certain appearances). This is, at any rate, the strongest position to take, as it is compatible with only one state of affairs. It is the most exposed to refutation, and, hence, more likely to be correct, if unrefuted.

In front of recalcitrant facts we might be led to a weaker position—one that allows languages to vary either in the inventory, or the number, or the order of the functional heads that they admit (or any combination thereof). Even if this position should eventually turn out to be right, methodologically it would be wrong to start with it, discarding the stronger

position. That would only make us less demanding with respect to the facts and could lead us to miss more subtle evidence supporting the stronger position (a risk not present under the other option). (Cinque 2002: 3–4)

Typological questions arise immediately when you try to advance along either route.

In our research, we follow generally the second mode. Why? Perhaps surprisingly, in part because it leads to better empirical coverage. The main reason is that recording what is can tell you what is possible but never tell you for sure what isn't possible. Of course, there are dangers, but you have to do good linguistics no matter how you operate. Elicitation has its pitfalls but so also does the online search!

Take the NP-Quantifier universal of Barwise & Cooper (1981):

NP-QUANTIFIER UNIVERSAL: *Every natural language has syntactic constituents (called noun-phrases) whose semantic function is to express generalized quantifiers over the domain of discourse.*

Since it was put forward as a hypothesis, there have been many studies of particular languages intended to test the hypothesis, and arguing that is wrong, right, in need of refinement, and so on, and questions about quantification have been routinely put into the task book for investigators of “new” languages. Alleged counterexamples have made the public press (cf. the *New Yorker* article featuring Dan Everett and the Amazonian language Pirahã: Colapinto 2007).

We take the thesis of *effability* as a general guide or heuristic which puts conditions of adequacy on the general framework within which languages can vary (von Stechow 2008, Katz 1976: 37):

EFFABILITY: *Languages are by and large equivalent in their expressive power.*

To give some content to this claim we need to spell out what “by and large” is supposed to allow. We can move toward this by making claims about meanings that must be expressible in every language. We say “meaning” because we want to leave open for now specific questions about whether a particular aspect of meaning is to be attributed to semantics in the narrow sense, to pragmatics and theories of conventional and conversational implicature, or the like. Here are some examples.

ABSOLUTE UNIVERSALS OF MEANING: *Every language has expressions that can*

- i. *refer to individuals,*
- ii. *make assertions,*
- iii. *express questions,*
- iv. *express commands and suggestions,*
- v. *make particular assertions (questions, etc.),*
- vi. *make general assertions (questions, etc.)*  
*and so on . . .*

We take up a number of such universals in section 6.

Let us be careful about what is claimed here: the mode or place of expressing these meanings is kept completely open. In particular, we do not claim that the distinctions implicit in the list are necessarily directly reflected in the grammar of any particular

language. For example, right or wrong, it allows Everett's claims that Pirahã (Everett 2005) does not overtly distinguish between particular and general assertions in its grammar.

## 2. Universals and universals

There are several kinds of universals:

- i. *Every language shows property P.*
- ii. *There is a universal set of properties  $\Pi$  from which languages choose.*
- iii. *If L has property P, then it has property Q.*

(i) and (ii) are *absolute* universals. (iii) is an *implicational* universal.

An example of an absolute universal was the one proposed by Barwise & Cooper (1981), repeated here:

NP-QUANTIFIER UNIVERSAL: *Every natural language has syntactic constituents (called noun-phrases) whose semantic function is to express generalized quantifiers over the domain of discourse.* [NP here corresponds to what is now usually called DP, following Abney 1987.]

Note that this claim is about syntax and semantics: a particular syntactic category and its interpretation is claimed to be universal. (On the fate of this proposed universal, see Bach et al. 1995.)

Examples of absolute semantic universals might be various proposals about the model structures used for model-theoretic interpretation, if it is claimed that they are necessary or adequate for the interpretation of every natural language. We will deal with such questions directly.

A purely semantic universal might be this:

*Every natural language has expressions that are interpreted as denoting individuals in the domain A of entities* (see section 3 below on model structures for this kind of differentiation).

A claim about grammar and interpretation might be one (like the Barwise-Cooper NP-Universal) that claimed that every language had particular categories—say proper names and pronouns—for this universal semantic type. Here again there could be a stronger claim: there is a particular category which is the category for individual names. (We return to this question below in section 6.1.1.)

An example of the second sort of absolute universals might be an enumeration of the sorts that are used to interpret various kinds of nominal expressions, as in Greg Carlson's (1977) hypotheses about kinds, individuals, and stages. Obviously, the strongest hypothesis would be that all languages make use of all of these semantic distinctions and the posited relations among them. A weaker hypothesis would relegate the distinctions to membership in a tool-box of distinctions that a language might or might not choose. A more realistic example might be the various distinctions of verbal meanings usually discussed under the rubric of *Aktionsarten* or aspectual categories.

### 3. Model-theoretic semantics

As we noted above, we will follow in the first instance the route of a denotational semantics, which is committed to associating things, relations, and the like—that is things that are not language—with linguistic expressions. This approach acknowledges the claim that when someone talks about some object, they are in general not just talking about a concept. *My cat is hungry* does not mean that the concept of my cat is hungry or falls under the concept of being hungry.

We should stress that model-theoretic semantics is not the same as possible-world semantics, which is just one choice among many about appropriate models. Moreover, the approach must necessarily proceed by making something like mockups or models of the space of denotations, since we cannot put real dogs, houses, much less whole worlds into our accounts (compare article 33 (Zimmerman) *Model-theoretic semantics*). The important contrast here is this: denotations are not just expressions in some other language: logical form, the Language of Thought, or the like.

### 4. Universal types: Model structures for natural languages

Here is a typical minimal model structure of the sort that has figured in formal semantic treatments of English and other languages (for example, by Montague 1973, henceforth PTQ):

MODEL STRUCTURE  $M_1$ :

- i.  $A$ : a set of entities
- ii.  $BOOL$ : two truth values  $\{1, 0\}$  (True, False)
- iii.  $S$ : a set of situations including worlds as maximal situations
- iv.  $F$ : set of all functions constructed (recursively) from the above

In addition, we suppose that there are various relations defined on the above sets, such as ordering, accessibility, and inclusion relations for  $S$  (on situations, see Bach 1986; Kratzer 1989, 2007; cf. also article 35 (Ginzburg) *Situation Semantics and NL ontology*). This model structure forms the basis for a hierarchy of semantic types (see below).

We believe that most model-theoretic semanticists who discuss various model-structures construe them as universal. For example, the standard model structure  $M_1$  just given builds on basic set theory. One might build a model using not set theory but mereology (theory of part-whole relations). Or one might have one which exploits both set-theory and mereology. But one could also suppose that some language uses one of these options and another language chooses another. This approach might underlie or be associated with claims like those made by Whorf about the different understandings of time and space as between Hopi (Uto-Aztecan) and Standard Average European, for example. In Bach (1981, 1986) the argument is made that such choices should not be made at the level of general model-structures and that the (universal) model-structure should be set up in ways that are not too specific. One such area is that of temporal relations. We believe that claims about the basic structure of time of the sort that Whorf made should not be reconstructed in the general model structure. They are probably best thought of as reflections of cultural lore. Intuitively, this means that the general structure of the semantics in the narrow sense should leave room for disagreements among users of the language. In

the case of temporal structures, this view leads to taking a relatively simple setup with events as constitutive elements and allowing for “local” relations of overlap and precedence among these events (see van Lambalgen & Hamm 2005).

The type theory and concomitant model structure just sketched can be considered universal in one of the senses we mentioned above: a set of semantic distinctions from which languages may choose. As a metatheory the model structure might need to be widened to allow  $n$ -ary functional types. For illustrative purposes, we have set the limit on  $n$  at two.

Most discussion of semantic universals is, however, not about the space of semantic models in and of themselves, but rather about the semantics of various linguistic elements, categories, features. The remainder of this chapter will deal with a selection of such issues.

## 5. Types and categories

We follow standard usage in distinguishing *semantic types* and *syntactic categories*. In a narrow sense, categories are taken to be labels for syntactic structures like *S*, *DP*, *VP*, and the like. In an extended sense we can include any kind of distinctive element of the grammatical description, including features and feature values.

There are various possibilities for the relationships between the syntactic items and the semantic values. Looking in one direction, from grammar to interpretation, the strongest hypothesis would be to require a functional mapping: for every syntactic category there is a unique semantic type for the interpretation of the expressions in that category. This is the requirement of classical Montague grammar.

This functional mapping has been relaxed in work that seeks to accommodate the various kinds of interpretations that seem to be required for some syntactic categories, notably nominal structures (discussion below in section 7).

One might consider a functional relation in the other direction. Take the two together and you will have a one-to-one correspondence between categories and types. As far as we know, no semanticist has proposed such a stringent requirement (sometimes people have claimed that Montague grammar requires such a one-to-one mapping, but this is wrong).

We can actually derive a prediction from the functional mapping from syntax to semantics:

*There can be semantically identical categories that are associated with syntactically distinct expressions. This happens in Montague's analysis of English in PTQ: common nouns and intransitive verbs are both interpreted as predicates, functions from individuals to truth values. (More on this below, section 7.)*

In the following discussion, we will start from the category-type scheme of Montague Grammar. The system of semantic types used by Montague in PTQ goes like this (compare the scheme for model structure  $M_1$  above):

- i. *e* is the type of entities
- ii. *t* is the type for truth values
- iii. *s* is the type for situations (or worlds)
- iv.  $\langle a, b \rangle$  is the type for functions from things of type *a* to things of type *b*

This setup departs from Montague's in respect of the treatment of situations (worlds in Montague) in that there is an explicit type here, while Montague provides a separate rule that builds functions for *senses* by a separate clause making types  $\langle s, a \rangle$  for every type. We believe this is a technical detail that has no importance. Moreover, as indicated above, PTQ works with sets of worlds and times.

Here are some type assignments for some categories of English (we ignore intensional types for simplicity):

- common nouns and intransitive verbs are both modeled by type  $\langle e, t \rangle$ , characteristic functions for entities, understood equivalently as sets
- transitive verbs are functions from entities to sets:  $\langle e, \langle e, t \rangle \rangle$
- sentences are interpreted as of type  $t$  or  $\langle s, t \rangle$ , the latter is Montague's modeling of propositions as sets of worlds
- Term phrases (DPs or in older syntaxes NPs) were modeled as generalized quantifiers, that is sets of sets:  $\langle \langle e, t \rangle, t \rangle$  (or properties if we bring in intensional entities).

In PTQ there are no expressions directly interpreted as denoting individuals (entities). The relaxing of the category-type mapping mentioned above (Partee & Rooth 1983; Partee 1987) allowed Term phrases to have three systematically related types of denotations: individuals  $e$ , predicates or properties  $\langle e, t \rangle$  (like common nouns), as well as the generalized quantifier type of PTQ.

A recurrent question about syntactic categories has been this:

*Do all languages share the same syntactic categories, and if so in the first or second sense of absolute universals distinguished above: that is does every language instantiate the same set, or is there a universal set from which languages draw?*

Given either view or indeed any view that identifies syntactic categories across languages, we are led to the parallel semantic question:

*Are syntactic categories given the same semantic interpretation across languages?*

This is just the question raised above for an individual language but taken up here about categories across languages.

It should be noted that none of the questions raised in this section makes any sense unless it is possible to identify or relate syntactic categories across different languages. It is instructive to compare the situation in syntactic typology: claims about basic clause structures as verb-initial and so on (VSO vs. SVO vs. SOV) presuppose that there is some definite way to relate the syntactic categories or relations that are appealed to for the comparisons.

## 5.1. A universal schema: Fregean functions and arguments

Frege's view of the semantics of language was built squarely on the relation of functions and arguments. Montague's PTQ takes over this view: the default interpretation of a construction of two expressions was to take one as a function from the intension of the other



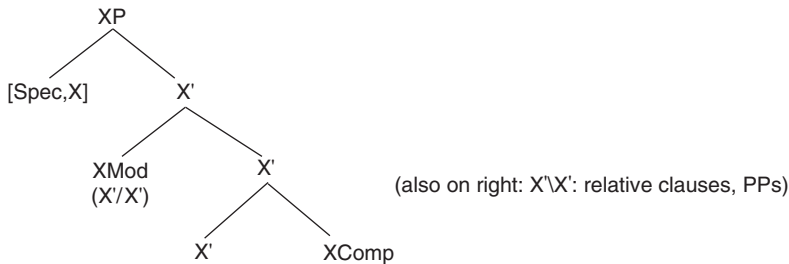
to some—possibly higher order—type (see Heim & Kratzer 1998). If we mirror the function-argument semantic interpretation in the syntax, we have a *categorial grammar* (Oehrle, Bach & Wheeler 1988; Wood 1993; Steedman 2000).

We now turn to a discussion of particular syntactic categories and questions about universals in their interpretation. Given limitations of space, we have to concentrate on a few areas and issues, with only brief mention or references for others.

## 5.2. Cross-categorial classifications

### X-BAR SCHEMES

So called  $\bar{X}$  (X-Bar) theory (Chomsky 1970; Jackendoff 1977) was set up to express cross-categorial regularities within various major categories. Skipping details, a uniform scheme was posited that looked like this:



### MODIFIERS

Free modifiers or adjuncts are in bad shape in many recent theories. An adjunct is an expression which goes together with an expression of a certain category  $X$  to yield an expression of that very same category  $X$ . In a categorial view, then, an expression of category  $X/X$  or  $X \setminus X$ . In traditional terms, these are the true endocentric constructions. Typical examples have been attributive adjectives, relative clauses, and some kinds of adverbs.

If we eliminate the possibility of adjunct phrases, we get this kind of basic structure:

In place of XMod      X':      [Spec' X']      X'

Direct immediate recursion is carried by endocentric modifiers, traditionally and in earliest generative grammars. Such modification by free adjuncts leads to predictions that a sequence of free adjuncts can occur in any order. Many recent writers have questioned or limited severely the postulation of such adjuncts, replacing them with stacked functional categories (Cinque 1999; Chao, Mui & Scott 2001; Scott 2002, 2003), as suggested by the structures mentioned just above.

### FUNCTIONAL CATEGORIES

Kayne (2005: 12–14) lists some forty (kinds of) functional elements relevant to syntax. An important issue we do not have space to enter into here is whether to choose entirely

separate categories or the same categories with different featural content? Above and beyond that are questions about the formal and semantic import of features and feature systems.

### 5.3. Configurational vs. rule-to-rule relations

In mainstream generative grammar (to borrow a term from Culicover & Jackendoff 2005), the relation between syntax and semantics is mediated by defining mappings from structures of some sort: phrase-markers or tree structures or so called logical forms. There are several other alternatives. The main method of mainstream formal semantics stemming from Montague uses a rule-to-rule relation: every formation rule in the grammar (usually just syntax) is matched by a unique semantic rule specifying how to combine the interpretations of the input expressions into the interpretation of the resulting expressions (Bach 1976). Something like this setup is compatible with multidimensional systems (Sadock 1991; Oehrle 1988) and has been widely assumed in a number of different frameworks, especially in those derived from Categorical Grammar (for example Jacobson 1996; Steedman 2000). One way to think about such systems is as grammars that recursively specify  $k$ -tuples or *signs* in the Saussurean sense including at least a phonological, a syntactic, and a semantic object. We can then compare different general theories by looking at the nature of these various objects, and the operations that are allowed in the recursion. These basically Saussurean views of linguistic objects as multidimensional signs has been emphasized especially in HPSG and related frameworks.

## 6. From types to categories

In this section we will look from semantics to syntax and discuss a number of central domains and their expression in syntax(es). We take off in each instance from one or another absolute semantic universal of the sort illustrated above in section 1. We believe much of what we say here is completely uncontroversial.

### 6.1. Individuals

UNIVERSAL I. *Every language has expressions that refer to individuals.*

In the type theory sketched, there are two options: denotations of types  $e$  and  $\langle s, e \rangle$ . The latter type is for what Montague calls individual concepts: functions from contexts (in this paper: situations, in Montague: world-time pairs) to individuals. This distinction is seen in the differing interpretations of an expression like *the president*.

In the context of our model structures, this means that every language has expressions that refer to individual members of the domain  $A$ , that is, things of type  $e$ . They can do this directly as in the primary use of proper names, personal pronouns, or deictics, definite descriptions, or indirectly, when we bring in intensional contexts. It is a matter of convention or culture just what kinds of things receive names in a language: people, places, times, memorable events. It is a matter of analysis or hypothesis what kinds of things are interpreted as being of type  $e$ : objects, stages of objects, kinds, groups, sets, have all been included in this type in various proposals (Carlson 1977 is a *locus classicus* for investigations in this area, a somewhat later reference Carlson & Pelletier 1995). The point here is that

a particular member of the set of entities can be singled out and referred to with a proper name.

The grammatical locus of individual reference is in the nominal domain with categories like N, Det, DP, NP and the like, with variations in various frameworks and theories and possibly languages. Early generative studies of English assumed that names were a subspecies of nouns, characterized (in English) as not going with determiners, except in special circumstances.

- (1) Mary is here.
- (2) \*The Mary is here.
- (3) The Mary that I knew is no longer.
- (4) Die Maria ist da.  
The Maria is here.

But the last example shows that in German proper names can go with definite determiners, and in some language they must do so. The whole grammar of proper names is fraught with details. In German, names of countries do not usually take determiners unless they are feminine or plural, and so on:

- (5) ... in Amerika 'in America'
- (6) ... in der Schweiz 'in Switzerland'
- (7) ... in den Vereinigten Staaten 'in the United States'

Many languages treat proper names in special ways, either as a subspecies of definite expressions or in their own right. Place names are a special case, combining the category of places with the category of names, sometimes with special selectional requirements or possibilities.

Personal pronouns like *she*, *he*, *I*, *you*, *they* form another major class of expressions referring directly to individuals. It is a matter of analysis and a certain amount of controversy where pronouns are to be placed in the syntax: as determiners (Postal 1969) or as a type of noun.

We see in the details of the grammar of names instantiations of a general principle of the semantics-grammar relation: THE YOU-DO-OR-YOU-DON'T PRINCIPLE (YDYD):

*Suppose a language encodes in its grammar a particular semantic distinction and suppose there is a class of expressions that as a matter of semantics express this distinction. Then the language will either require that that class of expressions conform to the grammatical marking or prohibit it.*

Here the principle shows itself in the domain of definiteness and proper names. Assuming that definite articles like English *the* are direct expressions of definiteness and that proper names are definite the collocation of the two is often either prohibited or required. Another instantiation of the principle is in the realm of numerals in construction with nominals. If a noun is construed with a number and the language has a grammatical distinction of number in its nouns, do you use the plural with a cardinal number (Corbett 2000)? Details of this kind of situation can be found in reference grammars of many languages.

The principle is a kind of reflex of the tension between the forces of redundancy and economy. Perhaps, Optimality Theory would provide a fruitful way to think about this situation. But the rankings between redundancy and economy cannot be global for a language, rather being tied to very particular parts of the language.

### 6.1.1. The nominal domain: NPs and DPs, Det, QP

Informally, the various categories that are associated with the label N include these: pronouns, common nouns, determiners, demonstratives, expressions of quantity. In addition, modifiers of various sorts come in here, we defer discussion to the section on adjectives (section 6.3.1) below.

The whole domain is clustered around individuals, up to generalized quantifiers, The NP-Universal of Barwise & Cooper falls under this rubric (above section 1, Barwise & Cooper 1981; Bach et al. 1995) and has been the locus of intense research and debate. One thread of this research goes to the heart of the constraints on category to type matches. In several papers, Partee and Rooth have argued for a systematic ambiguity in the interpretation of term phrases (DPs and the like) as denoting individuals ( $e$ ), generalized quantifiers ( $\langle\langle e, t \rangle, t \rangle$ ), and (nominal) predicates ( $\langle e, t \rangle$ ) (and corresponding intensional types, Partee & Rooth 1983; Partee 1987).

### 6.1.2. Number

The semantic domain of number enters into general theories of language in several places. At the level of lexical semantics there is the question of whether all languages have words for numbers, with widespread claims that some do not (Everett 2005 and subsequent debates such as Nevins, Pesetsky & Rodrigues 2007; Everett 2007).

In grammar, number enters into several different axes: numeral expressions in the nominal domain, inflections of nominal, adjectival, and verbal categories, connections to classifiers or counter expressions, and the like. We cannot go into these various areas here. As far as universality goes, the question of numbers and related categories was a prime example for Ken Hale (1975) in his important paper on “gaps in culture and grammar”. Hale argues for a kind of universality of potential, both in the domain of counting and in the grammar of relative clauses. Note that the potential for counting is present in the basic model structure we have posited as long as the domain of individuals is interpreted as containing discrete entities, and the functional types include types for sets.

As mentioned above, the realm of grammatical number offers another good example of what we have called the YDYD (say “YD-squared”) principle. In expressions of number plus nominal, if the languages have grammatical number they generally differ on whether the nominals may, may not, or must not express number in the nominal in concord with the number expression.

### 6.1.3. Nominal sorts

As we mentioned above, the nominal domain has been the locus for a lot of discussion of sorts, considered as subsets of the set of individuals. We have no space to enter into an extended discussion of the issues here. We simply mention two big areas of discussion: one is the discussion of generics with kinds, objects, stages and relations among them,

introduced by Greg Carlson (Carlson 1977; Carlson & Pelletier 1995; Kratzer 1995; cf. also article 47 (Carlson) *Genericity*), the other is the set of distinctions between Mass and Count expressions and Plurality (Link 1983; Landman 1996; cf. also articles 46 (Laser-son) *Mass nouns and plurals* and 96 (Doetjes) *Count/mass distinctions*). Some of the distinctions reflected in Carlson's original analysis have been widely reformulated and modified in approaches that bring in *events* or *eventualities* either in the semantics or in the syntax or both (Parsons 1990, Tenny & Pustejovsky 2000).

## 6.2. Propositions

UNIVERSAL II. *Every language has expressions that denote truth values and expressions that denote propositions.*

### 6.2.1. Clausal categories

The first generative grammars for natural languages (of all stripes) identified *S* as the highest category. Similarly, PTQ has *t* as the highest category, identified at the top level with the type *t* for truth value, or interpreted according to the general pattern as the intension of that type, that is, a proposition, when occurring as the argument of some function, such as a verb of propositional attitude like *believe* (propositions are of type:  $\langle s, t \rangle$ ).

In subsequent developments of the transformational-generative tradition, the category *S* was decomposed into more and more layers. Early on, something like Montague's distinction came in with *S* and  $\bar{S}$  (*S'*). Within *S*, another conceptual split came with the CASE grammar of Charles Fillmore (1968), subsequently followed up in the UCLA grammar (Stockwell, Schachter & Partee 1973). Fillmore's CASE grammar posited underlying flat structures, but conceptually and on the way to surface structure there was a sharp split between the constituent *M* (think Mood) and the core verb and arguments (somewhat more comprehensive than later argument structures plus verb). *M* continued the tradition of Aux but in Fillmore's scheme there was a more intimate connection between the main verb and its arguments than was expressed in the earliest phrase-structure rules of Chomsky:

$$S \rightarrow NP \text{ AUX } VP$$

Explosions of cascading structures happened at various stages of generative theory: in Generative Semantics with a meager set of categories: Verbs, NPs, *S*'s; in more recent generative theories with an apparently open-ended set of functional categories (compare Culicover & Jackendoff 2005: 98–103). The first steps in this development came with CP (complementizer phrase), IP (inflectional phrase) as reinterpretations of earlier *S* and  $\bar{S}$ . In an influential paper, Jean-Yves Pollock posited a split of IP into two further layers, on the basis of comparisons of French and English (Pollock 1989).

Some of the phrase types based on functional categories that have been proposed in recent times are these (we take up some of them in particular below):

- TnsP: tense phrase
- AspP: aspect phrase
- VoiceP: voice phrase

- AgrP1: subject agreement phrase
- AgrP2: object agreement phrase
- NegP: negative phrase
- FocusP: focus phrase

sometimes more than one of these, as for Hungarian, where several elements can come into focus, and so on.

We are concerned here only with the semantic side of these proposals. In view of what was said above about the syntax-semantics mapping, it is possible that all of these categories could be of the same semantic type, differing only in their syntactic categorization. Again, we cannot pursue the questions raised here in detail, but make a small choice from the extensive literature on these topics.

### 6.2.2. Cinque's cartography

Guglielmo Cinque has consistently pursued a research programme for mapping out a “cartography” of functional categories and related adverbial expressions with a wide cross-linguistic base (Cinque 1999, 2002). We do not have space to discuss the very rich set of categories and predictions that he and other “cartographers” have studied. We will take up just a few of the areas that have been studied from this point of view (see also sections 7 and 9 below). Here is an example of the kinds of data and arguments involved.

Two classes of clause-level adverbials — examples:

- (8) Unfortunately, it is raining.
- (9) It is unfortunately raining.
- (10) Probably, it is raining.
- (11) It is probably raining.
- (12) Unfortunately, it is probably raining.
- (13) \*Probably it is unfortunately raining.
- (14) It is unfortunate that it is probable that it is raining.
- (15) It is probable that it is unfortunate that it is raining.
- (16) It is raining, probably
- (17) It is raining, unfortunately.

With questions:

- (18) Is it probably raining?
- (19) \*Is it unfortunately raining?

With imperatives:

- (20) You will unfortunately go home.
- (21) You will certainly go home.
- (22) \*Go home unfortunately.
- (23) \*Go home certainly! \*Certainly go home!
- (24) \*Go certainly home!

and so on.

These two classes of adverbial expressions differ semantically. The type of *unfortunately* is called “evaluative”, they typically express something about the speakers feelings about the content of the sentence. The second type illustrated by *certainly* and *probably* are aptly called “modal”, having to do with judgments about the certainty, likelihood, probability of the truth of the remaining content of the sentence.

Cinque entertains briefly and dismisses the possibility that the ordering characteristics can be explained on a semantic basis and hence need not be directly reflected in the syntax (Cinque 1999: 134–136). It needs to be registered that possible paraphrases of the kinds of sentences under discussion have different properties, as shown by the contrast between examples (13) and (15) above. But in any case, careful consideration of meanings is required. There is a subtle shift in the sense of the words and their import in the examples above.

### 6.2.3. Tense

English and many other languages have sentential expressions which differ minimally in the presence or absence of tense, or some other nontense item like *to*:

- (25) Andy leaves.
- (26) (I saw) Andy leave.
- (27) (I want) Andy to leave.
- (28) (I am anxious for) Andy to leave.

In standard tense logics, tense is generally treated as a sentence operator. This view is compatible with the earliest generative treatments of English, which usually start with something like this rule:

$$S \rightarrow NP \text{ AUX } VP$$

Since there are three constituents, it is possible to interpret the tense (and aspect) part of the AUX constituent as having highest scope. Montague’s PTQ treats tenses and negation syncategorematically built into the rules for putting together tenseless Intransitive Verb Phrases. In the Montague tradition, Bach (1980) argued for an analysis in which tensed verb phrases are built as constituents that take subjects as arguments to make sentences with a corresponding semantic value: that is the basic structure would be something like NP tVP where tVP stands for tensed verb-phrase and includes the auxiliary elements.

### 6.3. Properties and predicatives

UNIVERSAL III. *Every language has expressions which denote functions from (possibly sequences of) individuals (or other semantic objects) to truth values or propositions. Some examples are types:  $\langle e, t \rangle$ ,  $\langle \langle s, e \rangle, t \rangle$ .*

In laying out the type theory above, we have followed a kind of binarism in the definition of the functional types. Because the functional theory in and of itself allows for

restructuring of  $n$ -ary functions to sequences of unary functions (“currying”) this does not actually have any limiting effect. As we noted, a change in the definition of possible functional types would get back the possibility of direct interpretation of flat structures. It would take us too far afield to pursue this question here. The type theory as laid out here goes well with the kind of syntax favoured by many analysts (Montague 1973; Kayne 1984 and elsewhere).

In a sense, Universal III follows from the first two, as long as we make the (reasonable) assumption that languages can make composite truth-bearing expressions about individuals. What kinds of grammatical categories correspond to these semantic types is in general a matter of controversy. In the following sections, we take up the main categories, which by and large correspond to very traditional ones.

### 6.3.1. Adjectives and adjectives

Traditionally, two quite different kinds of expressions have been called adjectives, distinguished as attributive or predicative:

- (29) Take the red box. (attributive)
- (30) This box is red. (predicative)
- (31) The former president spoke for his wife.
- (32) \*This president is former.
- (33) Johnny is ill.
- (34) \*The ill child wept.

Siegel (1980) is the *locus classicus* for the first detailed studies of adjectives in the model-theoretic tradition of Montague Grammar. Cf. also article 52 (Demonte) *Adjectives*.

These examples show that the two classes of adjectives in English are not coextensive. Languages differ a good deal in the extent to which these two uses are possible, the membership of the two classes, and the amount of overlap (see Chao, Mui & Scott 2001, and literature cited there).

Adjectives have figured large in the debates about universality of syntactic categories (Baker 2003). Recent research in the spirit of Cinque’s programme has classified attributive adjectives syntactically not as free endocentric modifiers but rather as specifiers for various functional categories (Chao, Mui & Scott 2001; Scott 2002, 2003).

As far as predicative adjectives are concerned, whether or not a language distinguishes verbs and adjectives seems to be largely a matter of grammar. Items which can stand by themselves (inflected) or with their arguments and modifiers to denote predicates are assigned to various classes of verbs, while those which require a copula to make such predicators are called (predicative) adjectives.

### 6.3.2. Common noun denotations

Traditionally and in Montague’s analyses of English, common noun denotations are assigned the type  $\langle e, t \rangle$ , or with intensional types  $\langle \langle s, e \rangle, t \rangle$ . These are the same types that are assigned to intransitive verbs and verb-phrases. Later, Muffy Siegel (1980) also assigned the same type to (predicative) adjectives. These assignments illustrate well the many-to-one relation between categories and types of Montague grammar



and related theories, reflecting the fact that the syntax of these kinds of expressions is sharply different. Gupta (1980) argued strongly that common noun meanings included a component of “re-identification” (*the same squirrel*) and this point is taken up by Baker in his book on lexical categories (2003). This view would not necessarily lead to a new type, but presumably would be dealt with by meaning postulates or by sorting.

### 6.3.3. The verbal domain

The prime category at the basis of predication is the verb, and this fact has gone into the terminology of most modern theories of syntax. In dependency grammar, the verb is the main expression from which other elements of a sentence depend. Many languages can use verbs as full sentences, inflected or not.

The minimal potential truth-bearing expression of natural languages is the combination of a subject and a predicate. We include here ambience sentences with no overt subject or a dummy expletive:

- (35) It's raining.
- (36) Piove. (Italian)  
      'It's raining.'
- (37) Hot!

In English, as in many languages, such combinations require a finite form of the verb, here a present tense, registering also the singular agreement. As mentioned above this bit of the sentence is generally stripped out or off as an element *Aux*, *Infl*, or *M* (see section 6.2.1 on Fillmore's CASE Grammar).

## 6.4. Eventualities

The term “eventualities” (Bach 1981) has come to be used for the set of distinctions in meaning and grammar that comprise such items as *events*, *processes*, *states*, *accomplishments*, *achievements*, and so on and use descriptive terminology such as *telic*, *atelic*, and the like. Modeling such distinctions in semantics has made up an important part of the literature of model-theoretic semantics over the last few decades (Verkuyl 1972, Dowty 1977, 1979). Here are a few examples illustrating differences in interpretation and acceptability that seem to depend on these various types of verbs and verb-phrases.

Activities:

- (38) John runs.
- (39) John is running.

Statives:

- (40) Sally knows the answer.
- (41) ?Sally is knowing the answer.

Activity (→ accomplishment)

(42) John was running for an hour.

Accomplishment:

(43) Harry discovered the answer in an hour.

(44) ?Harry discovered the answer for an hour.

## 7. From categories to types

A good bit of our discussion in the previous sections has already dealt indirectly with the perspective of this section, looking from grammar to interpretation, so we can be brief.

As we noted at the outset, the classical view of the relation between syntactic categories and semantic types is that the relation is a many-to-one mapping. So several different syntactic categories could be assigned a single corresponding type. This situation is realized in Montague grammar and its conservative extensions in the example of common nouns, intransitive verb phrases, and predicative adjectives—other categories come to mind as well such as certain prepositional phrases. We also noted that departures from this functional relationship have been argued for, but in such a way that there is a systematic relation among the various options, as in the Partee-Rooth treatment of term-phrase interpretations (Partee & Rooth 1983; Partee 1987).

When we look cross-linguistically at this question, there are several positions to consider. The strongest hypothesis would be to claim that the relations between categories and types is functional, and fixed for every language. Even stronger would be the claim that the relation is one-to-one in every case. It seems that the last claim cannot be reasonably maintained. Some semanticists have argued for a parametric view of the options (Chierchia 1998): languages may differ in systematic ways in their assignments of semantic types to syntactic categories. As in all parametric approaches to language variation, this view is intended to explain clusterings of properties across languages. And the general problem of such a parametric view is the same in the realm of semantics as in other areas. The range of variation within a single language tends to approximate variation across languages. The observation or principle has been called “the congruence of intra- and interlinguistic diversity” (Bach 1974: 255).

A good example of the failure of a one-to-one mapping from grammar to semantics is the treatment of kinds as in generic sentences like these:

(45) Dinosaurs are extinct.

(46) The lion is a carnivore.

(47) Man is not grand.

(48) A cat is a curious beast.

Bare plurals—as in (45)—are perhaps the most usual or unmarked way of referring to kinds in English (and the starting point for Carlson’s classic 1977 study; cf. also article 47 (Carlson) *Genericity*), but English includes all the other options illustrated in (46)–(48), some of which are the norm in other languages with comparable structures. There can be subtle differences among the various possible structures illustrated (Wilkinson 1991).

Similarly, some languages (Chinese, Japanese) have been called “classifier” languages since collocations of nouns and numbers are impossible without the help of counters

or classifiers. But English has nouns which also require similar counter or measure expressions (cf. also article 96 (Doetjes) *Count/mass distinctions*):

- (49) three pieces of furniture
- (50) \*three furnitures
- (51) three blobs of mud
- (52) \*three muds

## 7.1. Some many-to-one correspondences

We've already mentioned the three (or more) kinds of syntactic categories that map to the same type of  $\langle e, t \rangle$ : common noun (phrases), intransitive verbs, predicative adjectives. There are two other places where we might consider such many-to-one correspondences: clausal or *S* level elements and nominal expressions with adjectival extensions.

### 7.1.1. Clausal categories again

Referring back to the discussion of clausal categories (sections 6.2.1, 6.2.2), we note that there are possibly a large number of categories that can plausibly be considered to map into the types of truth-values or propositions. We mention here only a few of the possible categories:

- (53) NegP: Mary hasn't left.
- (54) Modal<sub>evaluative</sub>P: Mary unfortunately hasn't left.
- (55) Modal<sub>epistemic</sub>P: Mary has certainly left.
- (56) ForceP: Leave! (= illocutionary force)

### 7.1.2. Nominals with adjectives

Here we pick up the discussion on attributive adjective constructions (section 6.3.1). Some examples from Scott (2002) (Scott's numbering in parentheses):

- (57) He arrived in an ancient old car. (33a)
- (58) \*He arrived in an old ancient car. (33b)
- (59) What a long cool red dress! (29a) (cool = not hot)
- (60) What a cool long red drink! (29b) (cool = excellent)

(The point of the last two examples is that the two are judged ungrammatical if the interpretations of *cool* are switched.) Again, it is plausible that the semantic values of the adjectives are of the same type, perhaps the type of functions from  $\langle e, t \rangle$  or  $\langle \langle s, e \rangle, t \rangle$  to the same types, but the constraints on order can be encoded in the syntax. It is likely that there are at least two levels of adjectival modifiers or specifiers that are different in type (compare Chao & Bach in preparation; Chao, Mui & Scott 2001).

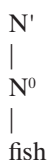
## 8. Lexical semantics

We have concentrated in this paper on the semantics of grammar. There is a very rich tradition of (formal and informal) analyses of the meanings of words and other lexical

items. Linguists differ a lot in the extent to which they try to tie together lexical and grammatical structures. Derivations of lexical items from syntactic structures has been a common thread in the generative tradition, especially in the so-called generative semantics tradition and more recently in some branches of the Chomskyan trend (Hale & Keyser 1993; for commentary compare Culicover & Jackendoff 2005: 53–56).

### 8.1. The syntax and semantics of lexical items

What is the semantic type of a lexical item as it comes from a lexical entry of some sort? A wide-spread assumption is that the category and the type of the item is just the same as that of the phrasal (syntactic) category into which it fits. In configurational terms, this is the question of the mapping that we assume given structures of this sort:



In Montague grammar something like this assumption (without the structural guise) is explicit in the principle embodied in the distinction between basic categories and phrasal categories and the “rule”:

$$\text{For all } A: B_A \subseteq P_A$$

That is, every member  $A$  of a Basic category  $B$  (more or less = lexical category) is a member of the corresponding Phrasal category  $P$ . This is shorthand for the more precise locution “every member of the basic—i.e. lexical—set indexed by the category  $A$  is a member of the phrasal set indexed by  $A$ .”

Assumptions like these went very well with the X-bar theories of phrase structure, which assumed that the syntactic categories were projected from the lexicon. With the explosion of functional categories mentioned above (sections 6.2.1 and 6.2.2), this idea about syntactic categories was swept away. Borer (2005a,b) and others assume that crucial parts of the syntax and semantics of expressions are contributed from the functional categories themselves (Borer’s “exoskeletal” theory). This approach is reminiscent of attempts to reduce lexical categories such as Noun, Verb, Adjective to a single category of Contentive or the like (Bach 1968). It is a task for semanticists to figure out how to deal with the semantics of the situation: just what is the semantic value of the “bare” lexical item, and how does the functional category contribute to the semantics of the item as it is used in a larger construction.

## 9. Conclusions

We hope to have shown here that the semantic perspective on language universals, both semantic universals *per se* and the semantics of syntax and lexicon, is and continues to be a vital part of the linguistic enterprise. In the last few years, there has been a considerable widening of the empirical base, as more and more languages—especially “under-represented” ones—are looked at with semantic questions in mind (compare the

conferences of SULA: the Semantics of Under-represented Languages of the Americas.) In semantics too it seems that looking at “other languages” leads to new insights about the language from which one starts.

We have not said very much about the relation between the conceptual and the model-theoretic mode of thinking about semantic universals that we mentioned at the outset of this chapter. We believe that both approaches are valid and complementary. Does the structure of our semantic theories reflect the way the world is or the way we conceptualize it? Such a Kantian kind of question leads to looking at the enterprise at a higher level, where “Natural Language Metaphysics” (Bach 1981, 1986) verges into metaphysics proper.

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*Emmon Bach, London (United Kingdom)*  
*Wynn Chao, London (United Kingdom)*



## 96. Count/mass distinctions across languages

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### Abstract

*This article examines the opposition between count and mass in a variety of languages. It starts by an overview of correlates of the count/mass distinction, illustrated by data from three types of languages: languages with morphological number marking, languages with numeral classifiers and languages with neither of these. Despite the differences, the count/mass distinction can be shown to play a role in all three systems. The second part of the paper focuses on the Sanches-Greenberg-Slobin generalization, which states that numeral classifier languages do not have obligatory morphological number marking on nouns. Finally the paper discusses the relation between the count/mass distinction and the lexicon.*

### 1. Outline

The first question to ask when looking at the count/mass distinction from a cross-linguistic point of view is whether this distinction plays a role in all languages, and if so, whether it plays a similar role. Obviously, all languages include means to refer both to individuals (in a broad sense) and to masses. However, it is a matter of debate whether the distinction between count and mass plays a role in the linguistic system of all languages, whether it should be made at a lexical level, and whether all languages are alike in this respect.

In English the count/mass distinction shows up in a number of contexts. Count nouns have a singular and a plural form while mass nouns cannot be pluralized unless they shift to a count interpretation. Numerals and certain other quantity expressions (*several*, *many*) can only be used with plural nouns, while others need a singular count noun (*each*, *a*) or a mass noun (*a bit*). If a numeral combines with a mass term, one has to add a measure word, as in *two glasses of wine*. This strategy is similar to the way numerals combine with all nouns in so-called numeral classifier languages such as Mandarin Chinese. In Mandarin, the use of the numeral forces the presence of a so-called numeral classifier, that is, an expression that indicates a unit of counting or a measure:

- (1) a. sān      běn      shū      [Mandarin]  
          three   CL<sup>volume</sup>   book  
      b. liǎng    jìn      mǐ  
          two      CL<sup>kilo</sup>    rice

Yet another type of strategy can be found in Tagalog (Austronesian, Philippines, Schachter & Otnes 1972). This language lacks number morphology, on a par with



Mandarin, but the use of a numeral does not trigger insertion of a classifier. A general overview of the main correlates of the count/mass distinction in these three types of languages will be given in section 2.

According to Greenberg (1972/1977: 286) languages that make use of numeral classifiers in their “basic mode of forming quantitative expressions” never have compulsory number marking on the noun (see also Sanches & Slobin 1973). It is important to realize that the implication goes only one way, as there are languages that have neither morphological number marking nor numeral classifiers, such as Tagalog. The Sanches-Greenberg-Slobin generalization and the relation between number and numeral classifiers will be the topic of section 3.

Section 4 focuses on the relation between the count/mass distinction and the lexicon. A central issue is the status of nouns such as *furniture*, which are in many respects similar to nouns that may be argued to have a “count” interpretation in numeral classifier languages.

## 2. Correlates of the count/mass distinction

### 2.1. Number morphology and the interpretation of count and mass terms

In many languages, including English, number marking is an important correlate of the count/mass distinction. For count expressions, both a singular and a plural can be formed, and sometimes also a dual or other number categories (trial, paucal). Mass terms may take number morphology only if they receive a count interpretation (see also section 4.1 below). For example, a noun like *gold* can be turned into the plural form *golds*, but then it gets a count interpretation such as ‘types of gold’ or ‘gold medals’. Morphological number marking on the noun is only one of the many ways of marking plural. In several languages clitics are used, or number is morphologically marked on a determiner rather than on the noun (see Corbett 2000; Dryer 2005).

It has often been shown that number marking in English does not exactly correlate with mass and count concepts (see Pelletier & Schubert 1989). There are nouns with a count interpretation that are morphologically mass in the sense that they do not have a singular and a plural form. Examples are *furniture* and *cattle* in English (note that the noun *cattle* is used in some varieties of English as an invariable count noun such as *sheep* or *fish*). These nouns will be called collective mass nouns (cf. Krifka 1991).

Plurals and mass nouns have similar semantic properties (cf. article 46 (Lasersohn) *Mass nouns and plurals*). More in particular, they both have the property of cumulative reference. As argued by Quine (1960), if two items can be called *water*, the item they form when put together can be called *water* as well. Link (1983: 303) adds to this that the same is true for bare plurals, as illustrated by the following sentence: “If the animals in this camp are horses, and the animals in that camp are horses, then the animals in both camps are horses.”

Singulars lack cumulative reference. The plural object formed of one teapot and another teapot should be called “teapots”, not “a teapot”. This can be accounted for in a model where singulars denote sets of atomic individuals, while plurals denote sets of individuals plus all possible sums of these individuals and mass nouns denote all possible sums of substance (cf. Link 1983; Krifka 1986, 1991; article 46 (Lasersohn) *Mass nouns and plurals*).

Even though mass nouns and plurals share the property of cumulative reference, it has been argued by a number of authors that they differ from each other with respect to their minimal parts. In the case of count nouns, it is in principle clear what units we are talking about (but see Pelletier & Schubert 1989: 342; Rothstein 2010; Nicolas 2004). Mass nouns, on the other hand, have been said to refer homogeneously. Homogeneous reference is defined as the combination of cumulative and divisive reference. Divisivity is the downward counterpart of cumulativity, and implies the absence of minimal parts: given a quantity of water, one can take a subpart of it, and that subpart will be water as well. Quine (1960) already pointed out that the concept of divisivity is problematic: there are parts of water that are too small to count as water, and this is even more clearly so in the case of furniture. Authors who claim that mass nouns have homogeneous reference usually make a difference between linguistic properties of meaning and the real world: homogeneity is not a property of the substance water, but rather of the linguistic representation of water. According to Bunt (1985: 46) mass nouns do not single out any particular parts and as such do not make any commitments concerning the existence of minimal parts. In the same spirit, Lønning (1987: 8) claims that “it is not critical if mass terms really refer *homogeneously* [. . .]. Rather what is of importance is whether they behave as if they did and what it means to behave in such a way.”

The claim of homogeneous reference has been challenged by Chierchia (1998a,b), who does take the real world properties of nouns such as *furniture* into account in his linguistic model. Chierchia argues that all mass nouns correspond to structures that have minimal parts, even though these minimal parts may be more or less vague. In this respect mass nouns are similar to plurals, which explains the existence of pairs such as *footwear* and *shoes*.

Chierchia argues that languages such as Mandarin lack true singulars: all nouns are mass nouns and as such they trigger insertion of a numeral classifier. As plural formation depends on the presence of nouns with a singular denotation and cannot apply to mass nouns, the language is predicted not to have plurals (for an extensive discussion of Chierchia’s proposal and of the relation between kind denotations, the occurrence of bare argument nouns and numeral classifiers cf. article 44 (Dayal) *Bare noun phrases*, article 47 (Carlson) *Genericity* and article 95 (Bach & Chao) *Semantic types across languages*).

In reaction to Chierchia’s claims, it has been pointed out that some languages have plural count nouns even though they seem to lack real singulars. Brazilian Portuguese *criança* ‘child/children’ formally alternates with a plural form (*crianças* ‘children’), but its meaning is number neutral rather than singular, that is, the use of this form does not imply singularity, but is neutral with respect to the singular/plural opposition. Within Chierchia’s framework the number neutral interpretation is identical to a mass interpretation. Given that number neutral nouns do not have singular reference, they would be predicted not to pluralize, and to behave like mass nouns, contrary to fact (see Munn & Schmidt 2005 and article 44 (Dayal) *Bare noun phrases*).

## 2.2. Count environments

In certain environments count interpretations are forced. This is particularly clear for numerals, even though other expressions may impose similar requirements (see section 2.3). This section discusses three ways in which nouns can adapt to the presence of a numeral. Section 2.2.1 focuses on English and other languages in which numerals trigger the

presence of number morphology. Section 2.2.2 discusses numeral classifiers. Finally, section 2.2.3 considers a system in which the numeral combines with number neutral nouns without any overt marking of countability.

### 2.2.1. Morphological number marking

In English, numerals typically combine with plural count nouns or, in the case of *one* with a singular count noun (e.g. *two books*, *one book*). If a mass term is used in this type of context, it either has to undergo a shift to a count interpretation and behave like a count noun (*two wines*), or a special structure has to be used that includes an expression indicating a unit of counting or a measure. This expression is usually a noun with number morphology, as in *two liters of water* or *three pots of honey*. The nouns that may be used in this position form an open class of items indicating for instance a conventional measure (*a kilo of sugar*, *a liter of wine*), containers or contained quantity (*a cup of coffee*, *a box of books*), shape (*a slice of bread*), collection (*a bunch of flowers*) and arrangement (*a pile of wood*) (cf. Allan 1977; Lehrer 1986). Following Grinevald (2004), these expressions will be referred to as measure terms. Measure terms are in many respects similar to classifiers, but do not form part of a general system of classification.

In English, where count and mass nouns are easily distinguished from one another by plural marking, measure terms are usually compatible with both mass nouns and plurals. In case they combine with a plural, they have scope over the pluralities: in *two boxes of books*, each box contains of a plurality of books. Some measure terms are even restricted to plurals; examples are *bunch*, *crowd* and *flock*.

There are no measure terms that combine with singular nouns in English. It will be argued below that this results from a cross-linguistic generalization that applies to both measure terms and numeral classifiers: all of these expressions combine with nouns that have cumulative reference. As English singulars lack cumulative reference, they cannot be used in this type of context. Note that measure terms differ in this respect from *type* and *kind*, as in *two types of car* (cf. article 47 (Carlson) *Genericity*).

Languages vary in the type of structures they use for measure terms (see for instance Koptjevskaja-Tamm 2001; Rothstein 2009). Even within Germanic two different types can be distinguished. Whereas English uses a pseudo-partitive construction (*two pots of honey*), Dutch and German use structures without a genitive preposition (*twee potten honing* lit. 'two pots honey'). Moreover, Dutch and German do not always require the presence of the plural morpheme on the measure term, as in *twee liter wijn* lit. 'two liter wine'. However, only a small number of measure terms can be used this way. In general non classifier languages tend to treat their measure terms as ordinary count nouns in the sense that they need to be marked for number.

### 2.2.2. Numeral classifiers

As already illustrated in (1), numerals in languages such as Mandarin trigger the insertion of a so-called numeral classifier. Numeral classifiers can be either mensural or sortal. Mensural classifiers are similar to the measure terms discussed in the previous section (Allan 1977; Grinevald 2004). Both Grinevald and Allan insist on the fact that measure terms and mensural classifiers should be distinguished from one another. Mensural

classifiers are part of a larger system of classification as they co-exist with sortal classifiers. One can add to this that some classifier languages only have sortal classifiers. In the numeral classifier language Mokilese (Austronesian, Micronesia, Harrison 1976: 106), measure words behave as count nouns, and need classification themselves: *jilu-w poaun in koahpihen* lit. ‘three-CL<sup>general</sup> pound of coffee’/ ‘three pounds of coffee’ (morpheme boundary added, cf. (4) below).

Sortal classifiers specify units “in terms of which the referent of the head noun can be counted” (Grinevald 2004: 1020). Sortal classifiers may indicate shape (long object, round object, flat object), an essential property (woman, man, animal, plant) or function (drinkable, for transportation) (see also Allan 1977 and Aikhenvald 2000). Whereas mensural classifiers usually constitute a rather large set, the number of sortal classifiers varies from language to language. In Totzil (Mayan, Mexico, Grinevald 2004), several hundred numeral classifiers have been identified, only eight of which are sortal, while Mandarin has several dozen sortal classifiers (Li & Thompson 1981). Even though it is clear that English does not have sortal classifiers, expressions such as *head* and *piece* in *two head of cattle* and *three pieces of furniture* come rather close (cf. Greenberg 1972/1977; Allan 1977: 293).

According to Grinevald (2004), sortal classifiers indicate a unit of counting while appearing to be semantically redundant in the sense that they specify an inherent characteristic of the noun they modify. In many classifier languages there is one classifier that functions as a general classifier, which is semantically bleached and tends to combine with a large set of nouns in the language. An example is Mandarin *ge*, the classifier normally used with the noun *rén* ‘person’, which tends to replace more specialized ones (Li & Thompson 1981). There are also many languages in which the sortal classifier may be left out without a change in meaning (see for instance Jacob 1965 and Adams 1991 on Khmer, an Austro-Asiatic language spoken in Cambodia).

It is usually predictable which sortal classifier should be used, even though Becker (1975) shows that creative language users such as writers may use the same noun with different (sortal) classifiers, thus emphasizing different aspects of the meaning of the noun. Similarly, classifiers may trigger different meanings of a polysemous noun (cf. Zhang 2007).

Cheng & Sybesma (1998, 1999) show that syntactic structures containing sortal classifiers (“count-classifiers”) differ from those containing mensural classifiers (“massifiers” or mass-classifiers in their terminology). Sortal classifiers, contrary to mensural ones, do not allow for the presence of *de*, a marker typically found at internal phrasal boundaries inside a noun phrase, and they cannot be modified by adjectives. This is illustrated for the sortal classifier *zhī* ‘CL<sup>branch</sup>’ and the mensural classifier *xiāng* ‘box’ in (2):

- (2) a. sān      (\*xiǎo)    zhī      (\*de)    bǐ      [Mandarin]  
          three    small    CL<sup>branch</sup>    DE      pen  
          ‘three pens’  
       b. liǎng    (xiǎo)    xiāng    (de)    shū  
          two    small    box      DE      book  
          ‘two boxes of books’

Cheng & Sybesma argue that “massifiers” (mensural classifiers) are ordinary nouns that under specific conditions may fill a classifier slot.

Classifiers may have different relations to the noun and to the numeral (cf. Greenberg 1972/1977; Allan 1977; Aikhenvald 2000). In many languages, they are fused with the numeral (e.g. Nivkh (Nivkh, Siberia, Gruzdeva 1998), Japanese (Downing 1996) and Moki-  
lese (Austronesian, Micronesia, Harrison 1976)). In other languages (e.g. Mandarin) they constitute a separate lexeme between the noun and the numeral and have been argued to form a constituent with the noun phrase first (cf. Cheng & Sybesma 1999). This pattern occurs in e.g. Thai (Tai-Kadai, Thailand), Tashkent Uzbek (Altaic, Uzbekistan) and As-  
samese (Indo-European, India) (cf. Aikhenvald 2000). The classifier and the numeral are always adjacent. It is possible, however, that the classifier forms a prosodic unit with the noun rather than with the numeral, as shown by Ikoro (1994) for Kana (Niger-Congo, Nigeria), but this is the exception rather than the rule (Aikhenvald 2000).

A classified noun is usually number neutral. When used as a bare noun, Mandarin *shū* ‘book(s)’ may be used to refer to one or several books (cf. among many others Krifka 1995; Rullmann & You 2006). The next section discusses a type of language with number neutral nouns that does not make use of numeral classifiers.

### 2.2.3. Number neutral nouns without numeral classifiers

In many languages of the world numerals combine directly with number neutral nouns (cf. Gil 2005). Even though this type of strategy is rarely taken into account in the literature on the count/mass distinction, the difference between count and mass does play a role in this type of languages as well (cf. Wilhelm 2008, who reached similar conclusions to the ones presented here on the basis of facts from Dëne Sųlíné, Athapaskan, Canada). The following examples from Tagalog (Austronesian, Philippines, Schachter & Otanes 1972: 143, 208) illustrate the use of numerals with count and mass nouns. In the latter case a measure term is inserted (a *ganta* corresponds to three liters):

- (3) a. dalawang            mansanas                            [Tagalog]  
         two+LINKER       apple  
         ‘two apples’  
      b. dalawang            salop na                    bigas  
         two+LINKER       ganta LINKER            rice  
         ‘two gantas of rice’

Schachter & Otanes indicate that Tagalog nouns are number neutral, even though in many contexts the plural marker *mga* may be added (interestingly not with numerals, as they note on page 142). However, they insist on the fact that there is a count/mass distinction in the language: “Tagalog makes a distinction between pluralizable and unpluralizable nouns that is like a distinction made in English. [. . .] In general, Tagalog count nouns correspond to English count nouns and refer to items that are perceived as distinct units: e.g., *bahay* ‘house’, *baro* ‘dress’, *bata* ‘child’.” (Schachter & Otanes 1972: 112) As for mass nouns, Tagalog and English are similar as well, even though nouns such as *furniture* tend to be count nouns in Tagalog. One might speculate that collective mass nouns, which have a count meaning but the morphology of a mass noun, typically occur in languages with an obligatory system of singular/plural marking, as the lack of number marking distinguishes them from other nouns with count interpretations (cf. section 4 below).

### 2.3. Selectional properties of determiners

Numerals are not the only expressions that may trigger number morphology on nouns or insertion of a classifier. Quite in general, determiners impose restrictions on the nouns they combine with (the term determiner will be used in a very broad sense for quantifying expressions as well as definite and indefinite determiners). In English, *several*, *few*, *many* and *different* only combine with plural nouns on a par with the numerals above *one*, while *a*, *every* and the numeral *one* select singular nouns. Interestingly, there do not seem to be any determiners that combine with all count nouns (singulars and plurals) and not with mass nouns. At least in English, determiners that combine with both singulars and plurals also combine with mass nouns (*some*, *any*, *the*, *no*), and as such they are not sensitive to the count/mass distinction.

A very large class of determiners combines with mass nouns and plurals. This class includes *a lot*, *more*, *less*. Most of these determiners can also be used as adverbs indicating the quantity corresponding to an event, as in *John slept a lot*. These “adverbial” determiners have been claimed to be sensitive to the property of cumulative reference (cf. Doetjes 1997, 2004). A small class of determiners is restricted to mass nouns, and these usually allow for adverbial use as well (*a bit*, *much*, *little*). In English these expressions are in complementary distribution with a plural selecting determiner (*much*—*many*, *little*—*few*, *a little*/ *a bit*—*a few*). One way of looking at these “mass only” determiners is to assume that their incompatibility with plurals is due to blocking by the plural selecting alternative.

Mandarin distinguishes between determiners that force insertion of a classifier, determiners that allow for the optional presence of a classifier and determiners that disallow classifiers. Not only numerals, but also demonstratives and certain quantificational determiners (e.g. *jǐ* ‘how many’, ‘a few’) require the presence of a numeral classifier. With certain other determiners the classifier is either absent or optional depending on the dialect (cf. *hěn duō* (%*wǎn*) *tāng* ‘much soup’ or ‘many cups of soup’, *hěn duō* (%*běn*) *shū* ‘many/a lot of books’). Mandarin speakers from the North tend not to allow for a classifier at all (sortal or mensural), while speakers from the South optionally insert a classifier. Furthermore, some speakers reject the use of a sortal classifier (*běn*) while accepting the use of container words such as *wǎn* in their container reading, but not when used as a measure. Despite the dialectal differences, these determiners are similar to *a lot* and *more* in English in the sense that they combine directly with mass nouns and count nouns, and as such can be said to be insensitive to the count/mass distinction. Interestingly, Mandarin also has a counterpart of *a bit*. The form *yī diǎnr* ‘a little’ never allows for insertion of a classifier, and is typically used with nouns that have a mass or an abstract denotation (Iljic 1994). The form alternates with *jǐ* ‘a few’, which always triggers insertion of a classifier.

As for Tagalog, Schachter & Otones (1972) state that expressions such as the cardinal numerals, *ilan* ‘only a few’, *ilan* ‘a few’ and *hindi ilan* ‘not a few, quite a few’ are used with count nouns, while for instance *kaunti* ‘a little’ and *hindi kaunti* ‘not a little, quite a lot’ typically combine with mass nouns. Other expressions, such as *marami* ‘a lot’, are insensitive to the count/mass distinction, and combine with count nouns and mass nouns alike.

As shown in Tab. 96.1, determiners in all three languages may be sensitive to the count/mass distinction.



Tab. 96.1: Selectional properties of determiners (examples)

|                 | <i>count</i>                                                     | <i>mass</i>                | <i>indifferent</i>     |
|-----------------|------------------------------------------------------------------|----------------------------|------------------------|
| <i>English</i>  | <i>one</i> (singular noun),<br><i>a few</i> (plural noun)        | <i>a little</i>            | <i>a lot</i>           |
| <i>Mandarin</i> | <i>yī</i> ‘one’, <i>jǐ</i> ‘a few’<br>(CL + number neutral noun) | <i>yī diǎnr</i> ‘a little’ | <i>hěn duō</i> ‘a lot’ |
| <i>Tagalog</i>  | <i>isa</i> ‘one’, <i>ilan</i> ‘a few’<br>(number neutral noun)   | <i>kaunti</i> ‘a little’   | <i>marami</i> ‘a lot’  |

3. The Sanches-Greenberg-Slobin generalization

3.1. Number and classifiers

An important universal associated with the count/mass distinction concerns the relation between number and classifiers (for universals in general, cf. article 13 (Matthewson) *Methods in cross-linguistic semantics* and article 95 (Bach & Chao) *Semantic types across languages*). In 1972 Greenberg postulates that languages without compulsory number marking on the noun may have obligatory use of numeral classifiers, referring to an unpublished paper by Sanches from 1971, later published as Sanches & Slobin (1973). Sanches originally states the generalization as follows (Greenberg 1972/1977: 286): “If a language includes in its basic mode of forming quantitative expressions numeral classifiers, then [. . .] it will not have obligatory marking of the plural on nouns.” Moreover, Sanches claims that classified nouns are normally singulars.

According to Greenberg, it rather seems to be the case that the classified noun is normally not marked for number. In what follows it will become clear that Greenberg’s version of the observation is on the right track: classifiers are used predominantly with number neutral nouns. Greenberg argues that the loss of number marking on nouns in a language may lead to the emergence of a numeral classifier system, in which case the classifier construction is modelled after structures containing a measure term.

The Sanches-Greenberg-Slobin generalization seems to be quite robust. When examining this universal, two aspects of the generalization should be kept in mind. In the first place, the generalization is implicational and only holds one way. Thus, it is not the case that languages without obligatory number marking on the noun will have a general system of numeral classifiers. The examples of Tagalog in section 2.2.3 illustrate this point. In the second place, the generalization speaks about “marking of plural on nouns”. As will become clear below, this should be taken literally in the sense of morphological number marking. Other types of number marking do not count (e.g. number morphology on a demonstrative or number marking by means of an independent morpheme cf. Dryer 2005). Moreover, the morphological number marking should be compulsory. Yucatec (Mayan, Mexico; Allan 1977: 294) is an example of a numeral classifier language with optional number morphology on the noun, which may be used even in the presence a classifier: *oš tul maak(oob)* lit. ‘three CL<sup>animate</sup> person(s)’/ ‘three persons’.

In the literature, several counter-examples to the Sanches-Greenberg-Slobin generalization have been mentioned, including for instance Nivkh (Nivkh, Siberia), Ejagham (Benue-Congo, Nigeria/ Cameroon) and Southern Dravidian languages (India) (cf. Aikhenvald 2000). However, none of them constitutes a clear case of a language with

obligatory number marking on the noun and a general system of numeral classifiers. Nivkh does not have compulsory number marking (Gruzdeva 1998: 17) while Ejagham is not a numeral classifier language (see section 3.4 below). As for Southern Dravidian Languages, Haspelmath et al. (2005) provide information on a number of languages of this genus, but do not classify any of them as a numeral classifier language with obligatory morphological number. Further research, providing detailed information about the relevant facts in potentially problematic languages, is necessary. Given the accessible data so far, it seems that if counter-examples exist, they are typologically extremely rare.

Several types of languages are of special interest for gaining a better understanding of the generalization. Section 3.2 discusses languages that have both obligatory number marking and obligatory use of numeral classifiers. Section 3.3 investigates optional use of classifiers in languages with obligatory number marking on nouns. In section 3.4 a mixed system will be discussed in which classifiers and number seem to co-occur. Section 3.5 concludes and reconsiders the Sanches-Greenberg-Slobin generalization in the light of the presented data.

### 3.2. Obligatory plural marking and obligatory classifiers

An example of a language with obligatory number marking and obligatory use of numeral classifiers is Mokilese (Austronesian, Micronesia; Harrison 1976; in the cited examples relevant morpheme boundaries have been added). Mokilese makes use of a limited set of classifiers. Singular indefinites are marked by suffixation of the classifier. The general classifier *-w* is preceded by the numeral *oa* ‘one’, suggesting that this numeral may have been dropped in cases where it is absent: *pukk-oaw* (*puk* + *oa-w*) lit. ‘book-one-CL<sup>general</sup>’/ ‘a book’, *koa-ul-pas* lit. ‘song-CL<sup>long object</sup>’/ ‘a song’. A plural indefinite is marked by a separate morpheme *-pwi*, which alternates with the classifiers (*woal-pwi* lit. ‘man-PL’/ ‘(some) men’). In case a numeral is used, the numeral fuses with the appropriate classifier and the use of *-pwi* is excluded. This shows that *-pwi* is more similar to a plural indefinite determiner such as French *des* in *des livres* ‘books’, than to the English plural suffix *-s*.

- (4) a. mwumw jilu-w/                      jil-men                      [Mokilese]  
       fish        three-CL<sup>general</sup>                three-CL<sup>animate</sup>  
       ‘three fish’  
       b. suhkoa rah-pas  
       tree        two-CL<sup>long object</sup>  
       ‘two trees’

The pattern found in Mokilese for indefinites is similar to the pattern found in Mandarin. The Mandarin numeral *yī* ‘one’ may be left out in direct object position, yielding a sequence of a classifier and a noun with a singular indefinite interpretation (cf. Cheng & Sybesma 1999). Mokilese *-pwi* resembles the element *xīe* in Mandarin, which is sometimes called a ‘plural classifier’ (but see Iljic 1994 for differences between *xīe* and classifiers). *Xīe* can be preceded by the numeral *yī* ‘one’ but it is incompatible with all other numerals: (*yī*)/ \**sān xīe rén/bǐ* lit. ‘(one)/three PL person/pen’/ ‘some persons/pens’. This property is reminiscent of elements such as *few* in English, that do combine with the indefinite determiner *a* but not with numerals (*a few pens* vs. \**two few(s) pens*).



However, Mokilese differs significantly from Mandarin with regard to the way in which demonstratives are used. Whereas Mandarin demonstratives trigger insertion of a classifier, demonstratives in Mokilese show up as suffixes and are obligatorily marked for number, as shown in *woall-o* (*woal* + *-o*) lit. ‘man-that’/ ‘that man’, *woall-ok* (*woal* + *-ok*) lit. ‘man-those’/ ‘those men’. Thus, the singular/plural opposition in this language is marked obligatorily, but it is marked on the demonstrative rather than on the noun. Consequently, the Mokilese data are in accordance with the Sanches-Greenberg-Slobin generalization.

The Mokilese data illustrate that morphological number on a noun differs from morphological number marking on a demonstrative. One could argue that Mokilese nouns are always number neutral, as in the case of Mandarin. Number marking plays a role at a different level: the demonstrative determiner has a singular and a plural form, not the noun. The presence of number marking on the demonstrative should not be taken to be a reflection of agreement with an invisible category for singular or plural on the noun, as the comparison with other classifier languages strongly suggests that Mokilese bare nouns are semantically and morphologically number neutral.

### 3.3. Optional classifiers and obligatory number

The Sanches-Greenberg-Slobin generalization is about languages that make obligatory use of numeral classifiers. In order to find out why languages make use of classifiers, languages with optional use of numeral classifiers are also an important object of study. Optional classifiers are very frequent cross-linguistically. Haspelmath et al. (2005) list almost as many languages with optional classifiers as languages with obligatory ones. Some languages with optional classifiers have a set of sortal classifiers and thus resemble Mandarin and Mokilese (e.g. Khmer, Austro-Asiatic, Cambodia; Jacob 1965). Other languages have only one optional sortal classifier, which is sometimes also called an enumerator (e.g. Hausa, Chadic, Nigeria; Newman 2000).

This section focuses on languages with optional classifiers that also have morphological number marking which in some contexts is obligatorily present. The first language that will be considered is Armenian (Indo-European, Turkey/ Armenia; Borer 2005; Bale & Khanjian 2008; Minassian 1980). Borer (2005: 94), citing Michelle Siegler (p.c.), gives the paradigm in (5) for Western Armenian (Turkey). Eastern Armenian (Armenia) is similar in the relevant respects.

- (5) a. Yergu (had) hovanoc uni-m [Western Armenian]  
       two (CL) umbrella have-1SG  
       b. Yergu (\*had) hovanoc-ner uni-m  
       two (\*CL) umbrella-s have-1SG

The data in (5) show that the numeral combines with a non-plural noun, with a plural noun or with a classifier followed by a non-plural noun, while plural marking on the noun following the classifier is excluded. Note that even though the use of the plural is optional with numerals and in a number of other contexts, it is obligatory in non generic noun phrases containing the definite article (cf. Minassian, 1980: 81–82 for Eastern Armenian). However, Bale & Khanjian (2008) show that the non-plural form is not a singular but

rather a number neutral noun, which means that it denotes an atomic join semi-lattice rather than a set of atoms. This is in accordance with the observation above that classifiers do not combine with real singulars, which lack cumulative reference. The data in (5) reflect the patterns discussed for Mandarin, Tagalog and English above. (5a) corresponds to the patterns found in Mandarin (classifier plus number neutral noun) and Tagalog (number neutral noun), while (5b) is similar to the pattern found in English.

Borer accounts for the data in (5) in a syntactic way. In her view, a count interpretation has to be syntactically licensed by the presence of a so-called “divider”. Both classifiers and number may act as dividers, but as there is only one syntactic slot available, stacking of dividers is excluded, ruling out the combination of a classifier and a plural. In order to account for the optionality of the classifier in (5a), Borer assumes that numerals in this language may function as dividers (Borer 2005: 117–118). Contrary to Borer, Bale & Khanjian (2008) offer a semantic explanation for the impossibility of the use of a classifier (5b). They argue that plurals in this language are real plurals in the sense that their denotation excludes the atoms (cf. article 46 (Lasersohn) *Mass nouns and plurals*). Under the assumption that the classifier needs atoms in the denotation of the noun it combines with, it is incompatible with the plural form.

From the perspective of the Sanches-Greenberg-Slobin generalization, the Armenian facts are particularly interesting, as they show that (optional) classifiers are not impossible in a system in which number marking is in some cases obligatorily marked on the noun. Languages with obligatory plural marking tend to lack number neutral nouns, but in some linguistic systems the two may co-occur. Sortal classifiers are typically found with nouns that are neither singular nor plural, as indicated by Greenberg (cf. section 3.1).

However, it is not the case that combinations of classifiers and plural nouns are completely excluded, contrary to the predictions of Borer. There are also languages that present all four possibilities given in (5). An example of such a language is Hausa (Afro-Asiatic, Niger, Nigeria; Zimmermann 2008), as illustrated in *kujèraa/kùjèruu (gùdaa) hudu* lit. ‘chair.SG/PL (CL) four/ ‘four chairs’. According to Zimmermann, various facts indicate that Hausa non-plural nouns are number neutral rather than singular. Moreover, he argues that the plural in Hausa does not include the atoms. If this is right, the pattern is not only unexpected under Borer’s syntactic account of the Armenian data in (5), but also under the semantic analysis of Bale & Khanjian.

The mixed properties of Armenian and Hausa seem to correlate with the existence of number neutral nouns in these languages. Hausa is of special interest, as this language uses the classifier also with plural nouns (cf. also the Yucatec example in section 3.1). It is unclear at this point under what conditions plural nouns can co-occur with sortal classifiers.

### 3.4. Mixed systems

It is clear from the preceding discussion that the distinction between languages such as English, Mandarin and Tagalog illustrated in section 2 is a very rough one, which does not account for the many existing intermediate cases. The patterns in Armenian and Hausa discussed in the previous section illustrate the fact that a numeral can be used in various ways with the same noun in a single language. There are also mixed systems where part of the lexicon has a singular/plural opposition, whereas a large class of other nouns with

count interpretations need insertion of an expression that resembles a sortal classifier in order to be combined with a numeral.

This is the case in Ejagham (Niger-Congo, Cameroon, Nigeria; Watters 1981), which is taken to be a numeral classifier language by for instance Aikhenvald (2000). Ejagham uses a noun class system that encodes, among other things, the opposition between singular and plural, resulting in obligatory plural marking on the nouns that fall in these classes. Numerals agree in noun class with the noun they modify, as in *Ṃ-díg mǎ-d* lit. '3-rope 3-one'/'one rope' and *à-ríg á-sá* lit. '6-rope 6-three'/'three ropes', where 3 and 6 refer to a singular and a corresponding plural noun class respectively (Watters 1981: 469, 471).

The language also has quite a large class of nouns with count interpretations that are members of a single noun class, which means that they do not introduce a singular-plural opposition. When these nouns are combined with numerals, a unit counter is used, which Watters calls a classifier (Watters 1981: 309–313). Many words for fruits, roots, trees, plants and vegetables are in this class, while most of their English counterparts are marked for number. The system strongly resembles a numeral classifier system. Watters distinguishes five different "classifiers", some of which can also be used as independent nouns. However, as noted by Aikhenvald (2000), the "classifiers" in this language are in a plural or a singular noun class, and the numeral agrees with the classifier in noun class. This is illustrated by (6). The classifier used in this example belongs to noun class 5 if it is singular and to noun class 9 if it is plural; GN is a (tonal) genitive linker:

- (6) a. *é-rám*                      ´                      *í-čǝkùd*                      *já-d*                      [Ejagham]  
          5-CL<sup>fruit</sup>                      GN                      19-orange                      5-one  
          'one orange'  
       b. *Ṃ-dám*                      `                      *í-čǝkùd*                      *é-bǎé*  
          9-CL<sup>fruit</sup>                      GN                      19-orange                      9-two  
          'two oranges'

The expression of singular and plural on the "classifiers" shows that they behave like ordinary count nouns in the language, and as such should not be considered to be sortal classifiers but rather count nouns that function as unit counters, on a par with *piece* in English (cf. the discussion in section 2.2 and Greenberg 1972/1977). Ejagham thus seems to have a large number of collective mass nouns, that is, nouns that are similar to *furniture* in English in the sense that they do not have a singular and a plural form, even though from a semantic point of view they have a count interpretation.

Ikoro (1994) argues that the unit counters used for part of the lexicon in Ejagham and the numeral classifiers generally used in the numeral classifier language Kana (Niger-Congo, Nigeria; Ikoro 1994) have a common origin, suggesting that collective mass nouns may well have played an important role in the genesis of the numeral classifier system of Kana (cf. Greenberg 1972/1977).

### 3.5. Consequences for the Sanches-Greenberg-Slobin generalization

In the preceding sections a number of languages have been looked at in view of the Sanches-Greenberg-Slobin generalization, which states that numeral classifier languages do not have obligatory marking of the plural on nouns. It has been argued in the preceding sections that the presence of number neutral nouns in a language seems to be the crucial factor for the presence of sortal classifiers, as illustrated in several ways.

In the first place, the generalization itself insists on the compulsory nature of number morphology: languages with optional number marking on the noun may have numeral classifiers (e.g. Yucatec, Mayan, Mexico; Allan 1977). If number is an optional category on the noun, the non-plural noun should have a number neutral denotation and cannot be a true singular, as it can also be used to denote pluralities.

In the second place, languages with number marking that is not realized as a morphological affix on the noun may have numeral classifiers. This possibility was illustrated on the basis of the numeral classifier language Mokilese (Austronesian, Micronesia; Harrison 1976), which marks number obligatorily on the demonstrative. At the level of the noun, number does not seem to play a role, and it makes sense to assume that bare nouns in this language are number neutral.

In the third place, a language may have obligatory number marking on nouns in certain contexts, while also having number neutral nouns. This seems to be the case in Armenian (Indo-European, Turkey/Armenia; Borer 2005; Bale & Khanjian 2008; Minassian 1980). The language has number neutral nouns, and optionally inserts a sortal classifier between a numeral and a number neutral noun.

The way the Sanches-Greenberg-Slobin generalization is formulated does not make reference to number neutral nouns, but rather to obligatory marking of plural on nouns. The case of Armenian shows that in some languages number neutral nouns may occur in a system with obligatory plural morphology on nouns. What does not seem to exist are languages with general use of numeral classifiers (i.e. sortal classifiers may or must occur with all nouns that have a count interpretation) and a systematic morphological singular-plural opposition, excluding number neutrality. This distinguishes between languages such as English, which has true singulars as well as obligatory plural marking on nouns, and languages such as Armenian where plural nouns alternate with number neutral forms rather than with (semantic) singulars.

Interestingly, one could say that number neutrality also plays a role in systems with a strict singular-plural opposition. In English *furniture*, *cattle* and *footwear* arguably have a number neutral interpretation, and the same is true for a large class of nouns in Ejagham (Niger-Congo, Cameroon/ Nigeria; Watters 1981). In order to use numerals with these nouns, one has to insert a count noun that functions as a unit counter.

At this point, a number of questions need further investigation. First, more languages need to be studied in order to see whether there are systematic differences between languages with obligatory use of numeral classifiers and languages with optional numeral classifiers. For instance, one may wonder whether there are obligatory numeral classifier languages with one single numeral classifier (cf. the systems of optional classifier insertion in Armenian and Hausa).

A second issue concerns the possibility of having numeral classifiers with nouns that are morphologically plural, as in Yucatec (section 3.1) and Hausa (section 3.3). Plural marking in combination with a classifier is the exception rather than the rule, and it is not clear at this point whether this pattern ever occurs in a language without number neutral nouns. More languages need to be studied in order to gain insight into this issue.

A further question that needs to be answered is why the generalization exists. Even though some proposals have been made in the literature, this is still an open question. In the syntactic literature, it has been argued that both classifiers and number may have a similar function in a language. As already indicated in section 3.3 above, Borer assumes that classifiers and number morphology function as so-called dividers. She claims that

count interpretations need to be syntactically licensed by the presence of a divider. As there is a single syntactic slot for the divider, the classifier and number morphology compete for the same syntactic position, which predicts that they are mutually exclusive. Similarly, Doetjes (1997) argues that both classifiers and number morphology function as grammatical markers of countability. Numerals need the presence of a grammatical element that signals the presence of minimal parts in the denotation of the noun. In this view, classifiers and number morphology have the same syntactic function.

From a semantic point of view, plural morphology and classifiers do not seem to have the same function. If it is true that the classified noun is number neutral, the denotation of the number neutral noun in a numeral classifier language is very close if not identical to that of a plural noun in a language with a systematic distinction between singular and plural (cf. article 46 (Lasersohn) *Mass nouns and plurals* for arguments in favor of including the atoms in the denotation of plural nouns in English). Classifiers have been argued to be “singularizers”, in the sense that they map an atomic semi-lattice into a set of atoms (Chierchia 1998b: 347; Cheng & Sybesma 1999: 521). This does not predict an alternation between classified nouns and plural nouns, unless one were to assign singular interpretation to plurals in the context of numerals, in which case the plural marker would reflect agreement rather than semantic plurality (cf. Ionin & Matushansky 2006, who argue in favor of such an approach). If one were to accept such a proposal, it would still not explain why, in the absence of classifiers, languages tend to use plural or number neutral nouns with numerals.

On the other hand, if mass nouns and count nouns have different reference properties, as proposed by Bunt (1985), one could say that numeral classifier languages lack a count-mass distinction: all nouns are mass, and as such, the classifiers are necessary in order to provide a measure or unit for counting. The next section will argue that such a view cannot be maintained. Both numeral classifier languages and languages with obligatory morphological number marking present evidence in favor of the idea that the count/mass distinction plays a role at a lexical level.

#### 4. Count versus mass in the lexicon

In the literature on the count/mass distinction, a central question is to what extent the correlates of the count/mass distinction have to do with lexical properties of nouns. According to a lexicalist point of view (see among others Gillon 1992), there are count nouns and mass nouns in the lexicon of a language such as English. A different point of view, recently defended by Borer (2005), takes the count structures in syntax to be triggers for a count interpretation of nouns that are lexically mass (see also Sharvy 1978). The reason for the existence of “unitarian expression approaches”, as Pelletier & Schubert (1989) call them, is the fact that most nouns can be either mass or count, depending on the context (e.g. *Kim put an apple in the salad* versus *Kim put apple in the salad*).

This section explores the semantic properties of count nouns and mass nouns, or rather, count meanings and mass meanings. Section 4.1 investigates meaning shifts from mass-to-count and vice versa and section 4.2 comes back to the status of count and mass in the lexicon in languages such as English. Section 4.3 extends the discussion to other types of languages, focusing specifically on numeral classifier languages, as these languages have been claimed not to have a lexical count/mass distinction (cf. Denny 1986, Lucy 1992

among others), while others refute this claim (cf. for instance Cheng & Sybesma 1998; Doetjes 1997).

#### 4.1. Shifts

Nouns that one would like to call “count nouns”, can easily be used with a mass interpretation. In order to illustrate this, Pelletier (1975/1979) introduces the concept of the “universal grinder”, suggested to him by David Lewis:

Consider a machine, the “universal grinder”. This machine is rather like a meat grinder in that one introduces something into one end, the grinder chops and grinds it up into a homogeneous mass and spews it onto the floor from its other end. [...] Now if we put into one end of a meat grinder a steak, and ask what there is on the floor at the other end, the answer is ‘There is steak all over the floor’ (where steak has a mass sense). [...] The reader has doubtless guessed by now the purpose of our universal grinder: Take an object corresponding to any (apparent) count noun [...] (e.g., ‘man’), put the object in one end of the grinder, and ask what is on the floor (answer: ‘There is man all over the floor’).

(Pelletier 1975/1979: 6)

Pelletier concludes that basically any noun, provided the right context, may have a mass interpretation.

Nouns that one would like to call “mass nouns” frequently allow for a count interpretation as well. Most if not all mass nouns in English have a “type of” reading which is count. So, *two golds* may mean two types of gold and two *two wines* two types of wine. Bunt (1985: 11) calls this the “universal sorter”. Moreover, mass nouns can often be used to refer to a typical object made of the stuff the mass noun normally refers to, or a portion of N-mass. In the case of *gold* this can be for instance a gold medal, as in: *He won two Olympic golds*, while the noun *wine* can be used for a glass of wine.

One might conclude from this that basically all nouns can be used in mass and in count contexts, and that these contexts force a count or a mass interpretation. This in turn begs the question whether we want to have a distinction between mass nouns and count nouns in the first place. Before addressing this question, some more cases of count-to-mass shifts and mass-to-count shifts will be considered (cf. Doetjes 1997; Nicolas 2002).

Going back to Pelletier’s universal grinder, it is clear that it grinds physical objects. However, there are also count nouns that refer to abstract objects. These usually do not allow for grinding. Take for instance the noun *aspect*. Can one put an aspect in the grinder? And if there is aspect all over the floor, what does that mean? The same is true for other abstract count nouns such as *characteristic* and measure nouns such as *mile* and *kilometer*.

As for mass-to-count shifts, the type reading and the portion reading seem to be rather common and productive. However, not all languages allow for these readings for all nouns. Take for instance the example of Dutch. In the first place, certain classes of mass nouns lack count readings all together. Dutch does not have a count noun *gold*: *\*twee gouden* ‘two golds’ being unacceptable. The same is true for other material nouns in Dutch, such as *hout* ‘wood’. In the second place, there are nouns that do have a type reading, but lack a portion reading. In that case, the portion reading can usually be derived by adding the diminutive marker *-tje* (cf. *twee wijnen* lit. ‘two wine+PL’/ ‘two types of wine’ vs. *twee wijntjes* lit. two wine+DIM+PL/ ‘two glasses of wine’).

Turning to other types of mass-to-count shifts, namely the ones that result in a reading of the kind *object made of N*, it is usually not predictable at all what the meaning of the count noun will be. Take again the English noun *gold*. Even though this word can refer to a gold medal, it is much harder if not impossible to use it in order to refer to a gold necklace.

## 4.2. The semantics of count nouns and mass nouns

The fact that nouns normally have both count and mass meanings led to question whether it is necessary to assume a distinction between mass nouns and count nouns in the lexicon.

Sharvy (1978) tentatively argues that English might be “like Chinese” and lack count nouns all together in the sense that all nouns need insertion of a classifier. The structure of *two beers* would be one with an empty classifier for *glass*, and the plural morphology on *beer* would originate from the covert classifier. Recently, Borer (2005) makes a similar claim, without assuming the presence of a covert classifier. In her view the presence of count syntax (as realized by number morphology and classifiers) triggers a count reading of a noun phrase: “all nouns are born unspecified for any properties, including count or mass, and [...] as a default, and unless more structure is provided, they will be interpreted as mass” (Borer 2005: 108).

Given the restrictions on the shifts discussed in the previous section, it is far from obvious that the count/mass distinction is absent at the level of the lexicon. In the first place, there are nouns that are always mass or always count. Moreover, when shifts take place, one often has the impression to be able to indicate a direction in which the meaning shifts. Another important question is what kind of object a given noun may refer to. Take the noun *chicken* and assume that this noun is lexically mass. The question is then how to predict what meaning one obtains if this noun is used with count syntax, as in *three chickens*. Why would this not mean, in a relevant context, *three drumsticks*? Under the assumption that the shifts discussed above represent lexical rules, lexical restrictions are expected, both on the possible interpretations of a noun and on the availability of count and mass readings.

The count/mass distinction can be implemented in the lexicon in different ways (cf. Pelletier & Schubert 1989). One could assume that the lexicon contains both a count noun *chicken* and a mass noun *chicken* which are [+count] and [–count] respectively. Alternatively, there might be a single noun with several senses that may introduce criteria for counting or not, but that are not marked syntactically by a feature [ $\pm$  count]. In the latter case, count syntax would force the choice of a sense of a word that introduces a criterion for counting. Mass syntax would be used in the absence of such a criterion.

A central point of discussion in this context is the status of collective mass nouns. As often noted in the literature on the mass count distinction, *shoes* and *footwear*, *coins* and *change* have very similar meanings. Given that collective nouns seem to provide a criterion for counting, what prevents them from being used in a count environment? In the spirit of Bunt and Lønning one could say that even though *footwear* and *shoes* are nouns that can be used to refer to the same objects, *footwear* represents this meaning as if it has homogeneous reference, while *shoes* provides a linguistically relevant criterion for counting.



However, there are reasons to assume that the nouns *footwear* and *furniture* provide a criterion for counting which is linguistically relevant (see for instance Chierchia 1998a,b; Doetjes 1997; Nicolas 2002; Chierchia 2010). For instance, *a pair of footwear* and *a pair of shoes* can be opposed to *#a pair of water*. The interpretation of this type of nouns in the context of degree words, and in particular comparative *more*, is even more telling. As shown in (7), the evaluation of the quantity of objects indicated by *more* depends on whether *more* is used with a mass noun or a plural (see Gathercole 1985; Doetjes 1997; Barner & Snedeker 2005):

- (7) Peter ate more chocolates than John ↔  
Peter ate more chocolate than John

In order to evaluate a sentence with *more* one needs a criterion for evaluating the quantity. When the plural *chocolates* is used, this must be the number of separate chocolates. As for *more chocolate*, the global quantity is evaluated, probably in terms of weight or volume. Thus, if Peter has eaten 5 big chocolates and John 6 quite small ones, the first sentence in (7) is false and the second true.

Barner & Snedeker (2005) show on the basis of a psycholinguistic experiment that the following equivalence holds:

- (8) Barbie has more pieces of furniture than us ↔  
Barbie has more furniture than us

The contrast between (7) and (8) indicates that collective mass nouns such as *furniture* impose a criterion for counting when combined with *more*, while non collective mass nouns do not, which demonstrates that not only count nouns but also collectives involve a criterion for counting.

This complicates a view according to which count and mass are not represented in the lexicon as features but rather as properties of meanings. It is clear that *furniture* behaves like a mass noun in the sense that it does not take number morphology and does not allow for direct modification by a numeral. If a count sense created by a mass-to-count shift in the lexicon automatically results in count syntax, it is strange to assume that *furniture* has count semantics and yet no access to count syntax.

One way to stick to a “senses approach” to the count/mass distinction, while taking into account the existence of count senses without count syntax (as in the case of *furniture*), is to assume that collective mass nouns enter the lexicon with a count meaning and lexical incompatibility with number (cf. Chierchia 2010 for a similar view). This might be related to the group interpretation associated with these nouns (cf. Borer 2005: 103, note 13). As such, they could be seen as the mass counterparts of group nouns such as *committee* (cf. Chierchia 1998a: 86). Assigning an exceptional status to these nouns makes it possible to assume that count meanings result by default in the obligatory use of number morphology in syntax, unless they are lexically specified as being incompatible with number. This correctly predicts that a collective meaning is always the core meaning of a noun, and cannot be obtained by a shifting process. Whenever the meaning of a noun shifts towards a count meaning in a language with obligatory morphological number marking on nouns, the noun will be marked for number.



The borderline between collective nouns and non collective ones is by no means a simple one to draw. Consider cases such as *a drop of water* and *a grain of sand*. One may wonder whether the criterion for counting introduced by *grain of sand* and *drop of water* is introduced by the noun or by *grain* and *drop*. The *more-test* might offer a way out: it does not seem to be possible to say: #*This small heap actually contains more sand than that big heap over there* implying that the small heap contains more grains of sand.

#### 4.3. “Count nouns” in numeral classifier languages

A related question is whether nouns in numeral classifier languages can be lexically count. The idea that Mandarin would be a language without a lexical mass-count distinction has been made for different reasons. In what follows it will be shown that the arguments that are offered in the literature are not valid and that there is evidence in favor of a lexical count/mass distinction in a language such as Mandarin.

A first reason why it has been assumed that numeral classifier languages do not distinguish between count nouns and mass nouns is the obligatory presence of classifiers in the context of numerals with both mass and count nouns, which is reminiscent of the insertion of measure terms with mass nouns in languages such as English. However, as shown in section 2.2.2 above, it is not true that mass nouns and count nouns introduce exactly the same structures, as one has to distinguish between sortal and mensural classifiers. The former typically combine with nouns that have a count interpretation (cf. Cheng & Sybesma 1999; Grinevald 2004).

According to some authors, classifiers are responsible for the presence of atomic structure in a very concrete way. Denny (1986) and Lucy (1992) argue for instance, that languages such as English have a lexical count/mass distinction while classifier languages do not, assuming that number marking does not introduce units of counting while classifiers do introduce such units. Based on psycholinguistic experiments among speakers of the numeral classifier language Yucatec (Mayan, Mexico), Lucy claims that his Yucatec subjects have a substance oriented way of viewing the world as compared to speakers of English.

Even though such a “parametric” view may seem appealing at first sight, the evidence in favor of this type of approach is not very strong. As shown by Li, Dunham & Carey (2009), a new set of experiments sheds serious doubts on Lucy’s interpretation of his results, and shows convincingly that being speaker of a numeral classifier language does not affect one’s perspective on substances and objects in the world.

From a purely linguistic point of view, the parametric approach is problematic as well (cf. Doetjes 1997). Some classifiers provide no information about what the atoms would be, and in this respect they do not differ from number morphology. Many classifier languages have for instance a so-called general classifier, which may replace other sortal classifiers, and does not contain any information about the units that are to be counted (e.g. Mandarin *ge*). Yet, it always triggers a count interpretation of the noun (see also Adams 1991). Moreover, numeral classifier languages often do not use classifiers in combination with expressions corresponding to large numbers. Rather, these expressions behave like classifiers themselves and are similar to English nouns such as *pair* and *dozen*. Again, no criterion for counting is present, yet a count meaning of the noun is necessarily present.

Finally, it has been claimed that classifiers need to be present in order to trigger a count meaning (see in particular Borer 2005). However, it turns out that count meanings may impose themselves in the absence of a classifier. This is particularly clear in the case of a grinding context. As shown by Cheng, Doetjes & Sybesma (2008), grinding is not possible in the following sentence:

- This type of data is hard to understand if one assumes that the noun *gǒu* does not provide a criterion for counting. The lack of grinding in Mandarin is quite interesting in view of the fact that numeral classifier languages have been a model to explain the fact that in languages such as English nouns may shift so easily from count to mass interpretations and vice versa, and confirms the idea that grinding should be seen as a lexical operation.

As a whole, it seems clear that there are reflections of the count/mass distinction in numeral classifier languages. They are not only present in syntax, but there are also reasons to assume that lexical entries of nouns may provide a criterion for counting or not depending on the meaning of the noun. What these languages lack is not nouns with count semantics, but rather nouns with a difference between a singular and a plural form. In this sense they resemble languages such as Tagalog, in which nouns are number neutral. If this is right, the difference between Mandarin and Tagalog is not a lexical difference but rather a difference in the type of requirements certain elements in the language (numerals, demonstratives) impose on the nouns they combine with.

From the data discussed above it seems that languages do not differ in having count meanings and mass meanings at a lexical level. However, they differ in the type of syntax triggered by count and mass meanings, in particular with respect to numerals. Numerals need something to count. As such, in order to combine them with a noun that has a mass meaning, either a measure term or mensural classifier has to be used, or the noun must shift towards a (usually lexically determined) count meaning. In case a noun has a count meaning, several things may happen depending on the language. In a language such as Tagalog nothing happens: the numeral combines directly with the noun. In a language such as English, nouns with count meanings are usually marked for number. If so, number marking is necessary in combination with the numeral. Finally, in numeral classifier

languages such as Mandarin, nouns with a count meaning are not marked for number, and in order to use such a noun with a numeral, a sortal classifier has to be inserted. Even though this basic classification is useful, it is important to realize that languages may have mixed properties.

Quite in general, the patterns that have been discussed are in accordance with the Sanches-Greenberg-Slobin generalization: the general use of classifiers is restricted to languages without compulsory number marking on the noun. This has been related to the fact that these languages normally do not have number neutral count nouns while classifiers combine predominantly with number neutral nouns. Nouns that are morphologically marked for plural are usually incompatible with classifiers, but some exceptions exist (Yucatec, Allan 1977; Hausa, Zimmermann 2008). In both languages, number marking on a classified noun is optional. What does not seem to exist is a language in which the use of a numeral triggers both obligatory insertion of a classifier and obligatory plural morphology on the noun.

The reasons behind the existence of the Sanches-Greenberg-Slobin generalization are not clear at this point, given that number neutral nouns and plurals are usually assumed to have very similar if not identical denotations. Somehow both plurals and classifiers seem to “foreground” the atoms, to use Chierchia’s (1998a) terminology. Further research needs to make clear what this foregrounding is and under what conditions plural nouns may co-occur with sortal classifiers.

### Acknowledgements

I would like to thank Willem Adelaar, Lisa Cheng, Camelia Constantinescu, Klaus von Heusinger, Theo van Lint, David Nicolas, Thilo Schadeberg, Kateřina Součková, Rint Sybesma, Roberto Zamparelli, the Netherlands Organisation for Scientific Research NWO (grant # 276–70–007) as well as the makers of the World Atlas of Language Structures (Haspelmath et al. 2005).

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## 97. Tense and aspect: Time across languages

1. Introduction
2. Aspectual systems
3. Tense
4. Tenseless languages
5. Tense and aspect in discourse
6. Conclusion
7. References

### Abstract

*This chapter discusses the cross-linguistic realization of temporal information. I introduce the notion of tense as the grammatical marking of location in time, and the notion of aspect through which the temporal structure of an eventuality (a state or event) is conveyed, this latter operating both through lexical meaning and through grammatical marking of the perspective or viewpoint from which an eventuality is seen. There is a complex interplay between tense and aspect across languages, and this is discussed with regard to the use of aspectual marking in tenseless languages.*

### 1. Introduction

Information about time is conveyed in language primarily by tense and/or aspect, depending on the resources of a given language. Tense locates events and states in time; aspect classifies and presents them according to key temporal properties. A language has a tense or aspectual system if overt morphemes, possibly alternating with zero, convey the relevant information. Semantically, temporal information is essential: location in time is one of the coordinates of truth-conditional assessment. If a language lacks tense, aspectual information allows the inference of temporal location. Tense and aspect are complementary domains. Tense takes situations externally, aspect deals with their internal temporal properties (Comrie 1976). The terms ‘situation’ or ‘eventuality’ (Bach 1986) include both events and states. Adverbs, present in all languages, also convey relevant information. Adverbs are discussed here only in connection with other topics.

### 2. Aspectual systems

Aspect concerns the internal temporal structure of events and states. Every clause of a language introduces a situation into the universe of discourse; and makes visible all or part of that situation for semantic interpretation and inference. There are two kinds of aspectual information: the properties of the situation itself (event structure) and the aspectual viewpoint (perfective, imperfective, neutral) that makes it semantically visible. The two interact in sentences. In some approaches they are distinct, in others they are not. I will emphasize here the approach in which they are independent, the ‘two component theory’ (Smith 1991/1997). Aspectual information specifies the event argument associated with every predicate.



The element of choice is important in the aspectual domain. Speakers can talk about a situation in the world in more than one way: for instance, depending on the particulars and shared knowledge, an event may be presented as open, ongoing, or bounded. Moreover, a situation can be presented as a state or event, as part of a pattern or discrete; etc. Thus the categories conveyed by aspectual information are ‘speaker-based’. The point will become clearer in the discussion that follows; it is one of the unique features of aspect.

## 2.1. Event structure: Situation type

Situation type indirectly classifies a sentence as expressing a situation or eventuality of a certain category. The categories are at once semantic and syntactic. As semantic concepts, they are idealizations of types of situations, differentiated by a cluster of temporal features. As realized linguistically, each category has unique distributional and interpretive properties; they are covert categories in the sense of Whorf (1956). There are five situation types: State, Accomplishment, Achievement, Activity, and Semelfactive. The two-valued temporal features Static-Dynamic, Telic-Atelic, and Punctual-Durative distinguish the situation type categories. (1) gives English examples of the situation types.

### (1) Situation types

States: static, unbounded

- a. Lee knows the answer. Sam is happy. We own the farm.
- b. Lions eat meat. John feeds the cat every day.

Events: dynamic

- c. Emily drew a picture. (Accomplishment)
- d. They reached the top. (Achievement)
- e. Jan slept. Lee pushed a cart. (Activity)
- f. The bird flapped a wing. (Semelfactive)

The state category includes generic and generalizing/habitual sentences (1b). They express a pattern rather than a particular situation (Krifka et al. 1995). They often have the basic verb constellation of an event or a state, shifted by coercion; see below for discussion (cf. also article 25 (de Swart) *Mismatches and coercion*).

The five situation types that I have mentioned are the basic stock of situation types in language generally, though there is some variation. Situation type is conveyed by the verb and its arguments—that is, the basic verb constellation—and by adverbs and other information in a sentence. The verb contributes important information, but the composite must be considered (Verkuyl 1972). For instance, *He built a house* expresses an Accomplishment, because the event is discrete, limited. But *He built houses* expresses an Activity, because *houses* is unlimited. Again, *discover* is an Achievement verb at the basic level; but *Tourists have been discovering that quaint little village for years* expresses a generalizing state. The semantic properties of the situation type categories hold across languages.

Situations with the feature [dynamic] occur at successive stages, each of which takes time. Every stage of a dynamic situation involves a change. Dynamic situations without duration involve a single stage. With duration, they have an initial endpoint and a final endpoint. Situations with the feature [static] consist of an undifferentiated interval that does not go on in time.

The features [telic-atelic] pertain to the final endpoint of a situation. Telic situations have an intrinsic terminal point, or natural final endpoint. The final endpoint involves a change of state, a new state over and above the occurrence of the situation itself. When this new state is reached the situation is completed and cannot continue. Telic situations have a heterogeneous part structure: there is no entailment from part to whole (Vendler 1957; Kenny 1963; Krifka 1998). Atelic situations have an arbitrary final endpoint: they may terminate at any time. Atelic situations have a homogeneous part structure but, unlike states, only “down to a certain limit in size” (Dowty 1986: 42; also see Taylor 1977); there is an entailment from part to whole. Durative events occur over an interval; punctual events occur at an instant, in principle. Certain punctual events may have preliminary stages, as in *She was reaching the top*. Here the progressive focuses an interval preliminary to the actual event.

The distributional properties that distinguish each category depend partly on semantics and partly on the particulars of a given language. They must be determined for each language. Dynamic situations in English are compatible with the progressive viewpoint, and with pseudo-cleft *do*. They appear with forms of agency and volition; with verbs relating a situation to the passing of time (*spend, take*); with adverbials of motion (*slowly, quickly*); etc. There are also interpretive properties. In sentences about the present with the simple verb form, dynamic constellations have a habitual interpretation, whereas state constellations do not. Accomplishment, Achievement, Activity and Semelfactive verb constellations are all interpreted in terms of dynamic situations.

The feature of telicity has indirect linguistic correlates. Distributionally, telic verb constellations are compatible with expressions of completion, e.g. verbs like *finish* and *take*, as well as *in* adverbials. In contrast, atelic verb constellations are compatible with expressions of termination, e.g. verbs like *stop*, and of simple duration, e.g. *for* adverbials. These facts lead to a useful contrast between types of adverbials and categories of verb constellations. In (2) the completive adverb *in an hour* is good with an Accomplishment verb constellation, and odd with an Activity. The simple durative adverb *for an hour* is good with an Activity, and odd with an Accomplishment verb constellation.

- (2) a. Lee repaired the machine in an hour. (Accomplishment)  
 b. #Lee walked in the park in an hour.  
 c. Lee walked in the park for an hour. (Activity)  
 d. #Lee repaired the machine for an hour.

The odd sentences (here marked by the symbol #) trigger a special interpretation of coercion, in which the verb constellations are reinterpreted to be compatible with the adverbs. Thus (2b) is taken as an Accomplishment, (2d) as an Activity. This distinction between completive adverbials and verbs can be used as a test for situation type, if the language allows. Not all languages have forms that clearly distinguish completion and simple duration.

Durative telic sentences are ambiguous with *almost*, whereas atelic sentences are not. Compare (3a) and (3b):

- (3) a. Pat almost sang in the rain.  
 b. Pat almost opened the door.



(3a) is unambiguous; but (3b) can mean either that Pat almost began to open the door, or almost finished opening it. If a language allows *almost* to appear in a position where it can have either interpretation, *almost* can serve as a semantic test for telicity. The semantic difference between telic and atelic sentences comes out in different relations between progressive (or imperfective) and perfective sentences. With telic sentences there is no entailment from progressive to perfective sentences. Atelic situations are homogeneous, however, so that there is such an entailment. If *Mary was sleeping* it follows that *Mary slept*.

State verb constellations do not appear with forms characteristic of dynamic syntax, and they have contrasting interpretive properties. States are compatible with forms of simple duration. These and other features/tests for situation type are discussed in Vendler (1957), Dowty (1979), and Smith (1991/1997).

One of the key features of aspectual information is boundedness. Telic events (Achievements, Accomplishments), and instantaneous events (Semelfactives, Achievements), are intrinsically bounded; states and atelic, durative events (Activities) are unbounded. Aspectual viewpoint gives boundedness information for a given sentence; see below. Boundedness is important for temporal inference and narrative.

The situation type category labels (State, Accomplishment, etc.) are each shorthand for a cluster of defining temporal features. I will assume that the defining features are stated in a 'temporal schema' associated with each situation type. Compositional construction rules interpret the situation type of a verb constellation as an entity with the defining temporal schema, for instance in Discourse Representation Structure (Kamp & Reyle 1993).

## 2.2. Events

### 2.2.1. Incremental themes and telicity

Telicity involves a change to an affected or effected object, the theme argument. Accomplishments are durative and telic. In an Accomplishment, there is often a close relation between the gradual course of the event and its effect on a theme. As the event progresses, the theme object is gradually affected so that the event 'measures out' the change of state (Tenny 1987). This applies nicely to events such as eating a sandwich, drawing a circle: one begins, taking a bite of the sandwich, drawing a curve. As the eating and drawing progress, there is less and less of the sandwich, more and more of the circle. Finally the sandwich is no more, you have eaten the sandwich; and the circle is complete, you have drawn a circle.

In cases like this, there is a homomorphism between the event's progress and the effect on the theme argument, known as the 'incremental theme' (Krifka 1998). Incremental themes are delimited, with the key property of 'quantization'. Quantized predicates have no proper parts that are instances of the predicate: If *X* is quantized, then  $\forall x,y[(X(x) \ \& \ X(y)) \rightarrow \neg(y < x)]$ . The complementary property is 'cumulative'. For a cumulative predicate that does not denote a singleton set, given any two elements in *X*, their sum is also in *X*.

The theme argument of a clause appears canonically in object position. However, themes can also appear as subjects, e.g. *The ship/John slowly entered the freezing water* (Dowty 1991). The properties 'quantized' and 'cumulative' also apply to nominals; for example, *an apple* and *a glass of water* are quantized, whereas *apples* and *water* are

cumulative. Not all Accomplishments fit this picture. Most serious among counter-examples are telic predicates for which “it makes no sense to see the extent of the event as determined by the extent of the theme” (Rothstein 2004: 98). Examples include *repair the computer*, *prove the theorem*, *wash the clothes*, etc. In these and other cases, the extent of the theme doesn’t determine the final endpoint of the event. Certain resultatives are also counter-examples to the incremental theme account. In *John sang the baby asleep*, for instance, falling asleep does not affect the extent of the baby incrementally (not feet first, then legs, etc.). Again, some predicates with quantized objects need not be telic: *wipe the table* may also be atelic. One might also object that the theory makes too much difference between Accomplishments and Achievements since it doesn’t apply to punctual telic events. The homomorphic theory of telicity holds for many but not all cases. Rothstein (2004) gives an extensive critique of the theory and proposes a general revision.

### 2.2.2. Events and states

The most far-reaching distinction among situation types is that between statives and non-statives, or states and events (cf. also article 34 (Maienborn) *Event semantics*). One way of understanding the difference is through mereology, or part structure. The mereological approach holds that mereological properties, or the relations between part and whole, are sufficient to distinguish states from events. Telic events are heterogenous: the whole is distinct from its parts. In contrast, statives are cumulative and homogenous, with uniform part structures. In this view only telic situations are events. Activities, which are homogenous, do not belong to the class of events. The class of Statives includes all unbounded situations, called imperfectives. Statives include State sentences, Activity sentences, and sentences with a progressive or other imperfective viewpoint (Herweg 1991). All are homogenous, and have the sub-interval property. The class is sometimes referred to as ‘imperfective’. These global categories are superordinate to the categories of situation type and viewpoint. They are claimed to account for sentence interpretation and the contribution of sentences to discourse.

Another approach takes *energeia*, or dynamism, as an essential property of events. Events take place in time. They occur in successive stages which are located at different moments. In contrast, states consist of an undifferentiated period, and continue unless something happens to change them. Taylor comments that although states are in time, they do not take time (1977: 206). *Energeia* accords event status to all dynamic situations. In a sentence with the perfective viewpoint an Activity has a final endpoint, albeit an arbitrary one. Activities move narrative time in discourse, thus providing evidence that they should be considered events (Smith 1999). Thus the global category of Events consists of Accomplishments, Achievements, Activities, and Semelfactives. Events are bounded in different ways. Telic events have intrinsic final endpoints; Semelfactives are single-stage events, with an intrinsic endpoint; Activities have arbitrary final endpoints.

### 2.2.3. Coercion

Aspectual choice enables people to talk about situations in the world in more than one way. States may be presented as events, for instance in an inchoative like *Suddenly she understood the truth*, or with the progressive *I’m loving this walk*. Single-stage events may

be presented as parts of multiple-stage events, as in *He knocked for five minutes*. Events may be presented as part of a pattern, a generalizing state, as in the habituals *We play a game of tennis every week*. Thus verb constellations do not always have their basic aspectual meaning.

‘Coercion’, or situation type shift, explains such cases (cf. also article 25 (de Swart) *Mismatches and coercion*). The basic-level situation type is coerced or shifted to another category. What triggers the shift is additional information. Moens & Steedman (1987) identified coercion patterns in an aspectual network; later work has elaborated on their insights. Coercion is due to a clash of temporal features between the simple verb constellation and another form; the clash triggers the derived-level reading. In (4) the verb constellation is Semelfactive at the basic level; the adverbial is durative.

- (4) Mary coughed for an hour. (Multiple-event Activity)

In the shift, the adverbial feature [-punctual] required for a situation which lasts an hour overrides the [+punctual] value of the basic verb constellation, which would otherwise pick out a single cough, which the aspectual system treats as instantaneous. The coerced sentence has the shifted situation type of Activity, a durative event.

The progressive viewpoint is associated with duration. It triggers a shift to a multiple-event Activity with a Semelfactive verb constellation [-durative], as in (5):

- (5) a. Mary was coughing. (Multiple-event Activity)  
 b. Mary was knocking at the door. (Multiple-event Activity)

These cases resolve a clash between feature values in a consistent, predictable way. Generalizing, the ‘principle of external override’ (Smith 1991/1997) holds for many instances of coercion. The principle holds for clashes between the temporal feature values of a verb constellation and the features of forms external to it. When there is such a clash, the temporal feature of the external form determines the shifted situation type. The principle can be stated in compositional rules.

Coercion explains the oddity—and the marked interpretations—of a sentence like *Lee ran in an hour*. The atelic verb constellation appears with the telic adverbial *in an hour*, and the whole is taken as telic—Lee has a certain amount of running to do. In *Lee read a book for an hour*, a telic verb constellation appears with an atelic adverbial, and the whole is atelic—Lee did some book-reading. Another type of example is the perfect, an aspectual operator that maps a situation onto a state. Coercion is stated as a group of “hidden operators” including grammaticalized aspectual operators like the Perfect or the Progressive (de Swart 1998). The coercion operators C are eventuality description modifiers, which map a set of eventualities onto another set of eventualities. The input and output types are represented as indices on the operator, e.g.  $C_{sd}$ ,  $C_{he}$ ,  $C_{eh}$ . The Progressive requires a mapping  $C_{sd}$ , from stative onto dynamic eventualities. Consider the highly marked sentence *Susan is liking this play*. The stative verb constellation is the input to the coercion operator, the progressive: [PRES [PROG [ $C_{sd}$  [Susan like this play]]]]. A dynamic interpretation is obtained by coercion; it is the right kind of input for the Progressive operator. These approaches provide that the interpretation of coercion is fully compositional.

## 2.3. Aspectual viewpoints

Aspectual viewpoints are salient in many languages of the world. They focus a situation like the lens of a camera. As the camera lens makes a scene available, so viewpoint makes semantically visible all or part of the situation expressed in a sentence. The visible information is available for pragmatic inference. (The terms ‘grammatical aspect’ or, in Wilhelm 2003, ‘outer aspect’ are also used in the literature.) Viewpoints are usually expressed by overt morphemes, for instance, the progressive auxiliary *be + ing* in English (*Joan is swimming*) or by inflections, such as the *imparfait* in French (*Joan nageait*). The key feature of an aspectual viewpoint is whether it makes visible an unbounded, ongoing situation or a closed, bounded one. Imperfective viewpoints are of the former category; perfective viewpoints of the latter. The neutral viewpoint allows either bounded or unbounded interpretation; this is the ‘zero-marked’ case, when no overt viewpoint morpheme appears.

Aspectual systems differ most in the viewpoint component. Languages may have one perfective and one imperfective viewpoint, like English; in contrast, Mandarin has two imperfective viewpoints and three perfectives. Viewpoints may be syntactically obligatory or optional. Linguistic expression of tense and aspectual viewpoint is distinct in some languages, intertwined in others. The two vary independently in English. In French and other Romance languages past tenses code different aspectual viewpoints: the *imparfait* is a past imperfective tense, the *passé composé* and *passé simple* are past perfectives. Finnish, Icelandic and German have only the neutral viewpoint; case-marking may convey boundedness information. In Chinese, Thai and some other languages aspectual viewpoint morphemes are optional and many clauses are zero-marked, with the neutral viewpoint.

### 2.3.1. Perfective viewpoints

Perfective viewpoints generally present situations as discrete, bounded. They vary across languages for Accomplishment sentences. In English, French, and Russian a perfective clause of a durative telic event expresses a completed event. The perfective is conveyed in English by the simple verb form (6a); in French and other Romance languages, by certain tenses (6b); and in Russian by prefix (6c). All three sentences have the same meaning.

- (6) a. He wrote a letter.
- b. Il a écrit une lettre. (French, *passé composé*)
- c. On napisal pis'mo. (Russian, *na-*, a perfective prefix)

The interpretation of completion can be demonstrated with conjunction. It is semantically contradictory to conjoin a perfective sentence with an assertion that the event continues:

- (7) a. #Mary opened the door, but she didn't get it open.
- b. #Donald fixed the clock and he is still fixing it.

In Mandarin Chinese, however, a perfective clause of a telic event only implicates completion. For instance, the first clause of (8) has the perfective morpheme *-le*; the second clause cancels the implicature of completion, and is not contradictory.

- (8) Wǒ zuótiān xiě-le gěi Zhāngsān de-xìn, kěshì méi xiě wán  
 I yesterday write-LE to Zhangsan DE-letter, but not write-finish  
 'I wrote a letter to Zhangsan yesterday but I didn't finish it.'

Completion is expressed directly in Mandarin by certain Resultative Verb Complements (RVC), which appear as verb suffixes with or without *-le*. RVCs contribute to situation type as well as viewpoint; similar morphemes are found in Russian and other languages.

Languages differ as to whether and how the perfective viewpoint applies to statives. Statives do not allow the perfective in Russian, Mandarin, and some other languages; although a stative verb constellation may be coerced to an inchoative. In French and other Romance languages, perfective viewpoints apply to statives, with a bounded meaning. The English perfective applies to states, focusing their complete temporal schema. Thus the English perfective, expressed by the simple verb form, presents statives as unbounded, shown by the felicity of *Mary knew the answer and she still knows it*. Formally, the perfective viewpoint can be stated in terms of endpoints: For an event *e* with the perfective morpheme *P*: *P(e)* holds of interval *I*, where  $t, t' \subseteq I$  and there is no  $t''$  such that  $t'' < t$  or  $t' < t''$ . This statement provides for termination.

### 2.3.2. Imperfective viewpoints

Imperfective viewpoints make part of a situation semantically visible, without information as to endpoints. In principle, imperfectives may focus an internal interval, a preliminary interval, or a resulting interval, depending on the situation. Imperfective viewpoints are conveyed by particular verb forms, e.g. the progressive auxiliary *be + ing* in English; by particular tenses, e.g. the *imparfait* in French; or by a preposition, prefix or suffix. Example (9) illustrates this; the three sentences all have the same meaning.

- (9) a. They are playing ball.  
 b. Tāmen zài dǎ qiú. (Mandarin: *zài*, the progressive form)  
 c. Ils jouaient aux balles. (French: *imparfait* tense)

The focused interval has the sub-interval property. This is why imperfectives are stative in global super-categories of aspectual meaning. General imperfective viewpoints are available for all situations; the French and Russian viewpoints are of this type. The progressive is a kind of imperfective, available for non-statives only: *Mary is singing*, but *\*John is knowing the answer*. There are also stative imperfectives, such as the Mandarin *-zhe*.

Within situation types, languages differ. For instance, Achievements do not allow preliminary intervals to be focused with the progressive in Mandarin, but they may be in English. Again, the imperfective may focus either an internal interval or a resultant interval, giving rise to ambiguous sentences like (10) in Japanese:

- (10) Yoshi-wa atarasii shatu-o ki-te-ita  
 Yoshio-NOM new shirt-ACC put on/wear-IMPF-PAST  
 a. 'Yoshio was putting on his new shirt.'  
 b. 'Yoshio was wearing his new shirt.'

Similar ambiguities arise in other languages. The imperfective viewpoint may be used to convey that a situation is ongoing, and that an event is not completed. The latter is an implicature only. There are many language-particular conventions associated with the imperfective. Russian has a ‘Statement of Fact’ convention by which speakers use the imperfective viewpoint to talk about well-known, completed events such as Tolstoy’s writing *War and Peace*; or to talk about recent events.

There is an intensional component to an imperfective of internal or preliminary interval. The imperfective makes visible stages of a process, which, if continued to its final endpoint, results in an event. The final outcome is unknown, so that one cannot infer from a progressive sentence, *They were building a house*, that the event was completed. Yet one interprets this sentence as expressing a telic event in some sense. This gap between knowledge of the type of situation and its outcome is known as the Imperfective Paradox (Dowty 1979). Dowty models the meaning of a progressive with a branching time model of the future; in at least one branch of the model the event in progress continues to its final endpoint, in others it does not. The approach is further developed in Landman (1992), with the notion of a continuation branch in which the event has a reasonable chance of continuing as expected.

Formal expression of the imperfective viewpoint can be stated for an interval that does not include endpoints;  $\text{Init}(e)$  and  $\text{Fin}(e)$  denote the endpoints of the event. For an Event  $e$  with an imperfective morpheme  $I$ :  $I(e)$  holds of interval  $I$ , where  $\text{Init}(e)$  holds at  $t$  and  $\text{Fin}(e)$  holds at  $t'$ , and  $t, t' \not\subset I$ .

### 2.3.3. The Neutral viewpoint

The Neutral viewpoint allows bounded and unbounded interpretations, depending on contextual information. It is more flexible than either perfective or imperfective viewpoints. The Neutral viewpoint arises in sentences with no viewpoint morpheme, zero-marked clauses. Therefore, it is not relevant to English or other languages in which a choice between overt aspectual viewpoints is obligatory. The neutral viewpoint appears in such varied languages as German, Mandarin Chinese, and Navajo.

In the two-component approach to aspect, all sentences have an aspectual viewpoint. Viewpoints make all or part of a situation visible for semantic interpretation (Smith 1991/1997). The neutral viewpoint is weak, requiring only that part of a situation be visible. This accounts for the indeterminacy of zero-marked clauses: they can be taken as bounded or unbounded, depending on the context in which they appear. The two possibilities are mutually exclusive for other viewpoints. The formal statement:  $N(e)$  holds for times  $t$  of interval  $I$ , where  $t \subseteq e$ . There is a default pattern of pragmatic inference for the zero-marked clauses (see section 3 below).

## 3. Tense

Tense is a grammatical form with temporal meaning; it conveys “grammaticalized location in time” (Comrie 1985: 10). Tense forms are usually morphologically bound inflections on the verb. The category has a limited set of members, forming a closed system. Choice from within the category is obligatory, so that all main clauses of a tensed language carry temporal information. In another approach, Dahl proposes a general

category of tense, aspect, and mood (1985, 2000). The building blocks for tense-aspect-mood are the individual tenses, aspects, and moods. They represent grams, on the cross-linguistic level a restricted set of gram types. We will not pursue this approach here. (Cf. also article 50 (Portner) *Verbal mood*.)

The dimension of time is single and unbounded, analogous to space but simpler. Like space, time requires an orientation point for location. The speaker is the canonical center of linguistic communication, so that the basic temporal orientation point in language is the time of speaking, Speech Time (*now*). ‘Absolute tenses’ are deictic: they are anchored to Speech Time (SpT). The present is simultaneous with SpT, the past precedes SpT, the future follows SpT. There are also ‘relative tenses’ such as the English past and future perfect, that have a flexible orientation point.

The grammatical domain of tense is the clause. Each tense assigns a temporal location to the situation talked about in its clause. Temporal adverbials, which are optional syntactically, affect the information conveyed by tense. In simple tenses they narrow down the time indicated by tense.

The temporal expressions of a language form a closed system, a limited domain. However neither the distribution nor the interpretation of tense is systematic in a combinatorial sense. Tenses do not combine nor embed freely, as would be expected in systems such as those of tense logic (Prior 1967). Tenses do not iterate (there is no \**Kim had had left*); complex tenses do not behave as nested operators, with one tense morpheme within the scope of another tense morpheme, so e.g. *Kim had left* is normally analyzed semantically as involving a single pluperfect temporal operator, rather than as a combination of separate past and participle operators. Nor is the relation of a temporal adverb to tense that of an operator: in *Mary left yesterday*, for instance, we don’t interpret *yesterday* as prior to the time indicated by the past tense. Rather, the adverb further specifies that time.

### 3.1. Tense systems

Tense systems differ in the distinctions they mark. The basic possibilities for absolute tenses are past, present, and future. *The World Atlas of Linguistic Structures* (Haspelmath et al. 2005) presents a study of tense distinctions across languages and their geographical distribution. The *Atlas* is based on a sample of languages distributed as evenly as possible throughout the world. The maps show 75 languages with both inflectional past and future; 59 languages with inflectional past, no future; and 35 languages with inflectional future, no past. In a detailed discussion of tense in the *Atlas*, Dahl & Velupillai (2005: 268–270) consider 222 languages, drawing also on the typological surveys in Dahl (1985) and Bybee, Perkins & Pagliuca (1994). More languages in the sample have both past and future, or neither, than languages that have only one of the two categories. Tense distinctions may contrast a positive value with a negative one—e.g., past vs. no information about time; or they may contrast two positive values—e.g., past vs. nonpast.

The most common distinction is between past and nonpast. Of 222 languages, 138 have a past-nonpast distinction, 88 have no such distinction. Some languages mark degrees of remoteness from Speech Time. About one-fifth of languages with past tense mark one or more remoteness distinctions in the past. The most common distinguishes ‘today’ from ‘before today’. There are some areal tendencies. The largest homogenous past-marking area extends from Iceland to the Horn of Africa to Bangladesh; other areas are Australia, northern South America, and central New Guinea.



Future distinctions, marked inflectionally, are made in about half of the language sample: 110 of 222 languages. There are some areal tendencies but no homogenous areas, unlike the past tense. Languages with inflectional futures tend to appear in North America, Australia, and New Guinea; on the South Asian continent; and in some European languages. South America and Africa are varied. In this study, irrealis categories that are not inflectional were not considered to be future tenses. Futures tend to be less bound morphologically than present or past tenses (Ultan 1978). In English, the future *will* patterns syntactically and semantically with modals rather than with tense. The special properties of *will*, often called *woll* in its abstract form (Ogihara 1996), are not discussed here. In other languages, including French, there is an inflectional future that patterns with the tenses (Smith 2006). The grammatical status of the future is evidently a language-particular matter.

Future tenses inevitably have a component of modality, or uncertainty. As Lyons (1977: 677) puts it: "Futurity is never a purely temporal concept; it necessarily includes an element of prediction or some related notion." The future is 'open': we cannot know what will happen but can only predict, with more or less certainty. Thus the categories of irrealis, modal, and future categories overlap. The close connection is often seen in historical development: future tenses tend to develop from modal categories (Ultan 1978). The component of modality makes the future more complex informationally than the past; this will be important in an account of temporal interpretation in tenseless languages, section 4 below.

Relative tenses are anchored not to Speech Time, but to another time in the linguistic or pragmatic context. The perfect, e.g. *Mary had already opened the package by then*, *Mary will have opened the package by then*, is the most common relative tense. The perfect conveys that a situation occurred anterior to a time specified in the context. Of the 222 languages examined by Dahl & Velupillai (2005), 108 or almost half, have a perfect construction. In the areas of Western Europe, South and Southeast Asia, languages tend to have them. Many languages in Africa, Mesoamerica, and the northwestern corner of South America also have perfects. The meanings of the perfect are discussed further below. The other relative tense is the future-in-past, which conveys that a situation occurs after a given reference time, as in the complement clause of *Gretchen said that she would leave soon*. Relative time reference is common in subordinate clauses.

Not all languages have tense. Of the 222 languages in the *Atlas* study, 53 languages have neither past or future tense. Temporal adverbs are not included in the categories discussed above; so far as I know they are optionally available in all languages. The temporal structure of certain language families is still unclear: for instance, whether Arabic, Korean, and certain Mayan languages have tense is in dispute. For Arabic, Brustad (2000) argues convincingly that the language is aspectual and tenseless.

### 3.2. Syntax

In tensed languages, tense is an obligatory bound morpheme that expresses temporal information. The tense morpheme is part of the grammatical 'spine' of a sentence. As such, tense has grammatical ramifications: it is involved in agreement, case, anaphora, and the finite/non-finite distinction. All main clauses have an obligatory tense morpheme, so that all main clauses convey temporal information. English, French, German, and Hindi are tensed languages.



The simplest syntactic assumption for a tensed language is that the basic phrase marker includes TensePhrase as a functional category. The tense morpheme has scope over an entire clause. In some accounts, e.g. Discourse Representation Theory, it is this structure that is then the input used to form a semantic representation. In a more syntactic approach, Stowell (1996) proposes that tense is a dyadic temporal ordering predicate. He posits a functional category ZP (for ZeitPhrase), the complement of tense; ZP is modeled on DP. The arguments of the tense head T represent times and situations. See also Giorgi & Pianesi (1997) and Demirdache & Uribe-Extebarria (2000).

Tenseless languages have a syntactic AspectPhrase category but no TensePhrase. These languages introduce some temporal information, but the information must be supplemented by pragmatic inference, as developed below. I do not posit syntactic structure that corresponds to the pragmatics of temporal inference. Thus although all languages convey information that allows temporal location, they do so with different syntactic structures and semantics.

### 3.3. Semantics

The semantics of tense deals with the times expressed by tense, and their relations; the notion of temporal standpoint, or temporal perspective, associated with tense; the interpretation of so-called 'sequence of tense'; and the problem of how temporal relations between situations are conveyed in tensed languages. Not all semantic theories address all these questions.

In traditional tense logic (Prior 1967), tense is an operator that existentially quantifies over times. Partee (1973) gives strong evidence against the treatment of tense as an operator. She shows that tenses have both deictic and anaphoric uses, somewhat like pronouns. One celebrated example of the latter is *I didn't turn off the stove*, uttered when driving down the road: here the past tense is "used to refer to an understood particular time not introduced by previous linguistic context" (Partee 1984: 244). Tenses should be represented as variables that bind the event argument of a predicate. The notion that tense operators existentially quantify over time is maintained in current theory. There is evidence that tense does not have the entire sentence in its scope, but that relative clauses and nominals are independent (see section 3.5 below).

The 'simple tenses' of past, present, and future require two times to represent their temporal meanings: the anchor of Speech Time (SpT) and the time of the situation expressed in a clause, Situation Time. Perfects and other relative tenses require three times. The past perfect, for instance, conveys that the situation talked about precedes another time that may or may not be specified:

(11) (Yesterday,) John had arrived.

John's arrival precedes another time, here 'yesterday'. Three times are required to account for the meaning of this construction: Speech Time, Situation Time (SitT), and another time, 'yesterday', known as 'Reference Time'. The perfect has an aspectual component: aspectually all perfects are stative. The notion of Reference Time (RT) was introduced by Hans Reichenbach (1947). His classic argument for RT contrasts a simple tense with the corresponding perfect: the two differ conceptually but not truth-conditionally. For instance:

- (12) a. Mary arrived.  
b. Mary has arrived.

The difference between (12a,b) is that of temporal standpoint or perspective. In (12a) the event is set squarely in the past: RT is the same as ET. (12b) presents the event from the standpoint of the present, so that RT is the same as SpT. Generalizing, all tenses are taken to involve RT. (13) states schematic meanings for three tenses:

- (13) Present:  $RT = SpT$ ,  $SitT = RT$   
 Present Perfect:  $RT = SpT$ ,  $SitT < RT$   
 Past:  $RT < SpT$ ,  $SitT = RT$

If simple and perfect tenses are analyzed in this way we capture both conceptual and truth-conditional meanings.

A second argument, also due to Reichenbach, concerns the temporal relation between events and statives or progressives in multi-clause sentences. In (14a) the arrival occurs during the interval of the smile; in (14b) it precedes the smile.

- (14) a. Mary was smiling when John arrived.  
b. Mary smiled when John arrived.

The notion of RT provides a locus for relating the events in a principled manner. The same argument can be made for events expressed in independent sentences (Hinrichs 1986). Partee (1984) notes that Reichenbach's notion of Reference Time provides the antecedent needed for the anaphoric use of tense.

Another argument for RT concerns the phenomena of shifted deixis. Deictic adverbials such as *now*, *in three days*, etc., normally anchored to the moment of speech, can shift their anchor to a past (or future) time, as in (15):

- (15) Mary sat down at the desk. Now she was ready to start work.

In such contexts the shifted *now* suggests Mary's perspective. The notion of RT is the anchoring point for this perspective. The approach of Reichenbach is widely accepted, although difficulties in his system have been pointed out and proposals made to improve it. The system as Reichenbach proposed it allows for too many relations between times; Comrie (1985) and Hornstein (1991) each have proposed changes to deal with this problem.

The boundedness of a situation determines the nature of its location at Situation Time. Bounded situations occur within the Situation Time interval; for instance, in *Mary walked to school* the event of walking occurs within the past interval talked about (see 16). Unbounded situations—ongoing events and states—overlap or surround the Situation Time interval; for instance, in *Mary was walking to school* the event extends beyond the interval talked about in the sentence (again see 16). These relations are part of the representation of tense meaning.

- (16) Bounded events (E) are included in the SitT interval: *Leigh built a sandcastle*.  
 $SitT \subseteq E$

Unbounded events and states (S) overlap the SitT interval: *Leigh was working*.  
E/S O SitT

Tense meaning of the Reichenbach type has been implemented in Discourse Representation Theory (DRT) with full construction rules (Kamp & Reyle 1993, Smith 1991/1997; cf. also article 37 (Kamp & Reyle) *Discourse Representation Theory*). DRT develops a dynamic semantic representation, known as a Discourse Representation Structure (DRS), that encodes information from the surface structure of the successive clauses of a text. Times are introduced as discourse referents into the DRS by tenses, and their relations stated as conditions.

A neo-Reichenbach semantics has also been developed in the framework of semantically-based syntax. In this approach, tenses are dyadic predicates of spatiotemporal ordering: they establish a topological relation between two time-denoting arguments. The tense head may have an external and internal argument (Enç 1987; Stowell 1996; Giorgi & Pianesi 1997; Demirdache & Uribe-Extebarria 2000). Another theory, due to Klein (1994), also involves three times. Klein posits that tense meaning relates Topic Time and Speech Time, while aspect relates Topic Time and Situation Time. The notions of Topic Time and Reference Time are quite similar: Topic Time is 'the time for which a claim is made' in a given sentence (Klein 1994: 3).

Other dynamic semantic approaches to tense meanings involve two times. De Swart (1998), for instance, gives a DRT account of this kind. The past, present, and future tenses involve two times, Speech Time and Situation Time. The perfect introduces the consequent state of an event into the DRS. As a state, the temporal interval of the situation overlaps the time talked about. Presumably in a past or future perfect, not discussed directly by de Swart, the situation overlaps the past or future time introduced by the tense. A 'relational semantics' view of tense is developed by von Stechow (1995): he proposes a formal account with a distinguished variable that denotes speech time, or a different anchor time. Operators on this variable produce the additional tenses.

### 3.4. The present perfect

The present perfect has some special peculiarities. Like other perfects it conveys anteriority and stativity: the present perfect focuses a current state that results from a prior event. Reference Time is equal to Speech Time (*now*) and Situation Time is anterior to now; this is the neo-Reichenbach view sketched above. Under appropriate circumstances the present perfect may convey different meanings, notably the perfect of Continuing Result, the Experiential, the Recent Past, Current Relevance, Indefinite Past. We ask whether these interpretations are semantic, involving distinct meanings, or whether they are due to pragmatic factors. McCoard (1978) argues convincingly for the latter case: pragmatic, contextual factors are responsible for the different interpretations. Rather than recognize different perfects, McCoard suggests one general meaning that underlies them all: the notion of an 'extended now' period. The extended now is a period that ends at Speech Time and extends into the past, perhaps delimited by temporal information in the sentence or context. The speaker chooses to present a given situation as falling within the extended now period. The extended now (XN) approach has been widely accepted. However, there are some points about the present perfect that it does not explain.

Within the XN approach, two distinct semantic meanings for the present perfect are now recognized: the universal and the existential (Mittwoch 1988). Sentence (17) is ambiguous:

- (17) Sam has been in Boston for 20 minutes.

On the existential reading there is a 20-minute period in the relevant XN interval in which Sam was in Boston; on the universal reading, the XN interval is a 20-minute period extending to the present, with the implication that Sam is in Boston now. Mittwoch explains the two readings in terms of scope. On the existential reading the adverb has wider scope than the perfect [Pres (w,i) [Have[for 20 minutes] (Sam be in Boston)]]; on the universal reading the perfect has wider scope than the adverb [Pres (w,i) [for 20 minutes [Have] (Sam be in Boston)]]. In confirmation of the scope hypothesis, note that when the adverb is preposed, as in *For 20 minutes Sam has been in Boston*, only the universal reading arises.

The properties of the XN interval itself have also been investigated, in an attempt to explain a strong constraint on the temporal adverbials and the present perfect in English. Adverbials that include Speech Time are good but past adverbials are not:

- (18) a. Sam has arrived now.  
b. \*Sam has been in Boston yesterday.  
c. \*I have seen Dana last year.

This constraint does not hold for all languages: Norwegian, Icelandic, German, Dutch, and other languages allow past adverbials with the present perfect. Further, the constraint is limited to the present perfect: adverbs specifying Situation Time are good with past perfects, e.g. *Sam had been working in Boston on Tuesday*. Past adverbials may appear with *since* in the present perfect: *Sam has been in Boston since last year*. (See Mittwoch 1988 for discussion of *since*.)

The differences can be accounted for nicely by providing that the XN interval differs across languages. In English the XN interval includes Speech Time. This explains why past adverbials cannot appear in the present perfect (Klein 1992; Pancheva & von Stechow 2004). The system of German is different. In German (and some other languages), the XN interval does not necessarily include Speech Time.

### 3.5. Dependent clauses

Tenses in dependent clauses are governed by the verb of the matrix clause and do not always have their expected, consistent values. This phenomenon is known as ‘sequence of tense’ (SOT). Latin had an intricate set of rules for the sequence of tense in matrix and complement clauses, including the perfect, the subjunctive, the imperfective, and occasionally the infinitive (Binnick 1991).

In English, SOT rules apply most clearly to a sequence of past tenses in main and complement clauses. To convey that the complement situation occurs at the time of the main clause—the simultaneous reading—the past tense appears (19a,b). In such cases it does not have the standard relational value of anteriority. To convey that the complement event time is anterior to the matrix time, the past-of-past reading, either the past or the

pluperfect is used (19c). Thus sentences like (19a,b) have an anterior and a simultaneous reading:

- (19) a. Jones said that Mary won the race.  
       b. Jones thought that Mary was sick.  
       c. Jones said that Mary had won the race.

Special provision must be made for the simultaneous reading. The European languages have SOT rules with variation. In Russian and other Slavic languages, and in Amharic, the simultaneous reading of a stative complement clause is expressed with present tense. In such cases the present tense has its standard relational value of simultaneity, dependent on the main clause. German allows both the English and Russian patterns. In some West African languages, complement tense is 'neutralized'; in some languages, such as Imbabura Quechua, relative tenses appear in complement clauses (Comrie 1985: 61, 104).

The special interpretation of tense in these dependent contexts can be handled by rule or by semantic features (Enç 1987; von Stechow 1995). An interesting case is that of a present tense embedded under a past tense, which has a 'double access' reading:

- (20) Mary said that Jones is sick.

The speaker is responsible for the truth of the complement both at the moment of speech, now; and for its truth at the past time of Mary's speaking (Abusch 1997).

Dependent tenses include the subjunctive, found in European languages. The subjunctive is sometimes called a 'mood', contrasting with the indicative (assertion) and possibly the optative (wish). The subjunctive appears with verbs of speaker attitude, especially those that express doubt or uncertainty; but in other cases it has a purely grammatical function. For instance, the French temporal conjunction *avant que* (before) requires the subjunctive. Infinitivals and other non-finite forms also appear in dependent contexts, and in such cases the licensing context provides the infinitival clause's temporal interpretation. For example, the infinitival *to win* is given a futurate interpretation in *Lee wants to win*, whereas *to lose* is given a past interpretation in *Lee was disappointed to lose*. Adverbial clauses in many languages require agreement with the tense of the main clause, sometimes expressed as zero tense.

### 3.6. Atemporal tense meaning

In certain contexts, tense has atemporal meaning. The past tense is often associated with non-actual, irrealis, and distanced meanings. The conditional is one such context: past tense frequently does not refer to time, but rather has a modal meaning. Consider these examples, based on Iatridou (2000):

- (21) a. If Jack took his medicine, he would get better.  
       b. If Jack had taken his medicine, he would have gotten better.

The past tense in both examples is atemporal. (21a) conveys that, if at some present or future time Jack takes his medicine, he can be expected to get better. There is an implicature that the medicine will not be taken. (21b) conveys that at some past time, if Jack took

the medicine, he would get better; and there is an implicature that the medicine was not taken. In (21b), the pluperfect *had taken* is morphologically (past (past)); it conveys both past and the atemporal meaning. Cross-linguistic studies show that, in conditionals, non-present tenses often have atemporal meanings (Steele 1975). The counter-factual meaning is salient in these examples, but it is only an implicature: it can be cancelled. For instance, one can reply to (21b): *Fortunately, he did (take it) and he is (better)*. The counter-factual meaning is strong in the past examples because past events are often known to the speaker and hearer. But when the facts are not known, conditional predictions about the past are natural and, in context, need not implicate counter-factuality.

Iatridou (2000: 246) proposes an abstract account of the past tense morpheme in which it has a single meaning, yet operates in more than one domain (specifically, times or worlds). This meaning is stated with an ‘exclusion feature’. Ranging over times, a past tense morpheme with the exclusion feature means that ‘the topic time excludes the utterance time.’ Ranging over worlds, it means that the world of the speaker, the actual world, is excluded—as in the conditionals discussed above. Verbs of wishing trigger, in their complements, the atemporal interpretation of the exclusion feature of the past tense morpheme. Other languages have additional contexts in which the exclusion feature comes into play.

### 3.7. Nominals and relative clauses

The temporal interpretation of noun phrases is independent of the main clause. For instance, consider the interpretation of *fugitives* in (22):

(22) Every fugitive was in jail.

The possible readings include individuals who are fugitives now, or were fugitives before they were in jail. Other examples include nouns that have a specific temporal modifier:

- (23) a. The former president came to the party.  
b. He met his future wife when they were 3 years old.

In the first example, the president was a ‘former president’ at the time of the party; in the second, the ‘future wife’ was a child at the time of the meeting. Such facts can be accounted for if nouns, like verbs, have temporal arguments whose values are supplied by the utterance context (Enç 1987).

In some languages nominals have been described as having a tense system independent of the main verb tense. Lecarme (2004) suggests that nominals in Somali, an African language, have a tense system. The past tense has a set of atemporal uses in contexts which involve a modal meaning. Lecarme suggests that an exclusion feature like that posited by Iatridou for main clause tenses can account for these cases. Many other cases where there is evidence for nominal tense systems, notably among South American languages, are discussed by Nordlinger & Sadler (2004). However, Tonhauser (2006) argues that at least one of these languages, Paraguayan Guaraní, is better described as having nominal aspect rather than a nominal tense system.

Relative clause tense is independent of the main clause tense. The tense of a relative clause is evaluated with respect to a contextually salient reference time.

- (24) a. Lee married a man who would become President.  
 b. Sam talked to the person who will chair the meeting.  
 c. Sheila will read all about those islanders, who had a weird cargo cult.

The examples show that both restrictive and non-restrictive relative clauses are temporally independent.

### 3.8. Tense uses: Primary and secondary

The prototypical uses of tenses follow their labels: a present tense sentence talks about present time, past tense about past time, etc. In these uses a given tense is compatible with adverbials of the same type, for instance, present tense with present adverbials, *Cynthia is in town now*. There are other uses, however.

The present tense is quite flexible. In many languages, including English and Romance, the combination of present tense and past adverbial—known as the ‘historical present’—can be used to talk about the past, typically in a narrative context. Such forms are often said to make narration vivid, by presenting past events as present, as in (25). The historical present can alternate with the past tense, or it can appear in sustained sequences.

- (25) Yesterday something unexpected happened. This man walks up to me and he says ...

The present tense can also be used to talk about the future, and can even appear with future adverbials, as in the use of the simple present in (26a), or in the construction known as the periphrastic future (26b), frequently found across languages. Yet another use of the present is to express general truths in sentence that are taken to be timeless (26c).

- (26) a. The train leaves tomorrow at 2pm.  
 b. Tomorrow the train is going to arrive.  
 c. The Texas redbud blooms in the early spring.

This flexibility shows that the present tense has a relational value of simultaneity, allowing it to be simultaneous with an explicitly given time as well as SpT.

The past tense can be used to convey politeness, as in (27):

- (27) I wanted to ask you a question.

Here the past tense sets up a distance between speaker and hearer, conveying respect for the hearer.

## 4. Tenseless languages

### 4.1. Temporal information in language: A classification

Languages can be classified according to how they convey temporal information. A three-way classification allows for the variation that we find: there are fully tensed languages, mixed-temporal languages, and tenseless languages. Tensed languages have been

discussed above. Mixed-temporal languages have some of the characteristics of tensed languages. They have inflectional morphemes and/or temporal particles and clitics that give direct temporal information. However, these forms are syntactically optional and do not participate in other grammatical processes. Thus a given sentence may or may not convey temporal information; Navajo and other Athabaskan languages are of this type. Finally, there are languages without temporal inflections or particles, such as Mandarin Chinese and Thai, some Mayan languages, and many others (Dahl & Velupillai 2005). I will refer to them as tenseless languages.

#### 4.2. The inference of temporal location

The sentences of tenseless and mixed-temporal languages need not have direct temporal information—though temporal adverbs are always possible. Aspectual information enables inference about temporal location. The property of boundedness is the key to such inference. We find that Speech Time, Reference Time, and Situation Time, and their relations, are relevant to these languages. Aspectual viewpoints code the relation between Reference Time and Situation Time, while the relation between Speech Time and Reference Time is due to inference. This is the key difference between tensed languages and other languages. In the latter, grammatical forms do not relate Reference Time to Speech Time.

This discussion focuses on Mandarin Chinese; the findings apply, *mutatis mutandis*, to other tenseless languages (e.g. Thai, Yukatek Mayan) and to mixed-temporal languages (e.g. Navajo). There is evidence that the grammar of Mandarin Chinese must recognize Reference Time and Situation Time (Smith & Erbaugh 2005). Consider first the two perfective viewpoint suffixes *-le* and *-guo* (cf. Mangione & Dingxuan 1993). They convey different relations between Reference Time (RT) and Situation Time (SitT). The suffix *-le* conveys that the SitT interval is simultaneous with RT; *-guo* conveys that SitT precedes RT. The examples illustrate, from Chao (1968).

- (28) a. Wǒ        shuāduàn-le      tuǐ  
          I        break-LE        leg  
          ‘I broke my leg (it’s still in a cast).’
- b. Wǒ        shuāduàn-guo      tuǐ  
          I        break-GUO        leg  
          ‘I broke my leg (it has healed since).’

Reference Time explains the contrast: the viewpoints code different relations between SitT and RT. The *-guo* perfective conveys that SitT is prior to RT; it is a perfect (in that it also has additional properties). The approach holds for all aspectual viewpoints, including the neutral viewpoint; the default is that RT and SitT are simultaneous. Additional evidence for RT in Mandarin is similar to that for tensed languages: (i) there are adverbials *yǐjīng* (‘already’) and *cái* (‘only then’) which require an RT different from SitT; (ii) there are occurrences of temporal deictic forms that have a shifted interpretation analogous to the use of the deictic *now* in *now it was quiet*; and (iii) situations in complex sentences and in discourse can stand in temporal relations that force some component sentences to be interpreted at RT.



Informal study of a variety of other languages that are mixed-temporal or tenseless (e.g. Thai, Navajo, Yukatek Mayan, Mam, ASL) suggests that the arguments for RT hold for them as well. The basic pattern of default temporal location holds quite generally for sentences without direct temporal information.

- (29) Temporal location pattern—a default  
     Unbounded situations, Present  
     Bounded events, Past

Situations located in the future require explicit future information. This pattern can be explained by three pragmatic principles. Two are specifically linguistic, the third holds for information generally.

- (30) Pragmatic principles of interpretation
- a. The Deictic Principle  
     Speech Time is the central orientation point for language. The present is located at Speech Time; the past precedes it, the future follows.
  - b. The Bounded Event Constraint  
     Bounded situations may not be located in the present.
  - c. The Simplicity Principle of Interpretation  
     Choose the interpretation that requires least information added or inferred.

Since the speaker is the center of linguistic communication, Speech Time is the default orientation point. The Deictic Principle (30a) allows situations to be located in the past, present, or future. But we do not locate all situations freely. There is a constraint that blocks bounded situations from location in the present: the Bounded Event Constraint (30b). In taking the temporal perspective of the present, speakers obey a tacit convention that communication is instantaneous. A report of a bounded event is incompatible with a present interpretation, because the bounds would go beyond the present moment (Kamp & Reyle 1993: 536–537). There are some real and apparent exceptions, e.g. sports announcer narratives, performatives, and stage directions (Smith 2003). Situations located in the present are unbounded: they include ongoing events (*Mary is drawing a circle*); particular states (*Agnes is excited*); and general states (*Louis often feeds the cat*). The third principle is a general simplicity principle. People often utter sentences that underdetermine an interpretation, saying the minimum that is necessary. Receivers fill out what is said with additional information, making the simplest possible completion. This is a very general principle of information-processing (Kanisza 1976).

Clauses without explicit temporal information are incomplete as to temporal location. By inference, unbounded situations are located in the present, since, by the Deictic Principle and the Simplicity principle this is the simplest deictic interpretation. On the other hand, bounded events are located in the past. The explanation for this familiar observation appeals to all three principles. By the Deictic Principle and the Bounded Event Constraint, bounded events are oriented to Speech Time but cannot be located in the present. They might then be located in the past or the future. By the Simplicity Principle, they are located in the past. The past is simpler in terms of information conveyed than the future because the past doesn't have the element of uncertainty that is always part of the future.

### 4.3. Applying the principles

Sentences with overt aspectual viewpoints are interpreted by default following the pattern given above in (29). Sentences with the neutral viewpoint require another principle, the Temporal Schema Principle, to explain their temporal interpretation, and this is introduced below. Adverbial or other information in the context can override these defaults.

I continue with examples from Mandarin Chinese (Smith & Erbaugh 2005), but it should be noted that the principles also apply to languages like English. By the Bounded Event Constraint, bounded events are not located in the present; rather, simple present tense event sentences are taken as generalizing, or habitual, hence the interpretations available for a sentence like e.g. *she sings*.

#### 4.3.1. Sentences with overt aspectual viewpoints

Imperfective viewpoints focus situations as unbounded, with no information as to end-points. Mandarin has two imperfective viewpoints, a progressive (*zai*) as in (31), and a stative imperfective (*-zhe*). Imperfective sentences such as (31) are taken as located in the present. The Deictic and Simplicity Principles predict this interpretation.

- (31) shíshí-shàng zhè-zhǒng móshì shì zài chāoxí zìrán kēxué  
 fact-on, this-kind model be ZAI copy natural science  
 ‘In fact, this model is already copying the natural sciences.’

Perfective viewpoints focus events with bounds, located in the past by default. There are three perfectives: *-le*, *-guo*, and resultative verb complements (RVCs). (32) has an RVC suffix:

- (32) ... zhè shì wǒ hé duō-wèi niánqīng xuézhě jiāo-tán hòu  
 ... this be I and many-CL young scholar exchange-talk after  
 suǒ dé-dào de jiélùn.  
 SUO reach-RVC DE conclusion

‘This is the conclusion which many young scholars and I reached after exchanging views.’

As noted, perfectives cannot be located in the present, by the Deictic Principle and the Bounded Event Constraint. They are located in the past rather than the future by the Simplicity Principle.

#### 4.3.2. Zero-marked sentences: The neutral viewpoint

There is a pragmatic pattern of interpretation for zero-marked clauses, based on event structure. One infers the boundedness of a clause from the temporal features of the situation expressed. Telic and single-stage events are intrinsically bounded, states and atelic events are unbounded.

## (33) Temporal Schema Principle (a default):

In a zero-marked clause, interpret boundedness according to the temporal features of the event or state entity.

This is a special case of the Simplicity Principle; it supplements the weak semantic information of the neutral viewpoint. In some languages, e.g. Thai, duration also plays a role in the temporal interpretation of zero-marked clauses (Smith 2008).

The Temporal Schema Principle allows the inference of boundedness; armed with this information, the pragmatic principles lead to temporal interpretation. Sentences with intrinsically bounded situation entities are taken as past, others are taken as present. Thus the interpretation of zero-marked clauses has one inferential step more than that of sentences with overt aspectual viewpoints. In another approach to zero-marked clauses, Bohnenmeyer & Swift (2004) propose that they be interpreted in aspectual viewpoint terms. Telic events are perfective, unbounded and atelic situations are imperfective. The two approaches are similar in recognizing boundedness in event structure as the key property.

Decoupling the two RT relations is the key to temporal inference in tenseless and mixed-temporal languages. Overt aspectual viewpoints code the relation between RT and SitT; the relation between RT and SpT is inferred. In zero-marked clauses, both boundedness and temporal location are inferred. This account of temporal inference shows the close relation between aspect and temporal location.

## 5. Tense and aspect in discourse

While the syntactic domain of tense and aspect is the clause, they have important discourse effects as well. Tense and aspect contribute to the advancement of discourse, to point of view and to subtle effects of patterning. The main factors are the same across languages. In discourse of tenseless languages, aspect plays an important role.

Discourse can be considered at the global and local levels. Globally a discourse belongs to a genre, e.g. fiction, news article, courtroom interrogation. At the local level of the passage, five 'discourse modes' can be recognized: Narrative, Report, Description, Information, and Argument-Commentary; the list ignores conversation and procedural discourse (Smith 2003). The modes are characterized with two interpreted linguistic features, both relating to temporality. One is the type of situation entity the text introduces into the universe of discourse, the other the principle of advancement. For situation entities, we recognize the main classes of Eventualities (events and specific states), Generalizing Statives (generic and habitual or characterizing sentences), and Abstract Entities (embedded facts and propositions). Each class has distributional correlates, so that they are linguistically based. Different situation entities are predominant in each discourse mode.

### 5.1. Tense interpretation in discourse

Three patterns of tense interpretation are found in discourse, depending on the discourse mode of a clause. They are Continuity, Anaphora, and Deixis. All texts advance through a structured domain, but not in the same manner: texts of different modes have different principles of advancement. Advancement is a linguistic feature in the sense that information in the text gives rise to a given interpretation. There is also a literal sense of advancement, in

which the receiver processes a text unit-by-unit. I discuss tense interpretation in this section; but note that the principles of interpretation hold for tenseless languages also.

Narrative is the most-studied type of discourse mode, and genre. In Narrative, situations are related to each other, and tense conveys Continuity; it does not involve time. The point is made emphatically by Weinrich (1973), who distinguishes text *commenté* and *raconté*, discursive and narrative. Tense is usually unchanging throughout a narrative; conventionally, past is the narrative tense although there are many narratives in the present, including the historical present. Within a given pattern of tense continuity, the perfect tenses allow reference to prior time; the prospective future-in-past allows reference to a subsequent time. Narrative introduces events and states into the universe of discourse. Aspect determines narrative advancement in tensed and tenseless languages; see below.

In Report, situations are related to Speech Time and tense is Deictic. The orientation center is usually Speech Time, in newspaper reports. But it may also be a past time. Time progresses forward and backward from that time. Report passages present situations from the temporal standpoint of the reporter. They are, like Narrative, mainly concerned with events and states. But in reports, the relation to Speech Time determines temporal advancement. This is due to the deictic pattern of tense interpretation. In (34) the adverb *here* in S1 reinforces the sense of the deictic center.

- (34) S1 A week that began in violence ended violently here, with bloody clashes in the West Bank and Gaza and intensified fighting in Southern Lebanon. S2 Despite the violence, back-channel talks continued in Sweden. S3 Israeli, Palestinian and American officials have characterized them as a serious and constructive dialogue on the process itself and on the final status issues. S4 News accounts here say that Israel is offering as much as 90 percent of the West Bank to the Palestinians, although it is difficult to assess what is really happening by the bargaining moves that are leaked. (*New York Times*, 5/20/2000)

In this mode, tense often changes from past to present, or to future. Reports in tenseless languages also follow the deictic pattern, by the principles of inference given above.

In Description time is static, suspended: there are no significant changes or advancements. Tense is anaphoric to a previously established time, and the text progresses spatially through the scene described. Typically in Description there is a locative phrase with scope over the material that follows. Tenseless languages have passages of description, usually with time adverbials that establish a Reference Time and/or a relationship to a prior situation. The Informative and Argument modes have deictic tense interpretation, but are atemporal. They progress through metaphorical changes of location in the information space of the text. Information passages tend to have a preponderance of general statives; abstract entities predominate in argument passages.

## 5.2. Aspectual contribution to discourse

Aspectual information plays a key role in the narrative mode. The aspectual property of boundedness determines narrative advancement. We interpret the events of a narrative as advancing in sequence, one after another. Bounded events—event clauses with the perfective viewpoint—advance narrative time; unbounded events and states do not. This is the basic finding of discourse dynamics (Kamp & Rohrer 1983, Partee 1984,

Hinrichs 1986). Temporal adverbials and inference also advance narrative time. When a narrative changes place, for instance, the reader often infers that there has been a change in time.

Imperfectives, progressives, and statives, including perfects, are taken as simultaneous to the previous Reference Time. The example illustrates:

- (35) S1 She put on her apron, took a lump of clay from the bin and weighed off enough for a small vase. S2 The clay was wet. S3 Frowning, she cut the lump in half with a cheese-wire to check for air bubbles, then slammed the pieces together much harder than usual. S4 A fleck of clay spun off and hit her forehead, just above her right eye. (Peter Robinson, *A Necessary End*)

In this fragment, bounded events appear in sentences 1, 3, and 4; they advance the narrative. S2 expresses a state, which we interpret as simultaneous with the previous RT. I ignore flashbacks, changes of scale, etc., which require special treatment. Narrative advancement can be modeled as a succession of RTs, or as a succession of Temporal Perspective points (Kamp & Reyle 1993).

Unexpected aspectual choices are often found in Narrative. The imperfective or progressive may appear where one would expect a perfective, an “idiosyncratic” choice (Fleischman 1991); such choices are found in medieval and contemporary French texts, and in other Romance languages. Actually these choices are far from idiosyncratic: they are expressive, conveying point of view and/or foregrounding. The expressive uses of aspect are possible because it is a closed, obligatory sub-system, often redundant with other information in a text.

In tenseless languages, narrative advancement proceeds along the same lines. Situations are related to each other, and narrative time advances with bounded events. Boundedness is conveyed with aspectual viewpoint and, in zero-marked sentences, with events that are intrinsically bounded. By the Temporal Schema Principle (33), such sentences are interpreted as perfective. Expressive aspectual choices also appear in tenseless languages. They are especially common when aspectual viewpoints are obligatory. Progressives appear in contexts that move narrative time—for instance, in narrative texts of the Mayan language Mam. They are used in Navajo narratives to highlight key events.

The entities introduced in Descriptive passages are states, ongoing events, atelic events. One can also assume a tacit durative time adverbial for descriptive passages.

- (36) S1 In the passenger car every window was propped open with a stick of kindling wood. S2 A breeze blew through, hot and then cool, fragrant of the woods and yellow flowers and of the train. S3 The yellow butterflies flew in at any window, out at any other. (Eudora Welty, *Delta Wedding*)

When telic events appear in description, they do not have their usual telic value. This is due to the implicit durative adverbial, which coerces the telic events, shifting them to atelic events. Thus the telic events in sentence 3 are coerced to stages of multiple-event activities. In descriptive passages of tenseless languages the situation entities are also unbounded. Thus Description passages tend not to have perfective sentences, although with coercion they are possible.

## 6. Conclusion

Aspectual systems provide event structure and aspectual viewpoints. The viewpoints focus events and states like the lens of a camera, making semantically visible all or part of the situation. Boundedness, a key feature in temporal interpretation, is conveyed by both the event structure and viewpoint components. Three times are needed, in tensed and tenseless languages, to account for temporal meanings. In tensed languages, tense codes times and their relations. Tenses introduce Speech Time, Reference Time, and Situation Time; tense also codes two relations, that between RT and SitT, and that between RT and SpT. This second relation determines temporal location. In tenseless languages, the two temporal relations are conveyed differently. Aspectual viewpoints introduce Reference Time and Situation Time and code their relation. The relation between Speech Time and Reference Time is not grammatically coded, but is inferred from aspectual information. The aspectual property of boundedness determines the inference of temporal location, guided by general pragmatic principles. Bounded events are located in the past, unbounded situations are located in the present. These are defaults: contextual information can override them, and can imply, for example, that an unbounded situation is located in the future.

This overview of time in language shows that the temporal sub-systems of tense and aspect are closely related. The similarities across languages are striking, although there are real differences. Yet, it is impossible to cover a wide range of languages in a single introductory article; I hope that the reader will be able to extend the approach to languages not discussed here.

### *A brief note from the final editors of the manuscript*

Professor Carlota S. Smith died on May 24, 2007 at the age of 73 after a long battle with cancer. She taught at The University of Texas at Austin for 38 years, and was the Dallas TACA Centennial Professor in the Humanities. Professor Smith's work on tense and aspect, perhaps her most important line of research, began in the mid-1970s. In many papers and in a very influential book (*The Parameter of Aspect*, published in 1991 by Kluwer), she analyzed how languages encode time, and introduced her signature 'two-component' theory of aspect. Her work on temporal aspect is notable for its empirical foundation in her careful analyses of languages, including English, French, Russian, Mandarin, and Navajo. Through her many years of research on Navajo, she became a member of the Navajo Language Academy. In 2003, Cambridge University Press published Professor Smith's second book, *Modes of Discourse*. This book analyzes the grammatical properties that distinguish different genres of discourse, and brought the analytic tools of linguistics to the humanistic study of literature.

Much of Professor Smith's most fruitful work is available in the posthumous collection *Text, Time, and Context: Selected Papers by Carlota S. Smith* (Springer 2009, edited by Richard P. Meier, Helen Aristar-Dry, and Emilie Destruel). The current article is the final piece of work that Professor Smith completed; she submitted it to the editors just a month before her death. It will presumably be the final publication of a distinguished and productive scholar who has forever changed the way linguists think about time.—David I. Beaver & Richard P. Meier, Austin, April 9, 2011.

### *Acknowledgment*

We wish to thank Yahui Huang for her assistance in checking the Mandarin data.

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Carlota S. Smith (†), Austin, TX (USA)

## 98. The expression of space across languages

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### Abstract

*This chapter provides an overview of the expression of space in the semantics of natural language. Dimensionality and location in space are clearly among the most basic concerns for any mobile organism and language prominently provides a rich way to communicate about spatial information. After a brief discussion of the linguistic constructions which typically express spatial relationships, the major semantic subdivisions of space and spatial relationships are presented: dimensionality (of a single entity), topological relationships (e.g. containment), deixis (or the spatial relationship between an entity and a simple reference point), reference frames (the geometry of locating one entity in space), and motion events. Throughout the discussion, there is an emphasis on semantic typology and cross-linguistic variation.*

### 1. The importance of space

The very essence of our existence is fundamentally spatial. We evolved in space, live in space, think about space, find things in space, and naturally we talk almost incessantly about space: the dimensionality of objects, location in space, change of spatial location, and the geometric relationship between objects situated in space. Given this fundamental nature of spatial locating and reckoning, space may be considered one of the most fundamental cognitive and semantic domains.

Spatial expression is often among the first elicited material in early language descriptions and accounts for a substantial portion of grammatical descriptions of well described languages. For example, spatial language constitutes a substantial portion of the use of adpositions, adverbial expressions, adjectives, and complex noun phrases.

Because space is understood as “concrete” (vs. abstract, figurative, or metaphorical) and because spatial relations are well describable in all languages, it provides an ideal and prevalent source domain (see article 26 (Tyler & Takahashi) *Metaphors and metonymies*) of vocabulary and grammatical constructions which can be used to describe non-spatial relations as well.

The various approaches which take spatial language and/or reasoning as fundamental to many or most other expressions are subsumed under the cover term “Localism”. Localist approaches argue that space is the premier source for expressions which refer to more abstract non-spatial relations. (See section 2 below.)

However, because spatial expressions are so commonly extended to refer to non-spatial expressions, expressions which are wholly dedicated to spatial expression are relatively rare. For example, while the adposition systems of many languages seem to largely express spatial relations, they also commonly express argument structure, temporal, causal and other relations. As a result, this chapter is organized according to the ways different types of spatial relations are commonly expressed in natural language rather than according to typical grammatical classification.

In recent decades, the range of linguistic variation concerning spatial expression has been demonstrated to be far greater than had been widely assumed primarily on the basis of analyses of (Indo-)European languages. The implications for semantic theory of this broader variation are only now beginning to be explored. For instance, since around 1990, some of this cross-linguistic variation has led to testing of various versions of the *linguistic relativity hypothesis* (see, e.g., article 95 (Bach & Chao) *Semantic types across languages*, or Pederson 2010).

There is a large and growing interest in the semantics of spatial language in various applied disciplines. For example, robotics and artificial intelligence are concerned with how to operationalize spatial representations and to implement human—machine interactions. Geographic Information Science has a fundamental concern with the language of space as the results of even a simple query will vary widely depending on the interpretation of the spatial terms used. More generally, spatial language and representation is a core concern of cognitive science, especially developmental psychology (see article 107 (Landau) *Space in semantics and cognition*).

For some general references on space beyond this short chapter, a good starting point (in German) is Klein (1991). For more recent typological collections see Levinson & Wilkins (2006a) and Hickmann & Robert (2006). Many references to spatial language are in fact more specific to particular subdomains of space and will be referenced in the appropriate sections below.

## 2. Localism

Localism is generally defined as the hypothesis that spatial expressions (including direction) are more basic, grammatically and semantically, than various kinds of non-spatial expressions. Claims of Localism can be of various strengths, from relatively weak claims that selected non-spatial domains are understood in terms of space to stronger claims that virtually all “abstract” categories are structured with a spatial understanding.

Some of the more forceful proponents of localism within linguistics include John Anderson (Anderson 1973) and Jan van Voorst (van Voorst 1993). Localism is also implicit in much work within Cognitive Linguistics and other fields which give a prominent role

to semantic mapping relations or metaphor, e.g., Lakoff & Johnson (1980). Within psychology, many since Miller & Johnson-Laird (1976) have argued that spatial organization is of central importance in human cognition.

Within semantics, localism has often structured the metalanguage. For example, Jackendoff (1983), following the line of work descending from Gruber (1965: 188) argued for the Thematic Relations Hypothesis: "In any semantic field of [EVENTS] and [STATES], the principal event-, state-, path-, and place-functions are a subset of those used for the analysis of spatial location and motion." Non-spatial expressions were understood to have a theme (akin to the located object), a reference object (akin to the Ground or Landmark), and a relationship which assumes the role played by location in the field of spatial expressions. (For an update on Jackendoff's Conceptual Semantics, see article 30 (Jackendoff) *Conceptual Semantics*.)

For example, Anderson (1973), Clark (1973) and others have long noted that temporal expressions follow the same form (or derive from) spatial expressions: *The future/building lies ahead of us*, *We meet at 10:00/the drugstore*, etc. The diachronic literature (see also articles 99 (Fritz) *Theories of meaning change* and 100 (Geeraerts) *Cognitive approaches to diachronic semantics*) often notes the development of temporal markers from spatial marker as well. For example, Traugott (1978) observes that "nearly every preposition or particle that is locative in English is also temporal" and all of these developed from initial spatial uses. The purely temporal *for*, *since*, (*un*)*til* were initially spatial terms as well. This is presumably motivated by the ready availability and conceptualizability of spatial relations together with a transparent mapping from the "here" to the "now". For example, any increase in travel distance from a present location correlates nearly perfectly with increasing time since being at that location. (However, for a challenge to the orthodox assumption that temporal markers inherently derive from spatial markers, see Tenbrink 2007.)

Tense markers commonly derive historically from deictic forms and motion verbs (e.g. English *gonna* and French *allez* + infinitive). Aspectual forms, especially progressives and statives, commonly derive from locative constructions (e.g. the English progressive: *is hunting* historically deriving from *is on/at/in hunting*). Similar observations of parallels between space and other non-spatiotemporal domains (possession, states, properties, etc.) argue for a generalized use of the metalanguage and analytical tools of spatial language for an understanding of non-spatial expressions.

## 2.1. Grammatical case

Various frameworks model grammatical case relations as largely spatially derived. For example, DeLancey (1991) argues that the traditional underlying cases need to be redefined in terms of AT or GOTO relations: the three basic case roles (Theme, Location, and Agent) boil down to "theme AT location", "theme GOTO location", and "Agent CAUSE theme GOTO location". In other words, states and events are essentially understood in terms of spatial relationships. Like DeLancey's, other case hierarchy theories essentially attribute a progression of force from an agent through the other mentioned participants but with varying degrees of spatial metalanguage, cf. the occasionally spatial descriptions of *action chains* in Langacker (1991), and the purely *energy transfer* model of transitivity in van Voorst (1996) which has no mention of spatial relations at all.

Of course, language with explicit case marking will typically indicate spatial relationships with at least one or two grammatical cases. Cases described as "locative", obviously

tend to be spatial, but they may in fact vary considerably from language to language in their semantics. For example, the Lithuanian locative case *-ė* tends to represent containment relations, but not contact or support relationships. There may also be multiple “locative” cases. For example, in Tamil, there is a general locative *-il* (for general location, such as *a cat is on the mat*). However, Tamil also has a case marker *-iṭam* which refers to location with an agent capable of control over the located item (akin to English *having money on him*).

Dative case is commonly used to express direction as well as locations. It often alternates with a locative case in interesting ways. To continue the Tamil example, ownership would be marked with the dative *-ku* (1s-Dat money Copula-Pr-3sn “I have money, [but not necessarily on my person]”). Replacing the dative case with the locative *-iTam* would indicate temporary control or possession, but not conclusive ownership. Compare with the English: *I have money* vs. *The money is with/on me*.

German famously has an Accusative/Dative distinction with many of its prepositions such that the Dative case indicates static location (e.g. *in dem* or *im* for static containment) while the Accusative indicates a change into that locative relationship (e.g. *in das* or *ins* for entering into containment). In contrast, French would use *dans* for both situations.

Instrumental/manner expressions and passive “by-phrases” are often marked with forms which historically derive from spatial path markers. For example, Dutch or German *door/durch* was a path marker which came to be used for marking a demoted agent via an instrumental use.

## 2.2. Fictive motion

Localism posits that spatial language is used to describe properties and relationships which are not literally construed as spatial. The idea of *fictive motion* (Talmy 1996) is that scenes or events which in terms of objective reality are not actually motion events are described or construed as though they were motion events. (The roots of this analysis are found in Talmy 1983.) For example, *This fence goes from the plateau to the valley* and *The scenery rushes past* are not referentially about motion even though they use motion verbs and path expressions. Indeed, most path expressions can be used for either dynamic or static spatial relations (*the man/the grass runs along the river*). Similarly, cases which express path (ablative, allative, inessive, etc.) typically have both dynamic and static uses as well.

These are not cases of metaphor, according to Talmy, as they are generally perceived as motion and therefore involve no mapping for literal source to metaphorical target. That said, the choice of verbs and other lexical items do seem to indicate that there are constraints on the ascription of motion. It is not an accident that one says *the highway runs through the mountains* rather than *the highway walks through the mountains*. English *run* has been conventionally understood to apply to cases other than actual motion events, whereas other motion verbs are prohibited from such uses.

Many of Talmy’s examples of fictive motion involve fictive paths. For example, shadows are construed as cast by objects onto and along the Ground (in reality, shadows are just areas struck by and reflecting less light). Perspectives are also represented using path expressions: *The trees get shorter as you move down the road*.

Fictive motion is seen as less veridical with reality of motion (i.e. likely not actual physical motion) and *factive motion* is understood to be more veridical (and likely true).

Events described as motion events must be understood as fictive as a matter of degree. There are clear parallels with the study of *perceived motion* in the visual system. For example, a linear flashing of a series of lights, when rapid and close enough, will be perceived as fictive motion.

Parallel work on non-real, non-metaphorical motion has also been pursued by Matsumoto (Matsumoto 1996b) which explores language-specific patterns across English and Japanese. See also Matsumoto (1996a) which relates fictive motion to change of state expressions more generally. Earlier treatments relating non-actual motion in language and vision include Jackendoff (1987) and Langacker (1986).

### 3. Formal marking of spatial expression

As mentioned above, no single area in grammar is purely dedicated to spatial expression. Given the tendency of spatial forms to become conventionally used for non-spatial expressions, it seems that should a language have a dedicated spatial system at one point, it would rapidly expand to non-spatial uses as well.

Nonetheless, there is a predominant spatial use of adpositional expressions in many unrelated languages. These are especially commonly used for expressing *topological relations* (cf. section 5). This is perhaps the closest to a spatially dedicated form class commonly found across languages. Here too, however, non-spatial uses of adpositions are frequent. Landau & Jackendoff (1993) argue that the prepositions are the forms which answer the *Where?* questions in language. This work drew heavily from work on European languages and today alternatives to adpositional expression are better known.

The *Basic Locative Construction* (or BLC) is a term formalized from work at the Max Planck Institute for Psycholinguistics. The assumption is that each language will have a construction which is the simplest answer to a question “Where is X?”. This is not to be confused with existential questions such as “Is something there?”. Levinson & Wilkins (2006b) propose that cross-linguistic variation leads to a BLC hierarchy, such that if a BLC is used for certain spatial descriptions, one can predict that it will probably also be used for certain others. For example, if a BLC can represent a *Figure* (the located object, see section 5 below) which is a part of a *Ground* (the reference or landmark object), then it will probably be usable for adornment or clothing—at least if this latter use is not preempted by a more specialized construction.

There has been particular interest in the necessity and/or specificity of a verb in the BLC. This is most elaborated in Grinevald (2006) who proposes a range of verb specificity in the BLC as follows:

- No locative information (no verb or just an existential copula)
- A dedicated locative verb (e.g., “to be at”)
- Postural verb (includes information about the disposition of the Figure, e.g. *sitting* vs. *standing*)
- Locative stems (e.g., classificatory verb stems as in Kwakwaka: “bulky object is somewhere”)
- Positional verbs (e.g., Tzotzil “seated on something elevated above the ground”)

The specificity of the verbs through this list generally increases through an increasing specification of the Figure in the verb. As a partial exception to this trend, postural verbs

elaborate on the nature of the relationship between the Figure and the Ground e.g. *surround* rather than just on the disposition of the Figure in isolation.

Positional verbs are robustly exemplified by Mayan languages (see Brown 1994 for Tzeltal and Haviland 1992 for the closely related Tzotzil). For example Tzeltal *pachal* is a verb used of wide-mouthed containers canonically ‘sitting’. In other words, positional verbs commonly have semantic elements typical of both postural and classificatory verbs.

One question regarding typical BLC constructions cross-linguistically asks how comparable they are in terms of information structure. Generally speaking, languages with extensive adposition systems have no obligatory use of an extensive set of verbs and vice versa. However, this is only an imperfect correlation. English generally does not require postural verbs in its BLC, though German with its comparable set of prepositions, generally does require postural verbs.

According to Kahr’s survey (Kahr 1975), every language has at least one adposition or affix that can be used to indicate that a Figure is in a spatial relationship to a Ground (although this form is likely to have other grammatical functions as well). When the relationship is canonical, often nothing more is needed. But to pin down a spatial relationship more precisely speakers may add a *relational noun* that specifies a particular *region* in relation to the Ground object, such as its top or ‘above’ region, its bottom or ‘below’ region, its side, back, inside, or outside region.

- (1) a. Neko ga matto no ue ni iru  
       cat SUBJ mat GEN ABOVE LOC be  
       ‘The cat is at the mat’s above-region’ (= the cat is on the mat)
- b. Ringo ga booru no naka ni aru  
       apple SUBJ bowl GEN inside LOC be  
       ‘The apple is at the bowl’s inside-region’ (= the apple is in the bowl)

To complicate matters, there is an unclear boundary between adpositions and relational nouns. Relational nouns are generally considered distinct from adpositions by virtue of still having formal properties of nouns (especially in taking articles or genitives) as in *on the top of*. (These typically derive from *part nouns*.) However, with time, relational nouns tend to lose their status as separate nouns and increasingly approximate adpositions or become part of compound adpositions, e.g. in English, *on top of*, *atop*, *across*, *between*. As mentioned in the previous section, grammatical case often expresses spatial relationships and there is a well-traveled diachronic pathway from adposition to case. There is also a strong tendency for adpositions and case to have complex semantic and constructional interactions. Note that adpositions often occur as compound adpositions, e.g. *in+to*, which raises the question of whether the forms should be treated as semantically compositional as well.

There is sometimes a broad discrepancy between how much information about the same scene speakers of two languages might provide. Languages such as English are *hyperspecifying* in their use of prepositions. For example, even if the containment of a book with respect to a drawer is completely expected, an English speaker will still specify that *the book is IN the drawer*. Other languages are more commonly *pragmatically inferencing* in that they will use a general locative form except when the location cannot be expected to be readily inferred or otherwise needs particular mention. For example, under most



circumstances, a boat and a fish will both be described as “locative” with respect to the water. However, should the boat be sunk or the fish be floating, then they would probably be described as “in(side)” or “on (top of)” the water respectively. Of course, while a language may be hyperspecifying in one domain, it will probably be pragmatically inferencing in another domain. Indeed these differences across languages in their description of space give each language much of its character.

Speakers and languages also vary in whether or not a particular situation should be expressed as though it were spatial at all. For example, an English speaker would typically describe an apple as (*impaled*) on a skewer. Describing this as a fundamentally spatial scene seems next to impossible in other languages which must say some variant of *the apple has been speared by the skewer* which is essentially an agent or instrument expression with only an implicit locative relationship.

*Path verbs* also express a Figure-Ground relationship in what might otherwise be an agent-patient grammatical construction. For example, *the fence surrounds the house* is not grammatically distinct from *the man eats the apple* or for that matter from *the men surround the prisoner*. Occasional path verbs incorporate Ground information, e.g. English *deplane* or French *se terror* ‘to land’, but all path verbs necessarily require spatially appropriate Grounds. For example, *enter* requires a Ground which can contain the Figure/subject. In many languages, simplex path verbs (most notably “go”, “come”, and “ascend”) have become conventionalized to the point of being obligatory direction markers that attach to a main *manner of motion* verb. Without the direction marker, the motion is typically taken to be *non-translational*, e.g. “running (in place)” (see section 8).

#### 4. Dimensional expressions

Dimensional expressions are those expressions which denote the spatial extent of an object. Dimensional expressions as usually discussed are the direct expressions of one or more dimensions of an object. Most common are expressions of breadth, depth, etc. As these are essentially the spatial properties of objects divorced from relational information, they are typically treated separately from spatial semantics and treated as object properties instead. There is an extensive typological summary by Lang (2001). See also the collection Bierwisch & Lang (1989) and a more recent theoretical overview by Tenbrink (2005).

In addition to direct expressions of dimensions, many languages make systematic use of classification systems which rely in large part on dimensional classification. For example, typical East and Southeast Asian nominal classifiers will include categories for long and thin objects, approximately round objects, and so on. Verbal classification systems, for example the classificatory verb stems of Navajo (see Young 2000), will have some stems specific to particular shapes, or dimensional configurations, such as *t-sooz* for flat and flexible items, though these forms seem to generally represent functional qualities rather than purely dimensional characteristics.

#### 5. Topology

The relationship between *Figure* and *Ground* is generally taken to be asymmetric: most descriptions of Figure and Ground cannot reverse these two roles. Talmy’s example is that a bicycle makes a reasonable Figure relative to a church as Ground, but it is not typically

appropriate to locate a church with respect to a bicycle. Similar asymmetries are found in other domains such as comment/topic and assertion/presupposition suggesting that at least with respect to language behavior, such asymmetry is a fundamental pattern.

Most commonly associated with adpositions, the expression of *topological relations* between a Figure and a Ground encompasses concepts of containment, contact, and other *non-metrical* concepts. Talmy (1977) borrowed the term *topology* from mathematics where it refers to geometry in an infinitely stretchable space. However, in semantics the term tends to be used for notions beyond the few which are topological mathematically (e.g. partial containment, and adjacency). Further semantic topology notions which are recurrently invoked include verticality, support, attachment, and sometimes occlusion. Topological space distinctions are quite distinct from the projective coordinate systems of reference frames discussed below.

Importantly, topological relations are not by any means limited to adpositions. For example, Finnish distinguishes between contact (case), containment (case) and inferior vertical (adposition):

- (2) a. The book is on/in/under the desk. (M. Bowerman, p.c.)  
 b. Kirja on kirioituspöydä-llä / kirioituspöydä-ssa / kirioituspöydä-n alla  
 book is desk-on / desk-in / desk-GEN under

Herskovits (1986) presented an extensive examination of largely topological relations expressed by English adpositions which helped to popularize semantic analyses of adpositions more generally. She argues for larger categories of *use types* as a way of categorizing the apparently endless range of spatial uses of English prepositions into larger generalizations. Since this work, there has been a small industry of cross-linguistic research in the expression of topological space. Initial reports assumed prepositions were semantically similar cross-linguistically, but as surveys were completed, notable variations were reported. This variation should not have been surprising since many second language learners will attest that learning the nuances of a foreign adposition system is maddeningly difficult.

For example, Bowerman (1996) gives the simple example of four languages each with a dramatically different pattern. Of the five logically possible groupings of these three topological relations (a cup on a table, an apple in a bowl, and a handle attached to a door), only one has not been found (a grouping of support “on table” with containment “in bowl” but without attachment of “handle to door”), cf. Fig. 98.1. These cross-linguistic patterns are examined in Bowerman & Pederson (1992) and subsequent work by Feist (2000, 2004). One finds that within the considerable cross-linguistic variation, there are systematic cross-linguistic patterns. This suggests strong universalist factors driving and constraining language particular patterns. That said, Choi & Bowerman (1991) demonstrate that even at early stages of spatial language acquisition, children more closely follow the adult pattern of their target language than they resemble children learning typologically different languages.

A recurrent problem for the semantic analysis of topological relationships is determining to what extent language variation represents different semantic patterns of the forms or differing construals of the reference. For example, English speakers say that freckles are found on the face (spots on a surface), whereas Swedish speakers say that the freckles



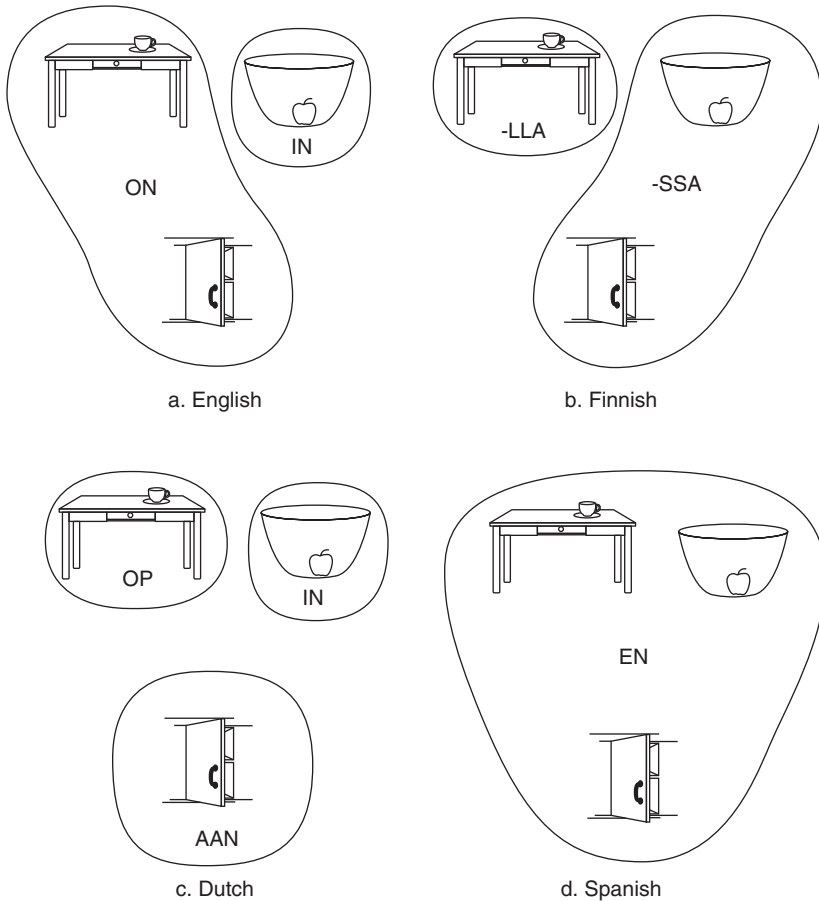


Fig. 98.1: *Classification of three static spatial situations in English, Finnish, Dutch and Spanish (from Bowerman 1996: 394)*

lie in the face (points within a bound area). This difference is not attributable to differences between the forms for ON and IN in English and Swedish, but to conventional construal of how to think about freckles. Similarly, Clark (1973) cites the example of British vs. American English collocation of the *house in the street* vs. *on the street* as indicating a different pattern of use rather than differing understandings of *in* and *on* across these two dialects. (Neither collocation is strictly geometrical as most houses lie alongside streets and neither “in” nor “on” them.)

However, the use of topological spatial expressions has also been demonstrated to be highly influenced by non-geometric factors. Specifically the role of the functional relationship between the Figure and Ground can profoundly affect whether or not a supposedly geometric term can be used. For an English example, if an apple is effectively prevented from rolling away because of its relationship to a bowl, then the apple can be said to be “in” the bowl even if it may lie atop a pile of apples such that it is geometrically far beyond the boundaries of the bowl. For research in functional determination, consult Carlson-Radvansky et al. (1999), Coventry et al. (2001), and Carlson & Kenny (2006).

## 6. Spatial deixis

There is a confusing array of uses of the term spatial deixis. Most generally it means any spatial reference which must be contextualized (typically relative to a speech event) for interpretation. Miller & Johnson-Laird (1976) is the standard reference for early modern work for deixis and spatial reference generally.

In this section, I briefly discuss spatial deixis as a class of spatial expressions distinct from topological relations (section 5) and reference frames (section 7). Specifically, these are the demonstrative expressions which rely on a spatial deictic center and indicate, e.g., *distal* (away from the deictic center) vs. *proximal* (near the deictic center) contrasts and other similar notions. For a comprehensive cross-linguistic overview of the semantics of demonstratives and spatial deixis, consult article 90 (Diessel) *Deixis and demonstratives* as well as Diessel (1999), Enfield (2003) and Imai (2003). There is also a typological overview in Haase (2001) and Klein (2001, section 44.6 Ortsdeixis).

While these contrasts may be expressed most commonly through a demonstrative pronoun system, some languages have developed further grammatical expressions for such contrasts. For example, Tamil has a prefix set (proximal, distal, and archaically medial) which can affix to different word classes and derive deictic demonstrative pronouns, determiners, and even some adverbs (e.g., *i-ppaṭi* “proximal: in this way”, *a-ppaṭi* “distal: in that way”).

Like topological relations, most deictic systems are metrically neutral in that a distal form may be used for a distance which might be used with a proximal form when the relevant scale differs. Generally speaking, most languages have two or three grammaticalized demonstratives indicating spatial deixis, though languages have been reported with as many as five purely spatial demonstratives.

Two term systems, unsurprisingly, indicate something like a proximal vs. distal distinction broadly applied. Some languages allow distal forms to be used for proximal locations when they are contrastive in some non-spatial way (e.g. referring to something less topical or less recently mentioned), whereas other languages prohibit this. For example, Arrernte speakers (Central Australian Pama-Nyungan) cannot refer to “this tooth” vs. “that tooth” when both are clearly proximal to the speaker (D. Wilkins, p.c.).

When there is a third demonstrative, interesting variation emerges. Essentially, one of the forms remains proximal, but there are multiple possible interpretations of what non-proximal might be. Some languages (e.g., Spanish and Japanese) use an addressee-based system in which the addressee by virtue of being a speech act participant is not distal, but is necessarily less proximal than the speaker. Alternatively, the notion of distal can be subdivided into nearer and farther, or visible and non-visible, relatively lower and higher, and so forth—presumably depending on the ecological needs of the community. For a study of demonstrative usage in interaction and an argument for minimal semantic description of the demonstrative forms, see Enfield (2003).

## 7. Reference frames

Reference frames are defined here as the system of locating one object relative to another using a co-ordinate system. As such, a reference frame is distinct from simple deictic location (here/there). Some deictic expressions clearly relate one item to another indirectly by virtue of expressing “by me”/“by you”, though these can be understood as essentially

indicating a search space without co-ordinates. A reference frame will narrow a search space by specifying some sort of co-ordinate system on which to locate an object. There are several ways to typologize reference frames, though the most widely followed today is the system most carefully presented in Levinson (2003). In this typology, there are exactly three frames of reference found in natural languages: the *intrinsic*, *relative*, and *absolute*. The intrinsic reference frame is presumed to be a linguistic universal (though languages may vary in how elaborately and when they use this system). Relative and absolute reference frames are taken to be optional alternatives.

As reference frames by definition rely on a co-ordinate system, there is a natural distinction between systems which derive the co-ordinates from features which are *intrinsic* to the Ground and those which derive their co-ordinates from features *extrinsic* to the Ground. Thus, examples of the former, such as “car in front of the store” or “stone to my right” are considered to be both examples of intrinsic reference frame use. Because the description of this Figure-Ground relationship remains constant even if the array of Figure and Ground are rotated relative to the world or an observer, these relationships have also been called “orientation-free” (Danziger 1994, 2001) whereas all other co-ordinate based depictions might be called “orientation-bound”.

Alternatively, a major distinction can be drawn between reference frame depiction which relies on speech-act participants (the speaker, but occasionally the hearer) for the determination of the co-ordinates and those depictions which do not derive from speech act participants. That is, “stone to my/our/your right” might be grouped with “car to the (my/our/your) right of the sign”. However, following Levinson, the former is intrinsic whereas the latter is *relative* because the latter’s use of co-ordinates derive from a viewer who is distinct from the Ground object. That is, in a relative reference frame, the use of *left/right* for relations on a transverse axis and the use of *front/back* for the sagittal axis consist of a transposition of a co-ordinate system from the speech act participant onto a presumed co-ordinate neutral Ground object. Language communities which have been reported to not use the relative reference frame appear to seldom use left and right in their otherwise robust inventory of intrinsic expressions, though intrinsic uses may still occur. This suggests that the use of “left” and “right” terms cross-cuts the terminological distinction of intrinsic versus relative. Indeed, no language appears to have been described which uses one term for “intrinsically left” and another term for “relatively/extrinsically left”.

Most discussions of relative reference frame implicitly assume an *egocentric* perspective or a reference frame based on the speaker as viewpoint. However, what we might term an *altercentric* perspective based on the hearer’s potentially distinct perspective is frequently found as well, e.g., *place the box to your left of the mailbox*.

As an alternative to both an intrinsic co-ordinate system and a speech-act participant relative system, a co-ordinate system can be derived from the world beyond the Figure, Ground, and viewers more generally. These *absolute* co-ordinates may consist of relatively abstract notions such as “North”, which may only be inferred from a landscape. Alternatively, they may be quite context-dependent, perhaps an impromptu use of a local, visible landmark in a direction extending beyond the Ground object (e.g. “toward the wall”). Accordingly, the classification of “absolute reference frame” comprises a considerable range of expressions and widely varying degrees of conventionalization and abstraction across linguistic communities. Note that whereas a relative reference frame is essentially defined as *viewpoint dependent* in that moving the speaker and or hearer

inherently disrupts the orientation of the coordinates, absolute reference frames, like intrinsic reference frames, are *viewpoint independent*.

Mühlhäusler (2001) provides an overview of the reference frame literature from the 1990's. Svorou (1994) examines the use and origins of terms for "before" and "after" (typical relative reference frame terms) across a carefully sampled set of the world's languages. Pederson (2003) argues speakers may not be consistently using coherent reference frames so much as ascribing ad hoc and conventional relationships using a number of cognitive operations. While it may be heuristically useful to have a three-way classification scheme, this may be an oversimplification of actual usage. Spatial terms in natural language seem to regularly extend from one reference frame to another suggesting at a minimum that there are rather porous boundaries between reference frames. For example, the term for "up(hill)" became associated with a particular cardinal direction in Tzeltal (Brown & Levinson 1993) and in Tamil (Pederson 2006).

Generally then, it can be a misleading simplification to describe a linguistic community as "relative-speaking" or "absolute-speaking" without defining the conditions of reference frame usage. The use of a particular reference frame (or a subtype such as a local landmark versus a cardinal direction system) typically varies with context. A New Yorker may speak of *uptown* vs. *downtown* when navigating Manhattan but not when arranging objects on a dinner table. For a discussion of scales in spatial reference see Montello (1993).

Additionally, as Levinson notes, speakers of presumably any language will use environmentally derived absolute co-ordinates when locating objects on a purely vertical dimension. Gravity has special salience and can almost always be referenced. However, even on the horizontal plane at the same scale, speakers will often use one co-ordinate system for transverse relations and another for sagittal relations. Even within a single reference frame, several languages have been reported as distinguishing directions along one axis of a reference frame (e.g. the sagittal or inland/seaward), but not differentiating direction on the other axis (e.g. the transverse or along the coast). See, e.g., Wassmann & Dasen (1998).

Indeed, the sagittal and transverse relationships have such perceptually distinctive properties it is remarkable that they are ever expressed using a single reference frame. As a simple example, English *left of the tree* and *in front of the tree* are both typically described as expressing the relative frame of reference. However, the assignment of "left" uses a transposition of the viewer's co-ordinates without any rotation as though the viewer were standing in the place of the tree facing the same direction. Hill (1974) describes rural Hausa speakers as using an *aligned* strategy in which the "front" of a tree is the side further from the speaker. However, to assign the "front" of the tree in French or English, the co-ordinates need to be rotated 180° from the left/right projection such that the front of the tree is treated as though it were facing the viewer. This *opposing* strategy is described in Vandeloise (1991). As a third variation, "front" may be used as an *ascribed intrinsic* use in which a Ground is treated as having a front by virtue of an ascribed path or direction rather than a current feature of the Ground. Someone standing at a speaker's back might nonetheless be "in front" of the speaker if that person is closer to the "head" of a queue.

There are relatively few studies that systematically explore how speakers assign reference frames when choices might be available, however Grabowski & Weiss (1996) survey experimental data from speakers of Western European languages. Anecdotal evidence

suggests that, cross-linguistically, there is considerable variation in the extent to which different spatial terms can be used for contact and adjacency relations “(immediately) at my left” vs. projected far from a Ground or viewer.

Given the acute differences in the logical properties of each reference frame, speakers must make quite different calculations about the spatial properties of scenes in order to speak about them. Levinson (2003) argues that there is an inherent untranslatability (at least for some situations) between these reference frames. For example, knowing that a bottle is (intrinsically) in front of a chair does not allow one to infer whether that bottle is also to the north (absolute) or to the speaker’s right (relative) of the chair. These logical differences which vary across linguistic communities, coupled with the foundational properties of space in cognition more generally, make investigations into reference frames ideal candidates for studies in linguistic relativity. See especially Pederson et al. (1998) and Levinson (2003). For an argument that perception need not be reference-frame dependent see Dokic & Pacherie (2006).

## 8. Motion events (dynamic spatial relations)

Thus far, we have focused on essentially static location. When there is a change of location, we refer to (translocational) *motion events*. Just as static locations are associated with stative expressions, motion events are associated with change of state expressions via metaphor, image schema, or simple analogy.

Talmy (1985) argues that there are certain recurrent elements to any motion event. The most fundamental of these is the fact of motion itself, such that static location can be treated as the limiting case of zero motion. There is also almost always expression of the Figure, the Ground, and a path. Beyond this, languages commonly express a manner of motion and sometimes a cause of motion. His approach groups languages in either of two ways. The first examines which semantic element is typically *conflated* in the meaning of the verb along with the fact of motion or location. For example, the path-conflation verb *ascend* describes both a fact of motion and an upward path. In contrast, a manner-conflating verb such as *crawl* conflates information about the particular manner of motion used by the Figure. Less common patterns exist, such as Figure-conflating: a verb like *rain* conflates the Figure (water drops) with motion (and perhaps direction of motion). Figure-conflation is an atypical pattern for English, but Talmy describes this as a common pattern in Atsugewi.

More widely cited is Talmy’s second typological distinction which examines which grammatical element will express the path. In a language with path-conflating verbs, simple paths will typically be expressed by the verb (the “Romance language pattern”). In languages without common use of path-conflating verbs, path is expressed in *satellites*, elements such as verb particles that are peripheral to the verb root (the “Germanic pattern”). Languages are assumed to be typically dominated by one of these two patterns and this has led to a number of linguistic relativity studies arguing both for and against the relevance of this linguistic pattern to non-linguistic categorization (Finkbeiner et al. 2002; Gennari et al. 2002; Loucks & Pederson 2011; Papafragou et al. 2002).

Even with careful semantic analysis, it is not always clear whether a particular manner of motion verb is also a verb of translocational motion. Languages with obligatory path verbs typically are described as having manner verbs which in the absence of path

verbs express manner without translational motion (e.g., a “flying” overhead without an entailment of motion across the sky), but the relation between what is semantically entailed and what is pragmatically implied is often not clear, especially for less extensively documented languages. Further complicating the semantics of motion verbs is the challenge of distinguishing between motion and fictive motion (see section 2.2. above).

## 9. Conclusion

Given the fundamental nature of spatial relations in human cognition, the extent to which expressions of space permeate language is scarcely surprising. While the semantics of spatial relations were once considered largely universal if not innate, in recent years, there has been a growing interest in exploring the range and depth of cross-linguistic variation. It has become clear that relying on simple translations of morphemes had overly biased analysts’ perception toward universality. A form such as “on” may be used quite differently in different languages and a form like “right” may refer to critically different reference frames depending on the language and cultural context of use. In other words, careful semantic analysis proves critical even for the seemingly most fundamental expressions.

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*Eric Pederson, Eugene, OR (USA)*

## XX. Diachronic semantics

### 99. Theories of meaning change: An overview

1. Basic issues of historical semantics
2. 19th century historical semasiology and the ideational theory of meaning
3. Diachronic structural semantics
4. Cognitive semantics
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#### Abstract

*Semantics as a scientific study first arose in the context of 19th century historical linguistics, and also in 20th century semantics and especially since the 1980s many foundational issues of semantics have been discussed in connection with problems of meaning change, e.g. the problem of polysemy. The kinds of questions that can be asked concerning meaning change and the types of possible answers to these questions are determined to a large extent by the theories of meaning presupposed in formulating these questions. So the history of historical semantics is highly instructive for a study of the ways in which the development of lexical semantics was advanced by competing theoretical conceptions of word meaning. Therefore my discussion of important traditions of research in historical semantics will be linked to and partly organized in relation to the theories of meaning embraced by scholars in the respective research traditions, e.g. traditional semasiology and its present-day successor cognitive semantics, structural semantics, and pragmatic semantics. Part of this history of theories will be told as a history of controversies. Aspects of meaning and change of meaning that have been discussed in these traditions include the conditions of semantic variation and change, types and regularities of meaning change, polysemy and its relation to meaning change, diffusion of semantic innovations, and the connections between semantic change and changes in social and cultural traditions.*

#### 1. Basic issues of historical semantics

Theories of meaning change have to give answers at least to some of the following questions: (i) Under what conditions are semantic innovations possible? (ii) Are there characteristic types and regularities of meaning change? (iii) How do universal constraints and cultural traditions interact in meaning change? (iv) How do innovations become routinized and conventionalized? (v) What are the paths and mechanisms of diffusion of semantic innovations? (vi) How does semantic innovation change the internal structure of a cluster of senses of a lexical item (the question of polysemy)? (vii) How does semantic innovation change the semantic relationships between different expressions (the question of meaning relations and semantic fields)? (viii) How are meaning changes

related to changes in the history of mind, the history of society, the history of theories (changes of knowledge and changes of concepts) etc.? (ix) How do we interpret texts from earlier historical periods (the hermeneutical question)? (x) What counts as an explanation of a meaning change?

One of the aims of this article is to show which of these questions have been tackled so far in different research traditions, in which ways and with what amount of success. The kinds of detailed questions that can be asked concerning meaning change and the types of possible answers to these questions are determined to a large extent by the theories of meaning presupposed in formulating these questions. Therefore my discussion of important traditions of research in historical semantics will be linked to and partly organized in relation to the theories of meaning embraced by scholars in the respective research traditions.

The relationship between historical semantics and theoretical semantics is not a one-sided affair. Not only did semantics as a scientific study first arise in the context of 19th century historical linguistics, but also in 20th century semantics and especially since the 1980s many foundational issues of semantics have been discussed in connection with problems of meaning change, e.g. the problem of polysemy. What Blank & Koch wrote about cognitive semantics could be generalized to other approaches to semantics as well:

In our opinion, investigation of diachronic problems can, in turn, sharpen our view for fundamental semantic processes and should therefore be able to advance theorizing in cognitive linguistics. In this sense, historical semantics is an ideal testing ground for semantic models and theories [...].

(Blank & Koch 1999: 1)

This includes issues like the boundaries between semantics and pragmatics, and methodological questions like minimalism. A case could be made for the view that theories of meaning which contribute to our understanding of meaning change are not only wider in scope than those that do not, but that they are actually superior. It is therefore not surprising that recently even scholars in the field of formal semantics, a family of approaches to semantics originally not attracted to historical questions, have taken up matters of flexibility of meaning and meaning change (cf. Eckardt 2006, and article 101 (Eckardt) *Grammaticalization and semantic reanalysis*). Generally speaking, the history of historical semantics is highly instructive for a study of the ways in which the development of lexical semantics was advanced by competing theoretical conceptions of word meaning. So part of this history of theories can be told as a history of controversies. In this context it is worth noting that the discussion of a rapprochement between competing schools of semantics (cognitive semantics, pragmatic semantics, formal semantics) which has been initiated in the last few years has also partly taken place in the context of historical semantics (cf. Geeraerts 2002; Eckardt, von Heusinger & Schwarze 2003; Fritz 2011; and article 100 (Geeraerts) *Cognitive approaches to diachronic semantics*). From the point of view of empirical research in semantics, the history of word meanings in different languages is an invaluable repository of data for semantic analysis and a source of inspiration for the treatment of questions like what is universal and what is culturally determined in meaning and change of meaning.

The history of historical semantics is also highly instructive for a study of the ways in which the development of lexical semantics was advanced by competing theoretical conceptions of word meaning. Part of this history of theories will be told as a history of

controversies. Aspects of meaning and change of meaning that have been discussed in these traditions include the conditions of semantic variation and change, types and regularities of meaning change, polysemy and its relation to meaning change, diffusion of semantic innovations, and the connections between semantic change and changes in social and cultural traditions.

## 2. 19th century historical semasiology and the ideational theory of meaning

Throughout the early development of historical semantics up to 1930 and in some cases much later (cf. Kronasser 1952) a view of meaning was taken for granted which has been called the ideational theory of meaning (cf. Alston 1964: 22–25). The classic statement of this theoretical view had been given by Locke as follows: „Words, in their primary or immediate signification, stand for nothing but the *Ideas* in the mind of him that uses them, how imperfectly soever, or carelessly [sic] those *Ideas* are collected from the Things, which they are supposed to represent“ (Locke 1689/1975: 405). By the time historical semantics emerged as a scientific enterprise in the second half of the 19th century, this view was more or less the common-sense view of meaning (cf. article 9 (Nerlich) *Emergence of semantics*). The fact that Frege and other contemporaries forcefully criticized this view on the grounds that ideas (“*Vorstellungen*”) were purely subjective, whereas meaning (“*Sinn*”) ought to be in some sense intersubjective, was either not noticed or not considered a serious problem (cf. Frege 1892/1969: 43f; Frege 1918/1966: 40ff; cf. article 3 (Textor) *Sense and reference*). (The problem of the subjectivity of ideas had of course been noticed by Locke.) One consequence of the ideational theory of meaning was that semantics was considered to be intimately related to matters of psychology, which was an unquestioned assumption for many linguists of the period. This attitude was, of course, also fostered by the fact that by the end of the 19th century psychology had become a highly successful and prestigious field of research. So at least paying lip-service to the psychological relevance of historical work was also a matter of scientific rhetoric for many linguists—very much like today. In the first paragraph of his classic “Meaning and change of meaning” Stern explicitly stated: “The study of meanings, as of all psychic phenomena, belongs to psychology” (Stern 1931: 1). It is therefore not surprising that the problem of lexical innovation was largely posed as a problem of individual psychology: How do new associations of ideas come about in the mind of an individual? To explain a change of meaning was to show how the mind could bridge the gap between a first cluster of ideas, the original meaning, and a second cluster, the new meaning. A case in point is the treatment of metaphor as a potentially innovative semantic technique. An explanation of a meaning change could be considered successful from this point of view if the gap between the original and the new set of ideas could be shown to be small, if the gap could be reduced by the introduction of plausible intermediary stages, or if it could be bridged with reference to general laws of association (cf. Wundt 1904: 623). This methodological principle, which one could call the principle of minimal steps, was based on a psychological hypothesis which was rarely made explicit as it was again firmly grounded in common-sense assumptions: The mind, like nature, does not take excessive leaps.

From this point of view three stages of a change of meaning could be differentiated: In the first stage a word is used in a certain context, in which a certain (additional)

idea becomes connected to the word. In a second, transitory stage the new idea is more intimately connected to the word through continuous use, so that the additional idea is called up in the mind even outside the original specific context. Finally, in the last stage, the new idea becomes the central idea (“Hauptbedeutung”) which again admits new combinations of ideas. So what happens is that a secondary idea which is originally only associated to the word in certain specific contexts gains in strength and becomes the primary idea (cf. Stöcklein 1898: 14f). This view anticipates both the recent emphasis on the importance of certain “critical contexts” of innovation (cf. Diewald 2002) and the cognitivist idea of shifts from peripheral uses to prototypical uses in meaning change and vice versa (cf. Geeraerts 1997).

In a classic of historical semantics, the chapter on meaning change in his book “*Prinzipien der Sprachgeschichte*”, Hermann Paul introduced a refinement of the ideational theory by distinguishing between established meaning (“*usuelle Bedeutung*”) and contextual meaning (“*occasionelle Bedeutung*”), a distinction which plays a fundamental role in his theory of meaning change (Paul 1886: 66ff). He defined the established meaning as the total content of ideas which is associated with the word for the members of a community of speakers, whereas the “occasional” meaning is defined as the content of ideas which the individual speaker associates with the utterance of a word and which he expects the hearer to associate with this utterance as well. “Occasional” meaning is considered to be richer in content and narrower in range than conventional meaning, it is generally more specialized and monosemous, whereas conventional meaning is more general and may be polysemous. The latter explication shows that Paul did not have at his disposal the sharp distinction between sentence (or word) meaning and utterer’s meaning which Grice introduced in his seminal article “*Meaning*” (Grice 1957) and which was also inherent in Wittgenstein’s distinction between “*bedeuten*” and “*meinen*” (Wittgenstein 1953). The main tenet of Paul’s theory is that every meaning change starts from an innovative occasional meaning. Such an innovative use may then be remembered by a speaker and thereby become a precedent for later uses. Through repeated application of the word in its occasional meaning the occasional meaning may become established in the community of speakers and thereby become “usual”. The next generation of speakers will then learn the word in its new conventional meaning. As an important element in his theory of meaning change Paul assumed that the types of meaning change exactly correspond to the types of modification of occasional meaning. This assumption makes the essential theoretical link between synchronic meaning variation and change of meaning, which up to the present day connects pragmatics and historical semantics. Paul’s theory of meaning change also comprises other elements which are familiar to modern historical semanticist, e.g. a version of the concept of common knowledge as a basis for semantic innovation and the idea that knowledge is socially distributed, which leads to semantic specialization in different social groups. The importance of context for the emergence of innovations was stressed by other authors of the semasiological tradition as well, e.g. by Wegener (1885) and Sperber (1923/1965), who explicitly differentiated between syntactic context and context of situation (“*Situationszusammenhang*”) (Sperber 1923/1965: 25). The relevance of the syntactic context for the emergence of semantics innovations, which has also recently been emphasized again (cf. Eckardt 2006), was stressed by Paul as well as by other contemporaries (e.g. Stöcklein 1898) and later representatives of semasiological research (e.g. Wellander 1917). Another aspect of meaning change that was

emphasized by several authors of this tradition was that, as mentioned before, in an early stage innovations are often restricted to a limited context from which they are then later generalized (cf. Stöcklein 1898: 13f; Sperber 1923/1965: 24).

One corollary of Paul's and others' view of meaning change was that meaning change leads to polysemy and that types of meaning change are reflected in types of polysemy, an idea that has recently been taken up again by various researchers (cf. Blank 1997; Fritz 1995; Geeraerts 1997). The most insightful early treatment of polysemy was due to Michel Bréal, who, in his "*Essai de Sémantique*" (1897), introduced the term *polysémie* and devoted a chapter to this phenomenon. Whereas polysemy was often thought of as a defect of language, Bréal pointed out the functional advantages of polysemy: "*Une nouvelle acception équivaut à un mot nouveau*" (Bréal 1897/1924: 146).

Outside the mainstream of traditional semasiology we find an important contribution to the theory of meaning change in a classic article by Antoine Meillet, "*Comment les mots changent de sens*", published in 1905 in "*Année Sociologique*" (Meillet 1905/1965). In this programmatic article, Meillet presented the outline of a sociolinguistic view of meaning change which consists in an integrated theory of innovation and diffusion. According to this theory, semantic changes arise mainly due to the fact that speech communities are heterogeneous and that they are organized into different social groups. In a rudimentary form Meillet's picture contains all the ingredients of later languages-in-contact theories of innovation and diffusion.

One of the main issues of late 19th and early 20th century historical semantics was the question of the regularity of meaning change. As the discovery of "sound laws" (e.g. Grimm's law) was the paradigm of successful linguistic research in the second half of the 19th century, one easily came to the conclusion that semantics should aim to find "semantic laws" on a par with sound laws. An important step in accounting for the variety of semantic innovation was to show how that innovation was guided. In remarkable unison the handbooks on historical semasiology which appeared from the 1870s onwards (Bréal 1897/1924; Darmesteter 1887; Nyrop 1903; Paul 1886; Whitney 1876) dealt with this question by giving a classification of types of semantic change. Seeking to impose order on the seeming chaos of semantic developments, they made use of categories well-known from classical logic and rhetoric: restriction of meaning, expansion of meaning, metaphor, metonymy, euphemism, and irony. The productive idea embodied in these classifications was the application of a methodological principle which had been forcefully proclaimed by the so-called Neogrammarians (Paul and others), the principle that the observation of present-day linguistic facts should serve as the basis for the explanation of the linguistic past. Following this principle, general knowledge about contemporary forms and conditions of referring uses, metaphorical and euphemistic speech etc. could be brought to bear on the explanation of historical changes. Of these categories of meaning change the first two (expansion and restriction of meaning) were often criticized as being non-explanatory, merely classificatory categories taken from logic, whereas a description of a semantic innovation as a case of metaphorical innovation was obviously accepted as explanatory. But, of course, the assertion that innovations of these types frequently occurred was no law statement, and therefore assigning an innovation to one of these types was, strictly speaking, no causal explanation. The same can be said for certain other generalizations that were formulated in this tradition and were called "laws", e.g. the generalization that semantically closely related expressions tend to show similar meaning changes (cf. Sperber 1923/1965: 67; Stern 1931: 185ff). In many cases the observation of parallel developments,

which is of course a methodically important step, amounts to no more than the documentation of data which call for explanation. (For further examples and discussion of the question of “semantic laws” cf. Fritz 1998: 870ff.) Generally speaking, explicit reflection on what could count as an explanation of meaning change was fairly rare in this period, and it was only much later that basic questions concerning the concept of explanation in historical semantics were raised (cf. Coseriu 1974; Keller 1990). Overviews of semasiological research can be found in Jaberg (1901), Kronasser (1952), Ullmann (1957), and Nerlich (1992) (cf. also article 9 (Nerlich) *Emergence of semantics*).

### 3. Diachronic structural semantics

In the late 1920s and early 1930s, structuralist methods, which had been particularly successful in phonology, began to become applied also to the field of semantics. Essentially, structural semantics is not a theory of meaning at all but rather a methodology for semantic analysis. The basic idea that semantic analysis of a linguistic item should not be restricted to individual words but should also take into consideration its neighbours, i.e. words with a similar meaning, and its opponents, i.e. words with antonymous meaning, had been well-known to late 19th century linguists before the advent of structuralism (e.g. Paul 1895). It is interesting to see that in describing parts of the vocabulary where the systematic character of groups of expressions is fairly obvious, pre-structuralist and non-structuralist authors often displayed a quasi-structuralist approach. This is true, for example, of descriptions of the history of kinship terms or forms of address.

In a more programmatic and theoretically explicit way this basic structuralist idea had been spelt out by Ferdinand de Saussure in his “Cours de linguistique générale” (1916). In Part 2, Chapter IV, § 2 of this groundbreaking book, which was compiled and edited by his pupils after his death, de Saussure discussed the difference between the meaning of a word and its “value” (“valeur”). He started out from the traditional definition of meaning as the idea conventionally connected to the sound pattern of an expression and then went on to argue that this definition captures only one aspect of meaning, which has to be complemented with a second aspect, the “value”, i.e. the position which the respective word occupies in a system of lexical items. To illustrate this point he compared the meaning/value of the French word *mouton* and the English word *sheep*. The two words, so his argument goes, may have the same meaning, i.e. they evoke the same idea of a certain kind of animal, but they do not have the same value, as there is in English a second word in opposition to *sheep*, namely *mutton*, which is not the case with French *mouton*. Apart from the fact that this description could be improved upon, this theory obviously shows a certain tension between the two aspects that determine meaning, which was not clarified by de Saussure or his followers like Trier (1931). The question remained open in which way meaning as idea and meaning as value contribute to the overall meaning of an expression. This theoretical problem did however not interfere with the application of the basic methodological principle.

Starting from de Saussure’s fundamental assumptions and applying his general methodological principles to the field of semantics, Jost Trier and some of his contemporaries (e.g. Weisgerber 1927) criticized the atomist views of traditional semasiology, as they saw it, and developed a type of structuralist semantics which in its early form was called the theory of *conceptual fields* (“Begriffsfelder”, Trier 1931), sometimes also called *lexical fields* (“Wortfelder”) or *semantic fields* (“Bedeutungsfelder”). The basic tenets of this



theory have been described by Ullmann (1957), Gloning (2002) and others. Therefore I shall only point out those facets of the theory that are particularly interesting from the point of view of theories of meaning change. As mentioned before, words were no longer considered as isolated units but as elements of a lexical system. Their value was defined by their position in a system of lexical oppositions and could be described in terms of a network of semantic relations. Trier himself used the concepts of hyponymy (“Oberbegriff”) and antonymy (“Gegensinn”), however, due to his informal style of presentation he did not attempt to make explicit these or other types of sense relations (cf. Lyons 1963), nor did he attempt the kind of componential analysis that later structuralist authors used (e.g. Bech 1951). Change of meaning, in Trier’s view, consisted in the change of the structure of a lexical system from one synchronic stage of a language to the next. Within the framework of this theory the task of historical semantics could no longer be the description and explanation of the historical fate of individual words (“Einzelwortschicksale”) but rather the comparison of the structures of successive synchronic semantic fields along the time axis. Trier used his methods to analyze stages in the history of expressions of intellectual appraisal in German from Old High German to Middle High German, i.e. adjectives corresponding in meaning approximately to Latin words like *sapiens* and *prudens* or English words like *wise*, *intelligent*, *clever*, *cunning* etc. as well as the respective substantives. Starting by assuming a given conceptual field and then differentially analyzing the expressions allocated to this field, he used an onomasiological approach on a large corpus of medieval texts. Trier’s pupils and followers applied this method to later historical developments in the intellectual field and to other fields like perception verbs (Seifert 1968) or adjectives of quantification and dimensionality (Stanforth 1967). Whereas Trier’s approach concentrated on the paradigmatic dimension, i.e. the dimension of items replaceable for each other in a certain position in the linear sequence, other authors dealt with the syntagmatic dimension, i.e. the co-occurrence of words in sentences. Again, this topic had also been dealt with by pre-structuralist authors like Sperber who, in his classic booklet (Sperber 1923/1965) analyzed the collocations (“Konsoziationen”) of various expressions. A well-known early structuralist paper on this topic is Porzig (1934), where the co-occurrence of words like *blond* and *hair* or *to fell* and *trees* is described. Historical changes in this dimension could also be considered part of the change of meaning of a given expression. However, authors of this period did not do much to clarify in what sense co-occurrence relations could be considered to be an aspect of the meaning of a word. This was only later achieved in the development of distributional semantics (cf. Firth 1957), an approach which has recently gained renewed attraction due to new techniques of corpus analysis, which make it possible to analyze characteristic collocations and their historical change in great detail and with a view to quantitative data (cf. Heringer 1999).

Later versions of structural semantics, which were theoretically more ambitious and descriptively more precise, were developed and applied to historical material by scholars like Gunnar Bech (1951) and Eugenio Coseriu (1964). Bech (1951) used a system of semantic features to characterize the meaning of lexical items belonging to a closely-patterned domain of vocabulary, namely the modal verbs of German (e.g. *müssen*, *können*, *dürfen*, *mögen*). A similar method was applied to the history of English modals by Tellier (1962). When the semantics of modals and their history became a focus of semantic research some twenty years ago (cf. Fritz 1997a; Diewald 1999; Traugott & Dasher 2002: 105ff), these classical studies also received new interest.



From the point of view of the theory of meaning, the semantic features used by Bech involve problems concerning their status and their formal properties, which they share with other concepts of semantic features and which have been discussed by Lewis (1972: 169ff) and others. It is not clear whether the expressions used to indicate the features were considered to be simply descriptive natural language predicates or part of a special metalinguistic vocabulary or if they were even meant to indicate a universal store of concepts. And, of course, the feature language had no syntax, which considerably restricted its descriptive power.

Criticism of structuralist semantics, especially feature semantics (*Semantic Markereese*, as Lewis called it), has come from various quarters, from truth-functional theorists, as mentioned before, and more recently from cognitivist and “meaning-as-use” theorists. Among the properties and assumptions of structural semantics which make it less adequate for historical semantics than other present-day semantic theories, the following have frequently been mentioned:

- i. Structuralist theory is strong on the aspects of the language system (“la langue”), but weak on the properties of speech (“la parole”), i.e. the use of language. As semantic innovation and diffusion are matters of language use, large portions of historical semantics cannot be adequately treated within the framework of structural semantics.
- ii. As structuralist semantics is focussed on the analysis of language-internal relationships, it has to draw a strict boundary between semantic and encyclopaedic knowledge, which makes it difficult to explain how innovative patterns of use like metaphor or metonymy work.
- iii. Due to its minimalist methodology, structuralist semantics is not well equipped to analyze cases of polysemy, which play a central role in semantic development.
- iv. Semantic features tend to be viewed in terms of necessary and collectively sufficient conditions for the correct use of an expression. This view precludes a satisfactory analysis of cases of family resemblances and prototype effects of the kind that Wittgenstein and cognitivists influenced by Wittgenstein (e.g. Rosch & Mervis 1975; Lakoff 1987) described. It therefore makes it difficult to account for minimal shifts of meaning and semantic changes involving the shifting of prototypical uses within the polysemic structure of a word.

To conclude: As structural semantics is essentially a theory of the structure of vocabulary and not of the use of vocabulary, it does not provide a theoretical framework for a number of important problems in historical semantics. Generally speaking, it fails to give an integrative view of linguistic activity in its various contexts, i.e. the relationship between language structure and social practices as part of historical forms of life. It does not provide the theoretical means for taking into account either the knowledge used in semantic innovation or the communicative function of innovations, two aspects which, according to more recent views, play a fundamental role in the explanation of semantic innovation. A final limitation lies in the methodological requirement that lexical oppositions should only be sought within homogeneous systems, whereas semantic change is often due to the heterogeneity of linguistic traditions within one linguistic community. As a consequence of these limitations, structural semantics has not contributed much to recent developments in historical semantics. It is, however, interesting to see that the structuralist

heritage has been absorbed by most later approaches, e.g. the principle that one should take into account the network of semantic relations between lexical units, both paradigmatic and syntagmatic (cf. Lehrer 1985; Heringer 1999).

#### 4. Cognitive semantics

The rise of cognitive semantics in the 1980s was partly driven by a dissatisfaction with structuralist and “formalist” theories of meaning and language in general (e.g. structural semantics, truth-functional semantics, Chomskyan linguistics). Many of the basic ideas of the various strands of cognitive semantics were developed and presented rhetorically, sometimes polemically, in opposition to these approaches (cf. Lakoff 1987; Taylor 1999). The following points summarize some of the basic tenets of cognitive semantics, of which most are in direct contradiction to fundamental assumptions of structural semantics as mentioned in the preceding section:

- i. Meanings are mental entities (e.g. concepts, conceptualizations or categories).
- ii. Aspects of meaning are to be described with reference to cognitive processing.
- iii. Concepts/categories exhibit an internal structure (clusters of subconcepts structured by different types of links, prototype structures, family resemblance structures etc.)
- iv. Categories are often blurred at the edges.
- v. Many categories cannot be defined by necessary and sufficient conditions.
- vi. Linguistic meaning is essentially encyclopaedic. There may be central and peripheral aspects of lexical knowledge, but there is no dividing line between encyclopaedic and lexical knowledge.
- vii. Metaphorical and metonymical models play a fundamental role for meaning.
- viii. Cognitive Grammar does not draw a distinction in principle between “sentence meaning” and “utterance meaning” (cf. Taylor 1999: 20).

Whereas structural semantics and its successors did not have much to say about phenomena like metaphor and polysemy, it was exactly these topics that played a central role in the development of cognitive semantics and which triggered the popularity of cognitive linguistics in the 1980s and beyond (cf. Lakoff & Johnson 1980; Brugmann & Lakoff 1988; Taylor 2002). And it is also these topics which made historical semantics interesting for cognitive semantics and vice versa. Of course, the differences between broadly structuralist views and cognitive semantics are linked to fundamental differences in the goals pursued by these directions of research, especially the cognitive linguists’ goal of using the study of linguistic meaning as a window on cognitive processes of conceptualization.

In certain respects, the cognitive view of semantics harks back to traditional semasiology, e.g. in its close relation to psychology, in its concept of meaning, its rejection of a clear distinction between sentence meaning (or word meaning) and utterance meaning, its pronounced interest in topics like polysemy and metaphor, and in its interest in semantic regularity and the “laws of thought”. This connection has been acknowledged by several scholars (e.g. Lakoff 1987: 18; Geeraerts 1997: 26f), but, as Geeraerts hastened to add, cognitive semantics is not to be seen as a simple re-enactment of the approach of the older school. What puts present-day cognitive semantics in a different position seems to

be not only the fact that there have been considerable advances in linguistic theory and semantic theory in particular, but also the availability of more sophisticated theories of categorization and conceptualization like the theory of prototypes and family resemblances developed by Rosch and others (e.g. Rosch & Mervis 1975), advanced psychological theories of metaphor (cf. Gibbs 1994), the theory of conceptual blending (Fauconnier & Turner 2002), and the conception of figure-ground organization from Gestalt psychology. Still, on account of the similarity in theoretical outlook it is not surprising that some of the objections to traditional “ideational” views (cf. section 2) have been raised also in relation to cognitive semantics. These objections include the problem of subjectivism (cf. Sinha 1999), the speculative character of the assumed conceptual structures and processes (cf. Taylor 2002: 64f) and, even more fundamentally, the question of circularity of (some) cognitivist explanations in (historical) semantics, which was raised by Lyons and others (e.g. Lyons 1991: 13) and has recently been brought up again by Keller (1998: 72). These objections are mostly not considered worth discussing at all by the practitioners of cognitive semantics or tend to be waved aside (e.g. Langacker 1988: 90), but there are exceptions, for instance John R. Taylor, who devotes a chapter of his book on cognitive grammar to these questions (cf. Taylor 2002, Ch. 4; cf. also Taylor 1999: 38). No doubt, these foundational questions should be given further reflection. There are also observations from historical semantics which could shed doubt on the advisability of the direct identification of meaning with concepts. In many cases of meaning change it is doubtful that one should describe the relevant developments as changes of concept. As for its contribution to historical semantics, it is particularly through research on metaphor, metonymy and polysemy in general that cognitive semantics has inspired historical work both theoretically and in its methodological outlook. Concerning relevant work in the field to date, we can discern two kinds of contributions. There is on the one hand programmatic work using synchronic data or well-known historical data for the purpose of demonstrating the feasibility and fruitfulness of a cognitive approach to problems of historical semantics (e.g. Sweetser 1990) and on the other hand genuinely data-driven empirical work, for instance by Geeraerts (e.g. Geeraerts 1997) or the Romance scholars Blank and Koch (e.g. Blank 1997; Koch 2001, 2003) both from an onomasiological and a semasiological perspective.

In addition to his empirical analyses, Geeraerts also focuses on theoretical matters of the explanation of change of meaning. He insists that one should not confuse mechanisms and causes of semantic change. The patterns of use he calls mechanisms (e.g. metaphor, metonymy, euphemisms etc.) “indicate the possible paths of change” (Geeraerts 1997: 103), whereas a cause “indicates why one of these possibilities is realized” by an individual speaker (Geeraerts 1997: 103). He further emphasizes that functional aspects should play a major role in the explanation of semantic changes. In his view, principles like the principle of expressivity or the principle of efficiency are causes in this sense (Geeraerts 1997: 120). As for these principles, expressivity concerns the communicative needs of the speakers, an aspect of meaning change that has always been emphasized in functional approaches (cf. section 6), whereas principles of efficiency include, amongst others, prototypicality as “a cognitive efficiency principle”. So, the upshot seems to be that, strictly speaking, there are no causes at all at this level of analysis. There is no doubt that principles play an important role in the speakers’ practice of finding new uses and accepting them. But they do not *cause* linguistic action, they *guide* linguistic action. At the level of the individual’s activities there are no causes of semantic innovation.

Somewhat outside the mainstream of cognitive semantics we find a group of Romance scholars (Blank, Koch, and their collaborators) who have contributed extensively to historical semantics from a basically cognitivist viewpoint. A “summa” of this research programme is the comprehensive book on the principles of lexical meaning change by the late Andreas Blank (Blank 1997), in which he discusses basic questions of meaning change, drawing on a wealth of data from the Romance languages. What links him to the cognitivist movement is his view that meanings have Gestalt properties and that forms of meaning change are essentially based on conceptual associations of various types (Blank 1997: 137ff). However, he criticizes the identification of meaning and concept and suggests a semiological model which reintroduces the differentiation of encyclopedic knowledge (“Weltwissen”) and language-specific semantic knowledge (“sememisches Wissen”) including knowledge of the polysemous meaning structure of words (Blank 1997: 102). Central to this framework is his presentation of types of meaning change in terms of techniques (or devices) of semantic innovation. He aims to show that what was often subsumed under “causes of semantic change” has to be differentiated into techniques of innovation on the one hand (e.g. linguistic devices like metaphor and metonymy), including their cognitive prerequisites, and motives for innovation and for the uptake and lexicalization of innovations on the other. Such motives include the speakers’ practice of observing communicative principles, a view which he shares with pragmatic theories of meaning change. On the cognitive plain, he characterizes metaphor and metonymy by the speakers’ use of similarity associations and contiguity associations respectively, explicating the traditional contiguity relation in terms of concepts, frames and scenarios.

In various case studies Blank shows the interaction of culture-specific knowledge and general cognitive principles as resources for semantic innovation. It is, among other points, Blank’s insistence on the importance of socio-cultural knowledge within historical traditions of discourse which shows a shift of emphasis in his view of semantic change as compared to the mainstream cognitivist focus on universal cognitive principles. This provides a fruitful tension between the historical and the universalist perspectives and “avoids prematurely treating the findings at the historical level as universal, especially making the characteristics of certain individual languages into the standard of an analysis of linguistic universals” (Koch 2003: 45).

## 5. Theories of grammaticalization

The term *grammaticalization* is generally used to refer to a type of historical change by which lexical items come to serve grammatical functions. In this process, the lexical items are said to become “semantically bleached” and they undergo syntactic restrictions and “phonetic erosion”. A classic example is the development of the Old English main verb *willan* ‘to want’, which becomes an auxiliary verb used to refer to the future, like in *she’ll come*. A similar type of development is the change from post-classical Latin *facere habeo* ‘I have to do’, ‘I will do’ to French (*je*) *ferai*, where the original Latin verb *habere* with the meaning ‘to have’ is grammaticalized into the future tense suffix *-ai*. This type of development was well known to 19th century linguists, who already used metaphors like *fading* or *bleaching* (German *Verblässen*) to describe the result of relevant semantic developments. In a much-quoted article, published in 1912, the French linguist Antoine Meillet introduced the term *grammaticalisation* to refer to this type of development and emphasized the “weakening” of both meaning and phonetic form (“l’affaiblissement du sens et

l'affaiblissement de la forme"; Meillet 1912/1965: 139) as characteristic of this process. He also put forward the view that innovations like the post-classical Latin *facere habeo* (as opposed to classical *faciam*) had a particular expressive value at the time when they were first used, but lost this value in the course of the further process of grammaticalization. From the 1980s onwards there has been a "veritable flood of [. . .] scholarship on grammaticalization" (Campbell & Janda 2001), including detailed analyses of individual phenomena like the ones mentioned before (e.g. Aijmer 1985) and comprehensive overviews of cross-linguistic research (Bybee, Perkins & Pagliuca 1994; Heine & Kuteva 2002) as well as introductory texts (e.g. Hopper & Traugott 2003).

From the point of view of historical semantics, the interest of grammaticalization research lies mainly in its contribution to the description of paths of semantic change from a given "source", e.g. a lexical unit denoting movement (*to go*), to a "target" expression which is used to signal future events (*to be going to*), some of which seem to have a remarkable breadth of cross-linguistic distribution. It is the richness of data from both genetically related and unrelated languages that makes grammaticalization research such a useful heuristic instrument for questions of regularity in semantic change. On the strength of these cross-linguistic data some quite strong claims have been made concerning the regularity of relevant types of semantic change, including the assumption that there exist quasi-universal "cognitive and communicative patterns underlying the use of language" (Bybee, Perkins & Pagliuca 1994: 15) and "the hypothesis that semantic development is predictable" (Bybee, Perkins & Pagliuca 1994: 18). Other researchers have been somewhat more guarded in their claims, restricting themselves to the assertion that there are interesting cross-linguistic similarities in the recruitment of certain lexical sources for given grammatical targets. A further hypothesis, which has received a great deal of attention in the last few years, is the hypothesis of unidirectionality, i.e. the non-reversibility of the direction of change from less to more grammaticalized (cf. Campbell 2001: 124ff; Hopper & Traugott 2003, Ch. 5).

As for their background of semantic theory, scholars working on grammaticalization are frequently not very explicit as to the kind of semantic theory they embrace. From the fact that some authors at times use the expressions "meaning" and "concept" more or less interchangeably one might infer that they are of a basically cognitivist persuasion (e.g. Heine & Kuteva 2002), whereas others rely on pragmatic (Gricean or Neo-Gricean) concepts (e.g. Traugott & König 1991). Concerning its descriptive methodology, research on grammaticalization, especially in the case of cross-linguistic surveys, often tends to settle for relatively coarse-grained semantic descriptions, which usually serve the purposes of this work quite well, but which can sometimes also give a wrong picture of the actual types of semantic micro-development. This preference for a semantic macro-perspective is not really surprising, as the focus of much of this work is the origin and development of *grammatical* forms.

From a theoretical point of view, some of the semantic concepts used in grammaticalization research are both interesting and, in some respects, problematic. This is true, for instance, of the term *bleaching* mentioned above, which comes in handy as a metaphorical cover-all for various types of semantic development. One such type of change is the loss of expressive meaning of metaphors in the course of routinization. Another type, which is often mentioned in grammaticalization research, is explained as "loss of concrete and literal meanings" and the acquisition "of more abstract and general meanings" (cf. Bybee,

Perkins & Pagliuca 1994: 5; Brinton & Traugott 2005: 100). This explanation presupposes that we know what an “abstract and general meaning” is, but a clarification of this concept, which again goes back at least to Meillet, is generally not attempted. As for the use of the *bleaching* metaphor, it seems that in many cases this may be quite harmless, but if used as a stand-in for more precise semantic descriptions, it might give an inaccurate view of the developments in question. For instance, calling the development of an additional epistemic use of the modal *may* (as in *He may have known*, as opposed to *You may go now*) a case of bleaching is downright misleading, as the epistemic use is in no way more “abstract” or the like and the non-epistemic sense normally remains being used alongside the epistemic one. The use of the term *bleaching* can be particularly problematic in those cases where the diagnosis of *bleaching* is based on a direct comparison of the source and the target use of an expression, leaving out several intermediate steps of development. As some authors have noticed, there is a tendency in grammaticalization research to reduce continuous, chainlike processes to two uses of forms, viz., source and target uses (cf. Heine & Kuteva 2002: 6), without paying attention to the complex development of systems of related uses of the expressions in question. In such cases the diagnosis of bleaching turns out to be an artefact of the descriptive methodology. These observations lead to the conclusion that the description of source-target-relations should be generally supplemented with detailed studies of the individual steps of semantic change in terms of the changing structure of clusters of uses. The importance of this methodological precept has also been acknowledged by scholars from the grammaticalization movement (Heine 2003: 83).

A closely connected conceptual question concerns the relation of “lexical meaning” to “grammatical meaning”. Traditionally, the background for the classification of the meaning of an expression as a case of grammatical meaning is often the following: If what can be expressed by a certain expression (e.g. declaring one’s future intentions by using a sentence with a modal verb) can also be expressed by a grammatical morpheme in the same or another language (e.g. by a future tense morpheme in Latin), then this expression has (a) grammatical meaning. This is somewhat doubtful reasoning, as one could easily turn the argument around and say that if a certain meaning can be expressed by non-grammatical means, then this is a case of non-grammatical meaning, which could be said for the expression of wishes or the expression of admonitions, which in Latin can be expressed by lexical means as well as by the use of the subjunctive mood (“*coniunctivus optativus*” and “*coniunctivus adhortativus*”). So, from the fact that Latin uses the subjunctive to express wishes it does not follow that ‘expressing wishes’ is a case of grammatical meaning. So there is a certain vagueness to the concept of grammatical meaning, which is sometimes acknowledged by the assertion that there is “no clear distinction between lexical and grammatical meaning” (cf. Taylor, Cuyckens & Dirven 2003: 1) or that there is a gradient from lexical to grammatical meaning.

A final point worth mentioning is the question of how the individual steps of a grammaticalization chain should be described and explained. Some researchers, mainly from the cognitivist camp, assumed that these individual steps were generally cases of metaphorical transfer, e.g. from the spatial to the temporal domain (from *going to* as a motion verb to *going to* as a future tense marker) or from the social to the cognitive domain in the case of the development of epistemic uses of modals from non-epistemic uses (e.g. the



*may* of permission to the *may* of possibility, cf. Sweetser 1990: 58ff). However, recent more data-oriented research has shown that in many cases there is no evidence in the data of metaphorical transfer at all, but rather of the use of contextual and general knowledge for small metonymic steps (cf. Brinton & Traugott 2005: 28; Fritz 1991, 1997b; Traugott & Dasher 2002). Generally speaking, the upshot of these observations on meaning change in grammaticalization is that there is no special type of semantic change characteristic of grammaticalization, but rather that it is generally well-known types of semantic change which contribute to the stepwise development typical of grammaticalization processes: “Grammaticalization is only one subclass of change based on expressivity” (Detges & WALTEREIT 2002: 190). To sum up, the contribution of the grammaticalization research programme in its various forms to the study of meaning change consists mainly in the fact that it initiated substantial cross-linguistic research into possible paths of semantic change and the issue of unidirectionality, which has considerable heuristic value for historical semantics.

## 6. Meaning as use and pragmatic semantics

The family of theoretical approaches dealt with in this section goes back mainly to works by Wittgenstein and some of his followers on the one hand (e.g. Strawson 1964; Alston 1964; Heringer 1978) and to Grice and his followers on the other. As is well known, Grice was very doubtful as to the usefulness of the precept that one should be careful to identify meaning and use (Grice 1989: 4), so it seems that there is at least a certain reading of Wittgenstein (and Grice), where the Wittgensteinian and the Gricean views on meaning are not easily reconciled. This has to do with their divergent views on the foundational role of rules and established practices on the one side and intentions on the other, which lead to differing perspectives on the analysis of the relation between *Bedeutung* (*Gebrauch*) and *Meinen* in Wittgenstein’s picture of meaning and *sentence-meaning* (or *word-meaning*) and *utterer’s meaning* in Grice’s theory. It is not possible to review here the relevant discussion (e.g. Black 1975; cf. Gloning 1996: 110ff). Suffice it to say that it seems possible to bridge the differences of these views by emphasizing the instrumental aspect of Wittgenstein’s view of language and taking into account the fact that Grice in his analysis of “timeless meaning” also accepted not only “established meaning”, but also “conventional meaning” with its element of normativity (“correct and incorrect use”, Grice 1989: 124ff). Such an integration of views (cf. Meggle 1987; Keller 1998) provides a useful starting point for an empirical theory of meaning and meaning change. For this kind of theory it comes quite naturally to see the historical character of meaning as an essential aspect of meaning and to view uses of linguistic expressions as emerging solutions to communicative and cognitive tasks (cf. Strecker 1987). It is furthermore part of the Gricean heritage to assume that what is meant is often underspecified by what is said.

It is remarkable that both Wittgenstein and Grice at least hinted at the fact that there is an historical dimension to the use of language, Wittgenstein in § 23 of his “Philosophical Investigations” (Wittgenstein 1953), where he emphasized that new types of language games continually arise and old ones disappear (cf. also Wittgenstein 1975, § 65), and Grice in a passage in “Logic and conversation”, where he mentioned that “it may not be impossible for what starts life, so to speak, as a conversational implicature to become conventionalized” (Grice 1989: 39). It is of course true, however, that neither Wittgenstein

nor Grice developed a theory of meaning change or of polysemy which could be simply applied to empirical work. This has to do with the context in which their theoretical views were developed. Wittgenstein's insistence on the importance of scrutinizing the multiple uses of words, for example, is not due to a special interest in polysemy as a linguistic phenomenon, but rather as a therapeutical move in conceptual analysis. Therefore, in order to implement the relevant ideas of these philosophers in an empirical theory of meaning change and the methodology of historical semantics one has to spell out in detail many aspects of meaning and meaning change which are only hinted at by these authors.

Such details of theory and methodology include: (i) an explication of the concept of "use" (cf. Heringer 1978; Heringer 1999: 10ff), including the analysis of types and aspects of contexts of use (cf. Fritz 2005: 17ff) and an explication of the relationship between "uses" and collocations of expressions (cf. Heringer 1999: 32ff), (ii) methods for the description of the structures of polysemies (cf. Fritz 1995), (iii) the classification of types of semantic innovations, their functions and resources (cf. Fritz 2006: 36ff; Keller & Kirschbaum 2003, Ch. 4), including the minimal changes in collocations which have generally been neglected by historical semanticists, (iv) corpus-based methods for the description of semantic innovation and meaning change (cf. Fritz 1991, 1997b; Heringer 1999).

The instrumental view of meaning provides powerful instruments, guiding principles and assumptions for historical semantics. Such instruments comprise (i) Grice's theory of implicatures as an instrument for analysing meaning innovation, including the role of "conversational maxims" and the structure of reasonings as hermeneutical devices (that inferences play an important role in meaning change), (ii) the concept of "mutual knowledge" (as a methodological fiction) developed as an extension of Gricean ideas (Schiffer 1972), which is related to such linguistic concepts as "common ground", (iii) Lewis's theory of convention (Lewis 1969), which shows the reasoning involved in a process of conventionalization, a useful instrument for the analysis of the dynamics of conventionalization, (iv) the contextual view of meaning rules embodied in the concept of language games (cf. Wittgenstein 1953, § 23), (v) the assumption that language games and meaning rules are embedded in historical forms of life, (vi) the assumption that in many cases the uses of a word have a family resemblance structure (cf. Wittgenstein 1953, § 66f), the assumption that among the uses of certain expressions there are more central and more peripheral cases (cf. Wittgenstein 1970: 190), the assumption that the meaning of natural-language expressions is (usually) open-textured (cf. Wittgenstein 1953, §§ 68–71: 84, 99), the assumption that there is no division in principle between knowledge of meaning and knowledge of fact (Wittgenstein 1953, §§ 79: 242; Wittgenstein 1975, § 63).

Whereas cognitive theories of meaning change tend to concentrate on the processes of conceptualisation which make an individual's innovation cognitively plausible, a functional and dialogical view also takes into account the fact that innovations are often sparked off and facilitated by the dynamics of local communicative context, that speakers aim at "recipient design" in their (innovative) talk and "work" to ensure uptake, that it is socially and culturally distributed knowledge which, in many cases, is both a condition and a consequence of semantic innovation, and that the reasons for which an innovation is attractive in the first place (e.g. functional benefits like expressive value or cognitive value) also facilitate its acceptance by other speakers and thereby advance its diffusion. Generally speaking, a basically functional and dialogic approach to meaning innovation



and meaning change favours an integrative perspective on the resources and the functions of semantic innovations and it also helps to focus on problems which are neglected by other approaches, e.g. the processes of routinization and conventionalization and the paths of diffusion of new uses (cf. Fritz 2005: 49ff). It also shows an affinity to an explanation of meaning change in terms of an invisible hand theory (cf. Keller 1990), in which action-theoretical concepts like intentions and maxims of action loom large.

Examples of the kinds of problems discussed in these frameworks and of the empirical work available include: the historical development of systems of metaphorical and metonymical links (Fritz 1995 on the history of the extreme polysemy of German *scharf*), the complex developments in the semantics of modal verbs (Traugott 1989; Traugott & Dasher 2002; Fritz 1991, 1997a, 1997b), developments in the history of speech act verbs (Traugott & Dasher 2002; Hundsnurscher 2003; Fritz 2005, Ch. 16), the development of evaluative uses of adjectives (Keller & Kirschbaum 2003), the development of various types of uses of conjunctions (causal, conditional, concessive) (Traugott & König 1991), the development of discourse markers and modal particles (e.g. Jucker 1997; Günthner 2003; Hansen 2005; Fritz 2005, Ch. 18), the functional explanation of grammaticalization in terms of unintentional results of expressive discourse techniques (Detges & Waltereit 2002), the description and analysis of invisible-hand processes in the conventionalisation and diffusion of lexical items (Keller & Kirschbaum 2003, Ch. 4), the functional explanation of developments in the structure of vocabulary (Gloning 2003).

A classical example of the Gricean approach to the analysis of an innovation is the description of the evolution of causal connectives from earlier purely temporal connectives (e.g. English *since*, German *weil*) given by various authors (e.g. Traugott & König 1991). This type of development was well known to pre-structuralist linguists and also described in ways broadly similar to modern Griceans (e.g. Paul 1895: 72 on German *weil*). However, the modern analysis achieves a higher degree of explicitness concerning the aspects of communication involved. A connective like *since* (Old English *sipþan*) originally meant 'after', however in certain contexts it seems to have been used to contextually suggest (in addition) a causal relation. Making use of the shared assumption that an event following another might be caused by the prior event and applying principles of relevance and informativity, the speaker could implicate or invite the inference that there was a causal relation between the two events. This could be described as a case of "pragmatic strengthening" (cf. Traugott 1989). When such a conversational implicature became conventionalized, a new variant of use arose, leading to polysemy, as in the case of Modern English *since* (temporal and causal uses). The theory of "invited inference" and "pragmatic strengthening" has also been applied to other types of expressions, e.g. speech act verbs (Traugott & Dasher 2002) and the development of epistemic uses of modal verbs (Traugott 1989; Traugott & Dasher 2002, Ch. 3). As Traugott and Dasher noted, the Gricean analysis covers many cases of what was traditionally subsumed under metonymy, which is not surprising, as metonymy uses shared knowledge concerning inferential ("associative") connections within a given domain. It is also worth noting that the Gricean viewpoint in some cases suggests a non-metaphorical inferential analysis where earlier cognitivist work preferred an explanation in terms of metaphorical extension (cf. Sweetser 1990, Ch. 3). This is the case for a much-discussed topic, viz. the rise of epistemic meaning in modals, where detailed corpus analysis seems to speak against an analysis in terms of metaphor (cf. Traugott 1989 for modals in English, Fritz 1991, 1997a: 94ff for modals in German).

Comparing the approaches presented in this section with the cognitivist approaches mentioned in the last section, one finds deep-going theoretical divergences and also differences in perspective, but also remarkable convergences (cf. Fritz 2011). A fairly fundamental theoretical difference consist in the fact that cognitivists embrace a representationalist view of meaning (words stand for concepts), whereas functionalists tend to favour an instrumentalist view. Related to this we find another divergence: at least from a purist Wittgensteinian position, the definition of meaning as conceptualization would seem to be an elementary category mistake. As for differences in perspective, the basic difference seems to be: Whereas cognitivists will use the analysis of semantic innovation mainly as a window on cognitive processes, functionalists will be primarily interested in the linguistic (pragmatic, rhetorical) practices of meaning innovation and their function in the strategic negotiation of speaker-hearer interaction. They will therefore view types of knowledge, connections between knowledge frames etc. as resources used for meaning innovation, usually showing a somewhat agnostic attitude towards the various types of “backstage cognition” (Fauconnier 1999: 96) assumed in cognitive approaches. On the other hand, cognitivists and functionalists join hands in assuming polysemy as a fundamental fact of linguistic practice and cognitive processes, family-resemblance and prototype structures of polysemous meaning, the central role of metaphor and metonymy in meaning innovation, and the indiscernibility of semantic and encyclopedic knowledge. As for the tendencies of convergence, which have been growing in the last few years, I shall add a few remarks in the concluding section of this article.

I should like to conclude this section by drawing attention to a problem which has, to my knowledge, so far not been seriously tackled by historical semanticists, but which is certainly also a problem for historical semantics and not just for philosophers and historians of science. This is the much-debated question of the relationship between theory change, change of meaning, and change of concepts. One of the central problems discussed in this debate, the problem of “incommensurability of theories”, is basically a problem of meaning. In a recent work on this topic, Kuukkanen states that “incommensurability may be taken as the practical difficulty of achieving translation and reaching comprehension in a situation where the same expressions imply radically different assumptions” (Kuukkanen 2006: 10). As Dascal has shown in various writings, there is at the moment an impasse in the philosophy and history of science (cf. Dascal 2000), which has to do with a lack of attention to the actual communicative processes (often) involved in the growth of scientific knowledge. At least partly, the questions if and how communication between opposing parties in a foundational controversy is possible and if in the course of such debates there is a change of meaning of relevant expressions are empirical questions that cannot be answered in the philosopher’s armchair, but only by empirical studies, to which historical semantics could certainly contribute. In the case of the famous Phlogiston controversy one could, for instance, show how critical expressions like *air* (*Luft*) or *combustion* (*Verbrennung*) are used by the opposing parties and in which way they are connected to the use of other expressions like *phlogiston* or *oxygen* and to descriptions of the experimental praxis involved in the development of this theoretical field. A case in point is the debate between the German chemist Gren and his opponents in the “*Journal der Physik*”, which ended by Gren’s conversion to (a version of) Lavoisier’s theory of oxidation. To my mind, the type of semantic theory that would be most adequate to this analytical task is a version of pragmatic semantics.

## 7. Formal semantics and pragmatics

Trying to write the present section some twenty years ago, one would have probably come to the conclusion that there was nothing to write about. Formal semantics was concerned with rules of inference, matters of compositionality and the proper treatment of quantifiers and logical connectives, but rarely with lexical semantics and certainly not with matters relating to the change of meaning. Now this is in fact not quite true. As far back as Frege's writings from the 1890s onwards we find an awareness that ordinary language is flexible in a way that influences the reliability of formal reasoning or at least implies aspects that might be relevant to logical consequence. Frege noticed that there are individual differences in the use of expressions (e.g. proper names with a different sense ("Sinn") for different persons, Frege 1892/1969: 42), that the denotation of certain expressions is determined by context, that we sometimes make certain presuppositions in using referring expressions, that natural language words are sometimes ambiguous, and that some natural language connectives (like *if—then*, *but* or *although*) have properties which their truth-functional counterparts do not have. In addition to their truth-functional properties the latter connectives serve to give extra hints ("Winke") as to the kind of connection involved (Frege 1918/1966: 37). As Frege also noted, the use of the conditional connective often suggests an additional causal connection, which is however not part of the truth-functional meaning of this connective. In Gricean terms it is a conversational implicature, but conversational implicatures may in time become conventional, as can be shown for many connectives in different languages.

So what we find in Frege's writings is a certain amount of attention to problems relating to semantic and pragmatic aspects of natural language, which are in turn related to questions of historical semantics, i.e. ambiguity, context-dependence, individual differences of use, and implicatures. But, of course, Frege mentioned these things mainly to get them out of the way of his project of producing a well-behaved language for scientific uses. Therefore, for him and for many later logicians and formal semanticists the standard solution to these problems was to suggest that one should "purify ordinary language in various ways" (Montague 1974: 84). Another strategy was to delegate these aspects of natural language use to an additional pragmatic theory, where they could be dealt with, for instance, with the help of Grice's theory of implicatures.

In recent times, this picture of how formal semantics relates to matters of semantic variation and semantic change has obviously changed. Generally speaking, there has been a development towards the integration of dynamic, pragmatic and lexical aspects of meaning into formal semantic or formal pragmatic theories which are relevant to questions of meaning change (cf. article 101 (Eckardt) *Grammaticalization and semantic re-analysis*). Although attempts to capture the dynamics of language change with formal theories have received sceptical comments in the past (cf. Eckardt 2006: 28), recent developments in formal semantics seem to give hope for a fruitful rapprochement. If the use of formal theories in historical semantics should in future contribute to an increase in explicitness, precision and systematicity of semantic analyses, this would certainly be a good thing. Of course, using a formal apparatus does not guarantee rigour in semantics, as Geach ably showed in his criticism of Carnap (Geach 1972).

There are various recent approaches which could be related to questions of meaning change or which have actually tackled such questions, of which I shall mention three. A first family of such approaches are dynamic theories which could be subsumed under the

heading of *update semantics/pragmatics*. The common denominator of such approaches is the view that the utterance of a certain expression changes the context, i.e. the common beliefs of the interlocutors, in a specific way (cf. Stalnaker 1978, 2002), from which one can go on to assume that the meaning of an expression could be modelled in terms of its context change potential. In order to model this dynamic aspect of discourse and meaning one has to assume some kind of score-keeping procedure, e.g. “commitment store operations” as in Hamblin’s Formal Dialectic (Hamblin 1970: 253, ff) or Lewis’s “rules specifying the kinematics of conversational score” (Lewis 1979: 346). This basic idea has been spelt out in different versions, e.g. in Kamp’s Discourse Representation Theory (cf. Kamp & Reyle 1993) and Heim’s file change semantics (cf. Heim 1983). By using these and similar methods, it is possible to produce semantic models of information growth which can, among other things, deal with the phenomenon of an incremental updating of common ground.

This type of approach could be useful for research in historical semantics in several respects. It could, for instance, give us a clearer picture of the processes involved in the emergence of “common ground” in general (e.g. the concept of mutual knowledge specified in Lewis 1969: 56, or Schiffer 1972) and conventions in particular (cf. Lewis 1969). As new uses of words often emerge against the background of common assumptions, the building-up of common ground is an important aspect of semantic innovation. By using this kind of apparatus one could, for example, model a very frequent type of semantic change which consists in the emergence of new evaluative uses of expressions originally used descriptively. Take a noun like (*young*) *servant*, which serves to refer to persons of a certain social status: If in a given speaker community the assumption becomes common knowledge that such persons frequently show criminal tendencies, this expression can be used to accuse someone of being a criminal, which in time may become a conventional use of the word. This kind of development is frequently found in various languages (cf. Middle High German *buobe* and *schalk*, English *knave* and *varlet*, French *gars*). A similar process permits descriptive adjectives to be used in evaluative function, which is also a very frequent type of meaning change.

A second trend in recent formal semantics and pragmatics is the interest in “systematic polysemy”, especially in the various uses of words based on metonymic relations, e.g. uses of expressions denoting institutions like *the university* to refer to the buildings housing this institution or to the members of this institution. Recent analyses of this kind of polysemy include Nunberg (1995), Pustejovsky (1995), Copestake & Briscoe (1996), Blutner (1998) and Peters & Kilgariff (2000). In historical semantics, awareness of this type of polysemy and its regular character goes back to its very beginnings in the 19th century, so historical semantics has much to offer in terms of historical data for this kind of phenomenon. On the other hand historical semantics could profit from relevant theoretical work and from work on large present-day corpora. Recent work has shown that metonymic sense extension can be considered a productive—or at least semi-productive—process, which is, however, subject to certain restrictions. One can assume that certain groups of words have the same extension potential, which is however not always exhaustively used. It would be very useful to systematically survey the ways in which this extension potential was used in different historical periods and to analyze the factors blocking the productivity of this process, of which some may turn out to be language specific or culture specific.

A third approach, which has fortunately gone beyond the programmatic stage and has produced actual empirical work in the field of historical semantics, is the formal reconstruction of the process of semantic reanalysis (cf. Eckardt 2006 and article 101 (Eckardt)

*Grammaticalization and semantic reanalysis*). Meaning change under reanalysis is particularly frequent in instances of grammaticalization. Cases in point are the development of the English *going-to* future marker or the development of the German quantifier-like expression *lauter* in the sense of ‘only’ or ‘many’ from the earlier adjective *lauter* ‘pure’. Eckardt’s analyses proceed from the idea that meaning change under reanalysis is essentially a change of the contribution of the respective expressions to the compositional structure of typical sentences. In order to analyze these changes in compositional structure, Eckardt uses techniques of truth-functional semantics, “which is still the semantic paradigm that addresses semantic composition in the most explicit manner” (Eckardt 2006: 235), and combines them with methods of conceptual semantics and pragmatics. This is an ingenious approach which considerably stretches the boundaries of what would traditionally be considered truth-functional semantics. One of the hallmarks of this approach is a high degree of explicitness and precision, which proves extremely useful in the analysis of rather subtle and complicated processes of change. In addition to reaching very interesting empirical results, Eckardt succeeds in demonstrating “that the notions and formalisms in formal semantics can be fruitfully set to work in the investigation of diachronic developments” (Eckardt 2006: 234) and that “the investigation of language change can offer substantial input to synchronic semantic research” (Eckardt 2006: 188).

## 8. Conclusion

As we have seen, historical semantics is a research area where fundamental problems of semantics tend to surface and which can be seen as a testing ground for theories of meaning and for methodologies of semantic description. A case in point is structural semantics with all its strengths and weaknesses, which brought into focus meaning relations between different expressions in a lexical paradigm, but which had no answers to problems like the nature of metaphor, polysemy and evolutionary processes in general, and which therefore fell into disfavour in the last twenty years. Historical semantics as a field of empirical research always flourished in times when it was a focus of theoretical debate. This is true of the 1890s, of the 1930s, and of the last 25 years. So, with cognitive semantics and pragmatic semantics competing and with formal semantics joining in the recent debate, signs are good for a dynamic development of this field of research.

It is obvious that the direction of interest and the emphasis on certain aspects of meaning change is largely determined by the concept of meaning which individual authors and schools of thought embrace. It is, however, striking to see that in many cases empirical work with corpus data forced researchers to transcend the limitations of scope of their respective theoretical frameworks and take into account aspects of meaning and meaning change which were not really covered by their semantic theory. This is true of most of the schools of historical semantics discussed in this article, and it seems to demonstrate the healthy effect of data-driven work, which potentially also motivates advances in theoretical reflection.

A good example of this effect is the attitude towards semantics and pragmatics as distinct areas of theory. Certain ways of making the demarcation would be completely unplausible for an empirical theory of meaning change from the start, e.g. viewing semantics in terms of truth-conditions and pragmatics as taking charge of the rest. But also the standard demarcation in terms of conventional and conversational aspects of

meaning does not fare much better. As most of the dynamic aspects of meaning change, e.g. innovation, selection, and diffusion, are generally considered to fall into the field of pragmatics, historical semantics, as it is practiced today, would have to be seen as a proper subfield of historical pragmatics. The publication policy of a journal like “Historical Pragmatics” bears witness to this view. If, however, semantics is considered to be concerned only with established meanings to the exclusion of contextually determined utterance meaning, we get a somewhat restrictive view of historical semantics, according to which it should concentrate on contrasting the established meanings of certain expressions at time 1 with those at time 2. This is basically the structuralist picture, which leaves out just about everything that is interesting about change of meaning. In view of the fact that routinization and conventionalization are gradual processes one could argue that there is a gradual transition from pragmatic to semantic phenomena. This argument, apart from showing that there is, strictly speaking, no such thing as a semantics-pragmatics interface, would make historical semantics a subject which hovers uneasily between two theoretical fields. So what seems to be needed as a basis for an empirical theory of meaning change is a genuinely dynamic theory of meaning and understanding which encompasses both the rule-based and the inference-based aspects of meaning. From this it does of course not follow that there is no categorial difference between speaker meaning (*Meinen*) and word/sentence meaning (*Bedeutung*), as some cognitive semanticists seem to assume.

Looking to the future development of historical semantics there seem to be at least three areas where progress in theory and methodology could be achieved: (i) the detailed comparison of competing theories of meaning as to their contribution to a theory of meaning change, and the clarification of points of convergence of these theories, (ii) further clarification of basic concepts like “explanation of meaning change”, “uses of words”, “metonymy”, and descriptive categories like “bleaching”, “subjectification” etc., (iii) further development of descriptive methodology, especially corpus-methodology, for historical semantics. Of these points I should like to briefly take up the first and the last.

As mentioned in sections 6 and 7 there is a tendency within cognitive linguistics to extend its scope to a “cognitive-functional” view (cf. Tomasello 1998). Within historical semantics this tendency is apparent in publications by Blank and Koch as well as in recent work by Geeraerts and others (e.g. Nerlich & Clarke 2001; Traugott & Dasher 2002), where we find attempts at integration of cognitivist and pragmatic views. Geeraerts explicitly stated that “such a process of convergence—if it will take place at all—could find a focal point in a pragmatic, usage-based perspective to lexical semantics” (Geeraerts 2002: 38f). This is not a trivial project, as there are still fundamental divergences in theoretical outlook between these approaches, e.g. the big divide between representationalist and instrumentalist (functionalist) theories of meaning and the complex corollaries of this divide concerning the status of conceptualization and linguistic meaning etc. It would be a remarkable development indeed, if the methodological needs of historical semantics should pave the way to bridging this theoretical divide. A similar thing could be said for the divide between cognitivist and realist theories of meaning, the latter of which are the prevailing view in formal semantics. In actual empirical work researchers often practice a certain degree of theoretical and methodological opportunism, which furthers fruitful empirical work while leaving basic theoretical questions untouched. Maybe this is a useful application of Austin’s principle of letting “sleeping dogmatists lie” (Austin 1970: 75).



From a more theoretically-minded perspective, however, one would like to see these foundational questions clarified.

Concerning descriptive methodology, it is worth noting that semantic minimalism, which is the methodological preference of many scholars in theoretical semantics as a means for preserving unity of meaning, is as a rule not favoured by researchers doing empirical work in historical semantics. The precept that one should not multiply senses (beyond necessity), advocated both by structuralists (e.g. Bech 1951) and, more recently, by Griceans (cf. Grice 1989: 47–50), is basically a useful principle in that it forces researchers to differentiate between what a word means and what is conversationally implicated in a certain context. But it also fosters the tendency to explain as implicatures what must be seen as established uses of expressions. This tendency is counterproductive in historical semantics, as in many cases the interesting question is exactly how to differentiate between conversational innovations and well-established uses of an expression. In this situation, corpus data often give very good indications as to which uses (or senses) of an expression can be considered firmly established at a given point in time and which are transient or peripheral. Furthermore, from what research in historical semantics has found in the last few years, both within cognitive and pragmatic frameworks, semantic minimalism seems to give a fundamentally wrong picture of what is going on in change of meaning in many cases. Arguably, the most fruitful approach to the description of meaning change from the semasiological perspective consists in treating semantic evolution as the development through time of sets of uses and their respective internal structures (cf. Geeraerts 1997: 23ff; Fritz 2006: 14ff).

As for corpus methods, corpus-based analysis has traditionally played an important role in historical semantics, because researchers cannot rely on their own linguistic competence in historical studies. Recent developments in corpus technology and corpus methods have strengthened this methodological preference and widened its scope of application. Modern corpus linguistics has, however, not only provided new methods of data generation and data interpretation, but has also inspired reflection on theoretical questions like the relationship between collocations of given expressions and their meaning (cf. Heringer 1999). Large corpora can also help to make visible phenomena which are not easily seen in smaller collections of texts, e.g. gradual changes in the contexts of use of given expressions within a diachronic corpus, which can be interpreted as reflexes of gradual changes of meaning. More sophisticated analyses of gradual change of meaning certainly belong to the desiderata for future empirical research. In semantics, the availability of large amounts of data does, however, not render unnecessary methodological procedures like the contextual interpretation of instances of the use of a word or the inference from distributional facts to semantic descriptions. This is true a fortiori of historical semantics. Such procedures are widely used, but are theoretically not well understood, so here we have another area where further studies are necessary. Generally speaking, the important recent developments in historical semantics have opened new vistas for empirical research, and in so doing have also shown the necessity for further clarification of basic theoretical and methodological issues.

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Gerd Fritz, Gießen (Germany)

## 100. Cognitive approaches to diachronic semantics

1. Cognitive linguistics and historical semantics
2. Diachronic prototype semantics
3. Conceptual metaphors through time
4. Diachronic onomasiology
5. Rounding off
6. References

### Abstract

*The emergence of Cognitive Linguistics (an approach to language description that pays specific attention to the crucial role of meaning in the structure and the functioning of language) has led to a renewed interest in mechanisms and processes of meaning change. In this chapter, the impetus for diachronic semantics that comes from Cognitive Linguistics is illustrated on the basis of three important areas of investigation, representing different levels of the semantic organization of the lexicon. First, the investigation of the internal semantic structure of individual expressions has been profoundly influenced by the introduction of prototype-based models of semantic organization. Second, if we zoom in on the links between the senses within such semantic structures, mechanisms like metaphor and metonymy receive new attention. Third, if we zoom out, beyond the level of individual expressions, towards the vocabulary as a whole, we witness a change towards a pragmatic, contextualized conception of onomasiology. The chapter spells out the consequences of these three developments for the diachronic study of meaning.*

### 1. Cognitive linguistics and historical semantics

Cognitive Linguistics is an approach to the analysis of natural language that focuses on language as an instrument for organizing, processing, and conveying information. This implies that the analysis of meaning is of primary importance for linguistic description: in Cognitive Linguistics, the formal structures of language are studied as reflections of general conceptual organization, categorization principles, processing mechanisms, and experiential and cultural influences. Cognitive Linguistics originated with a number of Californian linguists in the late 1970s and early 1980s, basically as an attempt to carry further the interest in meaning phenomena that was typical of the so-called Generative Semantics movement within generative linguistics. In contrast with Generative Semantics, however, Cognitive Linguistics is situated entirely outside the generative tradition. Leading figures within Cognitive Linguistics are George Lakoff, Ronald W. Langacker, Leonard Talmy, Charles Fillmore, and Gilles Fauconnier. For recent introductions and basic readings, see Geeraerts (2006), Kristiansen et al. (2006), Evans & Green (2006), Ungerer & Schmid (2006), Geeraerts & Cuyckens (2007), and compare article 27 (Talmy) *Cognitive Semantics*.

The renewed interest in semantics that drives the development of Cognitive Linguistics opens up interesting perspectives for diachronic semantics (for an exemplary sample of current research, see Winters et al. 2010). Specifically, the way in which the meaning-oriented research programme is elaborated in the context of Cognitive Linguistics links

up conceptually with the way in which meaning was studied in the prestructuralist heyday of diachronic semantics, i.e. with the study of meaning change that dominated the scene from roughly 1870 to 1930 and that is represented by researchers like Bréal, Paul, Darmesteter, Nyrop, and (at the end of the relevant period) Carnoy and Stern. For a systematic treatment of the main figures and currents, see Nerlich (1992) and article 9 (Nerlich) *Emergence of semantics*.

The link between Cognitive Linguistics and prestructuralist semantics rests on two specific points (compare Geeraerts 2010 for a more extended treatment in the context of the history of lexical semantics). First, the mechanisms of semantic extension, like metaphor and metonymy, that were traditionally studied from the point of view of diachronic meaning change only, reappear in the context of Cognitive Linguistics as synchronic phenomena: as associative links between the different senses of a lexical item or a grammatical construction, or as mechanisms that underlie the synchronic, contextual variability of meaning (compare article 26 (Tyler & Takahashi) *Metaphors and metonymies*). Second, both the prestructuralist tradition and Cognitive Linguistics take an integrated approach, i.e. an approach in which language is not considered to be an autonomous system, but rather an aspect of human life that is integrated into cognition and culture at large.

Cognitive Linguistics, however, does more than just pick up the thread of prestructuralist diachronic semantics. Although the study of meaning within Cognitive Linguistics at large is more concerned with the synchronic flexibility of meaning than with semantic change in the historical sense, the cognitive approach introduces a number of novel perspectives and areas for research into diachronic semantics, and these will constitute the focus of the present chapter. Four specific subjects should be mentioned in this respect: prototype theory, Conceptual Metaphor Theory, cognitive onomasiology, and grammaticalization research. The first three of these topics will be treated in the following pages. For grammaticalization and the related issue of regularity of change (Traugott & Dasher 2002), see articles 99 (Fritz) *Theories of meaning change* and 101 (Eckardt) *Grammaticalization and semantic reanalysis*. Each of the three topics is treated in a separate section, the first subsection of which introduces the domain. The second subsection presents an illustrative case study, together with an overview of some of the relevant literature. The third subsection introduces a number of theoretical or methodological issues that need to be further explored. The focus of the chapter will be on meaning changes at word level, but all of the phenomena discussed here can be straightforwardly extrapolated to the semantics of other meaningful linguistic elements, below or above the level of the word.

## 2. Diachronic prototype semantics

### 2.1. Introducing prototypicality effects

The prototype model of the internal semantic structure of words (compare Taylor 2003 and article 28 (Taylor) *Prototype theory*) highlights two structural characteristics: differences of structural weight on the one hand, and fuzziness and flexibility on the other. To illustrate, consider the word *fruit*. This is a polysemous word: next to its basic, everyday reading ('sweet and soft edible part of a plant, containing seeds'), there are various other readings conventionally associated with the word. In a technical sense, for instance ('the seed-bearing part of a plant or tree'), the word also refers to things that lie outside the range of application of the basic reading, such as acorns and pea pods. In an expression like *the fruits of nature*, the



meaning is even more general, as the word refers to everything that grows and that can be eaten by people (including, for instance, grains and vegetables). Further, there is a range of figurative readings, including the abstract sense ‘the result or outcome of an action’ (as in *the fruits of his labour* or *his work bore fruit*), or the somewhat archaic reading ‘offspring, progeny’ (as in the biblical expressions *the fruit of the womb*, *the fruit of his loins*).

Each of these readings constitutes a separate sense of *fruit*, but in turn, each sense may be thought of as a set of things in the outside world. The basic sense of *fruit*, for instance, corresponds with a set including apples, oranges, and bananas (and many other types of fruit). If you think of *fruit* in this central sense as a category, the set consists of the members of the category. These members are ‘things’ only in a broad sense. In the *fruit* example, they happen to be material objects, but in the case of verbs, they could be actions, or situations, or events; in the case of adjectives, they could be properties; and so on. Given this example, we can now describe the two structural characteristics that receive special attention within a prototype-theoretical framework.

### *Differences of structural weight*

Differences in salience involve the fact that not all the elements at a specific level of semantic analysis carry the same structural weight. For instance, the everyday reading of *fruit* occupies a more central position than the archaic reading ‘offspring’ or the technical reading. Various indications may be adduced for this central position. For one thing, the central reading more readily springs to mind when people think of the category: on being asked what *fruit* means, you are more likely to mention the edible parts of plants than a person’s offspring. For another, the ‘edible part’ reading is more frequent in actual language use.

In addition, the ‘edible part’ reading is a good starting-point for describing the other readings. It would probably be more easy to understand the expression *the fruit of his labours* (if it is new to you) when you understand the ‘edible part’ reading than the other way round. The basic reading, in other words, is the center of semantic cohesion in the category; it holds the category together by making the other readings accessible. Three features, in short (psychological salience, relative frequency of use, interpretative advantageousness), may be mentioned as indications for the central position of a particular reading.

Centrality effects are not restricted to the level of senses and readings, however, but may also be invoked at the referential level, i.e. the level where we talk about the members of a category. When prompted, Europeans will more readily name apples and oranges as types of fruit than avocados or pomegranates, and references to apples and oranges are likely to be more frequent in a European context than references to mangos. This does not exclude, moreover, cultural differences among distinct parts of Europe.

The terminology used to describe these differences of structural weight is quite diverse, and the description in the foregoing paragraphs has featured such (intuitively transparent) terms as *salience*, *typicality*, and *centrality*. The most technical term however is *prototypicality*: the central reading of an item or the central subset within the range of a specific reading is the prototype.

### *Fuzziness and flexibility*

How clearly distinguishable are the elements of a semantic description? Consider the question whether the central sense of *fruit* can be delimited in a straightforward fashion.

Such a delimitation will take the form of a definition that is general and distinctive: it is general in the sense of naming characteristics that are common to all fruits, and it is distinctive in the sense of being sufficient to distinguish the category ‘fruit’ (in the relevant sense) from any other category. (If a definition is not distinctive, it is too general: it will cover cases that do not belong in the category to be defined.)

Now, many of the characteristics that one might be inclined to include in a definition of the central reading of *fruit* do not have the required generality: fruits are not necessarily sweet, they do not necessarily contain parts that are immediately recognizable as seeds, they are not necessarily soft. There are, to be sure, a number of features that do have the required generality: all fruits grow above the ground on plants or trees (rather than in the ground); they have to ripen before you can eat them, and if you want to prepare them (rather than eat them raw), you would primarily use sugar, or at least use them in dishes that have a predominantly sweet taste. Taken together, however, these features do not suffice to prevent almonds (and other nuts), or a vegetable like rhubarb (which is usually cooked with sugar), from being wrongly included into the category that is to be defined. We have to conclude, then, that the central sense of *fruit* cannot receive a definition that is both general and distinctive. If we shift the attention to the members of a category, similar effects may be observed: the borderline of categories is not always clearly delineated. For instance, is a coconut or an olive a fruit? Observations such as these lead prototype theory to the conclusion that semantic structures need not necessarily consist of neatly delineated, rigidly defined entities, but that they may rather be characterized by a certain amount of fuzziness and vagueness—a fuzziness and vagueness that entails flexibility: if the criteria for using a word are less stringent than a naive conception of meaning would suggest, there is likely to be a lot of plasticity in meaning.

## 2.2. Illustration and overview

Following Molina (2000, 2005), the diachronic importance of prototypicality effects may be illustrated by the history of *sore* and *sorrow*. In contemporary English, *sore* essentially refers to a specific type of wound or physical injury, viz. a bruise, a raw place on the body as caused by pressure or friction. In Old English, however, the range of application is much broader. The following Old English quotations from the ninth and tenth century show that, next to the ‘wound’ reading as represented by (1a), we find references to bodily suffering (1b), to sickness (1c), and to emotional suffering (1d). (Note that the modern form *sore* appears in the older form *sar* in the following quotations, which date from the ninth and tenth century.)

- (1) a. *Wið wunda & wið cancor genim þas ilcan wyrte, lege to þam sare. Ne gefafað heo þæt sar furður wexe*  
‘For wounds and cancer take the same herb, put it on to the sore. Do not allow the sore to increase’
- b. *Pisse sylfan wyrte syde to þa sar geliðigað*  
‘With this same herb, the sore of the teeth calms widely’
- c. *Þa þe on sare seoce lagun*  
‘Those who lay sick in sore’
- d. *Mið ðæm mæstam sare his modes*  
‘With the greatest sore of his spirit’



Given that Old English *sore* thus appears to have a wider range of application than contemporary *sore*, what could have happened? How can we describe the semantic shift from Old English to contemporary English? Let us first have a closer look at the Old English situation. Two features that link up directly with the prototype-theoretical model as described above need to be mentioned.

First, the different meanings in Old English have a different status and a different weight within the cluster of applications. This becomes clear when we have a look at the frequencies of the *sore* quotations that may be found in the Oxford English Dictionary (OED) in the successive centuries: see Fig. 100.1 (simplified from Molina 2000: 99). The roman figures along the top of the figure indicate centuries; the lines indicate the distribution over time of the various readings of *sore*. While the ‘bodily suffering’ reading appears first and occupies the central position in the initial semantic structure of *sore*, the ‘injury, wound’ reading takes up a dominant position only much later. What we see, in other words, is an illustration of the first feature of prototypicality as defined: in the semantic structure of words, we have to distinguish central from peripheral instances. In the case of *sore*, the core meaning shifts over time from ‘bodily suffering’ to ‘wound’.

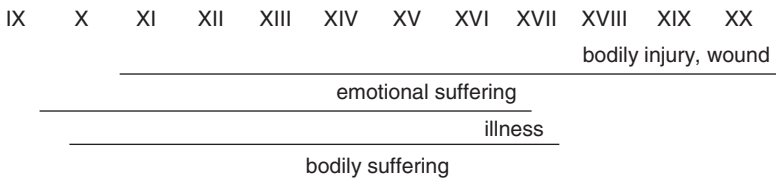


Fig. 100.1: Distribution of SORE meanings over time

But *sore* illustrates the second feature of prototypicality as well. *Sore* and *sorrow* are etymologically unrelated, but the ‘emotional suffering’ reading of *sore* overlaps with *sorrow*, which exhibits only that meaning. In fact, the frequent co-occurrence of *sore* and *sorrow* in alliterating binominals, as in the Middle English examples (1e)-(1f) below, indicates that both words were readily recognized as (near-)synonyms: in Middle English, the formal closeness and the semantic overlap between the two words seem to converge towards an incipient merger. From the prototype point of view, this specific configuration of *sore* and *sorrow* (in the forms *sorhe* and *sorge* in the quotations) illustrates the absence of rigid borderlines between words.

- (1) e. *Ant te unseli swalen sunken to helle, to forswelten i sar & i sorhe eaure*  
‘And the unhappy souls sink to hell, to die in sore and sorrow ever’  
f. *On heorte he hafde sorge & sar*  
‘On heart he had sorrow and sore’

Summarizing, the initial situation in the semantic history of *sore* is one in which the concept of ‘bodily suffering’ occupies the centre of the word, with metonymical extensions towards ‘illness’ and ‘wound’ on the one hand, and on the other with a metaphorical extension towards ‘emotional suffering’ that constitutes an overlap, possibly even an incipient merger, with *sorrow*. Fig. 100.2 graphically represents the situation. Solid circles represent meanings of *sore*, the dotted circle that of *sorrow*. The size of the circles identifies the

centrality of the meaning: 'bodily suffering' is the core of the *sore* structure. The links with the secondary readings are identified as being metonymical or metaphorical.

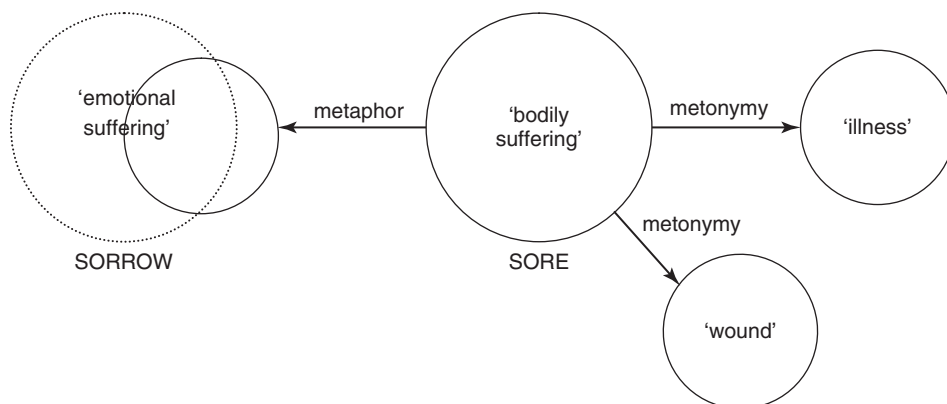


Fig. 100.2: The SORE cluster in Old English

The major force in the transition towards the present-day situation may now be identified: the French loan *pain*, first attested in 1297, takes over the meaning of *sore*. But typically (and this is where the fruitfulness of a prototype-theoretical approach shows up most clearly), it does not substitute *sore* in a wholesale manner, but rather occupies the central area of the meaning of *sore*, leaving only the specialized 'wound' reading with *sore* itself. In terms of the graphical representation of Fig. 100.2, the center of the *sore* cluster is so to speak invaded and occupied by *pain*, and as such, the original cluster dissolves, with only a fraction of the original range staying with *sore*. It should be mentioned that the story told here is a simplified one: it does not involve intriguing questions like the relationship between *pain* and *pine* (an older word for 'suffering', which survives in the verb *to pine* 'to suffer'), or the relationship between the nouns *sore* and *sorrow*, and the adjectives *sore* and *sorry*. Nevertheless, it illustrates how useful it can be to think of semantic structures as clusters of readings organized around prototypical cores.

The prototype structure of semantic change in its various aspects is discussed at length in Geeraerts (1997), a monograph devoted entirely to diachronic prototype semantics. Apart from Molina (2000, 2005), which served as the basis for the illustrations above, it is further acknowledged and exemplified in one form or another in many studies, among them Dirven (1985), Casad (1992), Evans (1992), Dekeyser (1996), Cuyckens (1999), Soares da Silva (1999, 2003), Koivisto-Alanko (2000), Tissari (2003). While these are predominantly lexical studies, the application of the model to the evolution of grammatical rather than lexical categories is illustrated and discussed, among others, by Winters (1989, 1992), Melis (1990), Nikiforidou (1991), Luraghi (1995), de Mulder (2001).

In this context, we should also mention studies that focus on the individual links within the prototype structure: the traditional mechanisms of semantic change. Apart from the theoretical attention for metaphor and metonymy as synchronic phenomena (see article 26 (Tyler & Takahashi) *Metaphors and metonymies*), these involve suggestions to revise the traditional classification of semantic changes, such as Grygiel's attempt (2004) to explain the emergence of new meanings on the basis of Fauconnier's blending theory. For a comprehensive treatment of the classification of semantic changes, see Blank (1997).

### 2.3. Further perspectives

Apart from the further descriptive elaboration of diachronic prototype semantics, two broad areas for further research may be identified. A first topic involves the relationship between the notion of prototype and the concept of stereotype as defined by Putnam (1975). According to Putnam, ordinary language users possess no more than 'stereotypical' knowledge about natural kinds, that is to say, they are aware of a number of salient characteristics, such as the fact that water is a transparent, thirst-quenching, tasteless liquid. The technical definition of *water* as  $H_2O$ , on the other hand, is to be located primarily with scientific experts. It is the experts' knowledge that ultimately determines how natural kind terms are to be used. On the one hand, a 'division of linguistic labor' ensures that there are societal experts who know that water is  $H_2O$ , that there is a distinction between elms and beech, how to recognize gold from pyrites, and so on. On the other hand, laymen attune their own linguistic usage to that of the expert scientists, technicians, etc. The members of the non-specialized group are not required to have expert knowledge, but if they wish to be considered full-fledged members of the linguistic community, they are supposed to know the 'stereotype' connected with a category. A stereotype is, thus, a socially determined minimum set of data with regard to the extension of a category. Given the similarity between Putnam's stereotypes and the prototypes of Cognitive Linguistics (both consist roughly of the most salient information connected with a category), the division of linguistic labor might be used to rescue a classical, view of concepts that contradicts the flexibility signalled by prototypicality. Expert definitions being classical (they specify an essentialist 'hidden structure' for natural kinds), the stereotypical concepts of everyday language users might now be seen as hardly more than a sloppy derivative of those classically defined expert categories. 'True' (expert) definitions would be classical, and stereotypical/prototypical concepts might be dismissed as sociolinguistically secondary phenomena.

However, as a 'sociolinguistic' theory about the social factors that determine how lexical items may be used, the division of linguistic labor theory is not entirely adequate. The primacy of expert definitions would seem to imply that natural language follows the developments and discoveries of science in a strict fashion. In actual fact, however, natural language categorization is not only determined by the state of affairs in the sciences, but also by the communicative and cognitive requirements of the linguistic community in its own right. More generally, if Putnam's view is seen as a theory about the sociolinguistic structure of semantic norms, his hierarchical model (with experts at one end and laymen at the other) is only one among a number of alternatives, some of which (such as the one described by Bartsch 1987) link up closely with a prototypical conception of categorial structure. For further discussion of Putnam's views and semantic change, see Eckardt (2003), Geeraerts (2008) and article 101 (Eckardt) *Grammaticalization and semantic reanalysis*.

A second, not unrelated topic for further scrutiny involves the role of prototypicality in an explanatory theory of semantic change. Prototypicality effects may be observed, but to what extent can they be explained, and further, to what extent can they themselves contribute to the explanation of change? These questions are best addressed in a functional theory of semantic change (see Geeraerts 1997 for a more extended treatment). There are, in fact, several functional reasons for having a prototypical conceptual structure of word meanings, and all three are functional requirements that the conceptual

system has to fulfil if it is to carry out optimally its task of storing categorial knowledge and making it accessible for cognitive and communicative purposes.

The first of these requirements has been mentioned by Eleanor Rosch (who first drew the attention to prototype effects) herself (see Rosch 1977): it is cognitively advantageous to lump as much information as possible into one's conceptual categories. Making conceptual categories as informatively dense as possible enables one to retrieve the most information with the least effort. Clearly, prototypically organized categories achieve such an informational density, because they are clusters of subconcepts and nuances.

Further, the cognitive system should combine structural stability with flexibility. On the one hand, it should be flexible enough to adapt itself to the ever-changing circumstances of the outside world. On the other hand, the categorial system can only work efficiently if it does not change its overall structure any time it has to cope with new circumstances. Again, prototypical categories obviously fulfil the joint requirements of structural stability and flexible adaptability. On the one hand, the development of peripheral nuances within given categories indicates their dynamic ability to deal with changing conditions and changing cognitive requirements. On the other hand, the fact that marginally deviant concepts can be peripherally incorporated into existing categories indicates that the latter have a tendency to maintain themselves as particular entities, thus maintaining the overall structure of the system. Prototypical categories are cognitively efficient because they enable the subject to interpret new data in terms of existing concepts; as expectational patterns with regard to experience, prototypically organized categories maintain themselves by adapting themselves to changing circumstances.

In short, the cognitive system favours prototypical categories because they enable it to fulfil the functional requirements of *informational density*, *structural stability*, and *flexible adaptability* as a pattern of expectations. This functional view of conceptual structure can be further specified in the following way. The flexibility that is inherent in prototypically organized concepts cannot work at random; there have to be a number of principles that restrict the flexible extendibility of concepts. These principles define what is an acceptable extension of a particular concept. The traditional associationist mechanisms of semantic change (such as metaphor and metonymy) have precisely that function; they restrict the set of acceptable conceptual extensions to those changes that are brought about by regular associationist mechanisms such as metaphor and metonymy. In this sense, then, the traditional classificatory categories of historical semantics can in fact be incorporated into a functional classification of the causes of semantic change. But prototypicality itself has a similar restrictive function: the constraint that new meanings be linked to existing ones prevents the semantic flexibility of lexical items from deteriorating into communicatively inefficient arbitrariness.

The implications of prototype theory for the functioning of the human conceptual capacities make it an explanatory basis for diachronic semantics, because the dynamic nature of human thinking is recognized as one of the fundamental structural characteristics of conceptual categories. In this respect, accepting prototype theory is a question of explanatory adequacy rather than descriptive adequacy: prototype theory explains the observed prototypical characteristics of semantic change, because it relates them to general epistemological beliefs about the working of the human conceptual system, beliefs it shares with other cognitive theories. And at the same time, of course, the overall conception of a prototypical organization of conceptual categories can itself be explained on functional grounds.

At the same time, however (and this is where a domain for further research may be identified), the functional motivation behind prototypicality effects is not the only functional principle at work in the association between linguistic forms and meanings. Consider homonymic clashes. Gilliéron's famous example involves the collision of Latin *cattus* ('cat') and *gallus* ('cock') into Gascon *gat* (Gilliéron & Roques 1912). The tension is resolved by replacing *gat* ('cock') by *bigey*, a local equivalent of *vicaire* ('curate'), or by *azan*, the local equivalent of *faisan* ('pheasant'), or by the cognates of Latin *pullus*. The moral of the story is usually taken to be that homonymic ambiguities set off therapeutic diachronic changes towards their resolution. The rationale behind the avoidance of homonymy might be called a principle of formal efficiency, more particularly a 'one form — one meaning' principle: formally disambiguated languages are functionally superior, because they avoid communicative misunderstandings. But a formal kind of efficiency of this type contrasts with the type of efficiency underlying prototypicality effects: in the former case, there is a tendency to reduce polysemy, in the latter, semantic diversity is enhanced. It will have to be determined, then, how exactly the various functional principles interact.

### 3. Conceptual metaphors through time

#### 3.1. Introducing conceptual metaphors

Suppose that you talk about relationships in the following way.

- (2) He is known for his many rapid *conquests*. She *fought* for him, but his mistress *won* out. He *fled* from her *advances*. She *pursued* him relentlessly. He is slowly *gaining ground* with her. He *won* her hand in marriage. He *overpowered* her. She is *besieged* by suitors. He has to *fend* them off. He *enlisted* the aid of her friends. He made an *ally* of her mother. Theirs is a *misalliance* if I've ever seen one.

All these expressions are related by a common theme: love is war. A source domain (war) is more or less systematically mapped onto a target domain (love). The target domain is understood in terms of the source domain; the conceptual structure that we associate with the source domain (like the recognition that a war involves specific actions like fighting and spying and fleeing and finding allies) is invoked to bring structure to the target domain.

Crucially, this mapping involves not just a single word, but a whole set of lexical items, and entire subfield of the vocabulary. In such cases, Cognitive Linguistics speaks of *conceptual metaphors*: metaphorical mappings that are not restricted to a single item but that overarch an entire subset of the vocabulary. Typically, in Conceptual Metaphor Theory, such supralexic metaphors are identified by a 'target domain is source domain' format: LOVE IS WAR. (For an introduction to contemporary metaphor theory, see Kövecses 2002, and compare article 26 (Tyler & Takahashi) *Metaphors and metonymies*.) From a cognitive point of view, such conceptual (rather than lexical) metaphors are extremely interesting, because they may well reveal underlying patterns of thought, basic models that we use to reason about a given topic (like love). From a historical point of view, then, the question arises to what extent such conceptual metaphors for a given target domain change through time: can an analysis of changing conceptual metaphors reveal cultural

and historical changes in the way in which a specific domain of human experience is conceptualized?

### 3.2. Illustration and overview

Following Geeraerts & Grondelaers (1995), let us consider the evolution of anger metaphors in English. Conventionalized phrases such as those in (3) have been subsumed by Lakoff & Kövecses (1987) under the conceptual metaphor ANGER IS HEAT, which is further specified into ANGER IS THE HEAT OF A FLUID IN A CONTAINER when the heat applies to fluids, and into ANGER IS FIRE when the heat is applied to solids.

- (3) I had reached the boiling point, She was seething red with rage, He lost his cool, You make my blood boil, He was foaming at the mouth, He's just letting off steam, Don't get hot under the collar, Billy's a hothead, They were having a heated argument, When I found out, I almost burst a blood vessel, He got red with anger, She was scarlet with rage, I was fuming, When I told him, he just exploded, Smoke was pouring out of his ears, He was breathing fire, Those are inflammatory remarks, That kindled my ire, He was consumed by his anger.

At a lower level of analysis, these and many similar expressions are grouped together under labels such as when the intensity of anger increases, the fluid rises (his pent-up anger *welled up* inside him), intense anger produces steam (I was *fuming*), and when anger becomes too intense, the person explodes (when I told him, he just *exploded*). Next to the basic conceptual metaphor ANGER IS HEAT, less elaborate metaphorical patterns such as ANGER IS INSANITY, ANGER IS AN OPPONENT, ANGER IS A DANGEROUS ANIMAL, and CAUSING ANGER IS TRESPASSING are identified. Lakoff & Kövecses tend to interpret these findings in terms of physiological effects: increased body heat is taken to be a physiological effect of being in a state of anger, and anger is metonymically conceptualized in terms of its physiological effects.

If we now have a look at the following quotations from Shakespeare's *The Taming of the Shrew*, we may easily come to the conclusion that these examples too illustrate the conceptual metaphor ANGER IS HEAT.

- (4) Were I not a little pot and soon hot [IV:1:5]
- (5) Is she so hot a shrew [IV:1:17]
- (6) I tell thee, Kate, 't was burnt and dried away,  
and I expressly am forbid to touch it,  
for it engenders choler, planteth anger;  
and better it were that both of us did fast,  
since, of ourselves, ourselves are choleric [IV:1:156]
- (7) Grumio: What say you to a neat's foot?  
Katherina: 'Tis passing good. I prithee let me have it.  
Grumio: I fear it is too choleric a meat.  
How say you to a fat tripe finely broil'd?  
Katherina: I like it well. Good Grumio, fetch it me.

Grumio: I cannot tell. I fear 'tis choleric.  
 What say you to a piece of beef and mustard?  
 Katherina: A dish that I do love to feed upon.  
 Grumio: Ay, but the mustard is too hot a little [IV:3:25]

But would these older images have the same, allegedly universal physiological basis as the contemporary expressions described by Lakoff & Kövecses? It has been described by various authors (among them Schäfer 1966; Pope 1985) how the psychology of Shakespeare's dramatic characters unmistakably refers to the theory of humours. The humoral theory, to be precise, is the highly influential doctrine that dominated medical thinking in Western Europe for several centuries.

The foundations of the humoral doctrine were laid by Hippocrates of Kos (ca. 460 BC—ca. 370 BC). Physiologically, the four humoral fluids regulate the vital processes within the human body; the secretion of the humours underlies the dynamical operation of our anatomy. Psychologically, on the other hand, they define four prototypical temperaments, i.e. a person's character is thought to be determined by the preponderance of one of the four vital fluids in his body. Thus, the *choleric* temperament (given to anger and irascibility) is determined by a preponderance of the yellow bile, while the *melancholic*, gloomy and fearful, suffers from a constitutional excess of black bile. The *phlegmatic* personality is typically placid and unmoved, while the *sanguine* temperament (defined in correlation with blood, the fourth humour) is passionate, optimistic, and brave. The singular combination of physiological and psychological concepts that characterizes the theory of humours also shows up in the fact that a disequilibrium of the fluids does not only characterize constitutional temperaments, but also causes temporary diseases—which are then typically described in bodily, biological terms as well as in psychic terms. For instance, an overproduction of yellow bile may be signalled by the patient's vomiting bile, but also by his dreaming of fire. In the same line, an excess of blood shows up in the redness of the skin and swollen veins, but also in carelessness and a certain degree of recalcitrance. In this sense, the humoral theory is a medical doctrine: it identifies diseases and their symptoms, and defines a therapy. Obviously, the basic therapeutic rule will be to restore the balance of the humours, given that a disturbance of their well-balanced proportion is the basic cause of the pathological situation. The long-lasting popularity of blood-letting, for instance (a standard medical practice that continued well into the 19th century) has its historical origins in the theory of humours.

The connection between yellow bile and fire that was mentioned a moment ago is not accidental. It is part of a systematic correlation between the human, anatomical microcosm and the macrocosm, thought to be built up from four basic elements. Thus, yellow bile, black bile, phlegm, and blood corresponded with fire, earth, water, and air respectively. In the Aristotelian elaboration of the Hippocratic doctrine, these correlating sets of microcosmical and macrocosmical basic elements were defined as combinations of four basic features: cold, warm, wet, and dry. Blood was thought to be warm and wet, phlegm cold and wet, yellow bile warm and dry, and black bile cold and dry.

The classical humoral doctrine received the form in which it was to dominate the Middle Ages in the work of Galen (129–199). He added a dietary pharmacology to the humoral edifice. All plants (and foodstuffs in general) could be characterized by one of four degrees of warmth, cold, wetness, and dryness. Given that diseases are caused by an excess of one of the four humours, and given that these are themselves characterized by the four



features just mentioned, the basic therapeutic rule is to put the patient on a diet that will ensure a decrease of the superfluous humour.

In the course of the Middle Ages, the Galenic framework was further developed into a large-scale system of signs and symbols. In a typically medieval analogical way of thinking, widely divergent phenomena (ranging from the ages of man to astrological notions such as the system of the planets and the signs of the zodiac) were fitted into the fourfold schema presented by the medical theory. In Tab. 100.1, an overview is given of a number of those correlations. The humoral edifice began to be undermined as soon as the Renaissance introduced renewed empirical medical investigations, like William Harvey's description of the circulation of the blood in 1628. However, the disappearance of the theory from the medical scene was only very gradual, and it took approximately another three centuries before the last vestiges of the humoral framework were finally removed. The standard view of the historians of medicine is, in fact, that only in the middle of the 19th century did the humoral pathological conception receive its final blow.

Tab. 100.1: A system of humoral correspondences

|                       | <i>phlegm</i> | <i>black bile</i> | <i>yellow bile</i> | <i>blood</i> |
|-----------------------|---------------|-------------------|--------------------|--------------|
| <i>characteristic</i> | cold and wet  | cold and dry      | warm and dry       | warm and wet |
| <i>element</i>        | water         | earth             | fire               | air          |
| <i>temperament</i>    | phlegmatic    | melancholic       | choleric           | sanguine     |
| <i>organ</i>          | brain/bladder | spleen            | liver/stomach      | heart        |
| <i>color</i>          | white         | black             | yellow             | red          |
| <i>taste</i>          | salty         | sour              | bitter             | sweet        |
| <i>season</i>         | winter        | autumn            | summer             | spring       |
| <i>wind</i>           | North         | West              | South              | East         |
| <i>planet</i>         | moon          | Saturn            | Mars               | Jupiter      |
| <i>animal</i>         | turtle        | sparrow           | lion               | goat         |

It will be clear by now that the conceptualization of anger in the Shakespeare quotations conforms to the model furnished by the theory of humours: anger is caused by black bile, also named choler (6), the production of which may be stimulated by certain kinds of food (6), (7); while a choleric temperament is a permanent personality trait (6), the main attribute of the choleric personality is hotness (4), (5). The fact that passages such as the ones quoted above can be multiplied from the work of other English Renaissance playwrights like Webster, Marlowe, or Jonson, leads Schäfer (1966) to the conclusion that the humoral conception of physiology and psychology is something of a true fashion in the plays produced when Queen Elizabeth I reigned in England, from 1558 until 1603. He attributes this to the fact that it is only in the middle of the 16th century, after the invention of printing, that the doctrine became known to a wider audience than that of learned men who could read the medical authorities in their Latin and Greek originals. But if this dissemination of the doctrine of humours from the realm of learned knowledge to that of popular belief implies that it is technically a piece of *gesunkenes Kulturgut*, the question arises how far it actually sank. In particular, how deeply did it become entrenched in the language itself?

In Tab. 100.2, we have systematically brought together a number of items and expressions in three European languages (English, French, and Dutch) that can be considered a part of the legacy of the theory of humours.



Tab. 100.2: Lexical relics of the humoral doctrine

|                        | <i>english</i>                                           | <i>french</i>                                                  | <i>dutch</i>                                                                                             |
|------------------------|----------------------------------------------------------|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| <i>phlegm</i>          | <i>phlegmatic</i><br>'calm, cool,<br>apathetic'          | <i>avoir un flegme imperturbable</i><br>'to be imperturbable'  | <i>een valling</i><br>(dialectal) 'a cold, a<br>running nose' (literally 'a<br>falling', viz. of phlegm) |
| <i>black bile</i>      | <i>spleen</i><br>'organ filtering the<br>blood; sadness' | <i>mélancolie</i><br>'sadness, moroseness'                     | <i>zwartgallig</i><br>'sad, depressed' (literally<br>'blackbilious')                                     |
| <i>yellow<br/>bile</i> | <i>bilious</i><br>'angry, irascible'                     | <i>colère</i><br>'anger'                                       | <i>z'n gal spuwen</i><br>'to vent (literally 'to spit<br>out') one's gall'                               |
| <i>blood</i>           | <i>full-blooded</i><br>'vigorous, hearty,<br>sensual'    | <i>avoir du sang dans les veines</i><br>'to have spirit, luck' | <i>warmbloedig</i> 'passionate'<br>(literally 'warm-blooded')                                            |

If we zoom in on one of the cells of Tab. 100.2, still further examples may be found. According to Roget's Thesaurus, the items listed under (8) all refer to anger or related concepts.

- (8) *choler* 'anger', *gall* 'anger', *rouse one's choler* 'to elicit anger', *stir one's bile* 'to elicit anger', *galling*, 'vexing, causing anger', *choleric* 'irascible', *liverish* 'irascible', *splenetic* 'irascible', *hot-blooded* 'irascible', *fierce* 'irascible', *hot-headed* 'irascible'

Given these lexical relics of the humoral doctrine, it will be obvious that the conceptual metaphor ANGER IS THE HEAT OF A FLUID IN A CONTAINER neatly fits into the humoral views: the body is the container of the four cardinal fluids, and anger involves the heating up of specific fluids (either yellow bile as the direct source of ire, or blood, which is not only a humour in itself, but which is also a carrier for the other humours). This means, in other words, that the purely physiological interpretation put forward by Lakoff & Kövecses needs to be interpreted along cultural and historical lines. When we recognize that the medieval physiological-psychological theory of the four humours and the four temperaments has left its traces on our emotional vocabulary, we learn to see the ANGER IS THE HEAT OF A FLUID IN A CONTAINER metaphor as one of those traces. It is then not motivated directly by the physiological effects of anger, as Lakoff & Kövecses suggest, but it is part of the historical (but reinterpreted) legacy of the humoral theory.

Although the interest for a cross-cultural comparison of conceptual metaphors (see Kövecses 2005 for a theoretical view and Sharifian et al. 2008 for an illustration) generally seems to be bigger than that for a historical comparison, a growing number of researchers is undertaking diachronic studies on the ways in which particular conceptual metaphors develop: see Gevaert (2001, 2005), Fabiszak (2002), Tissari (2003), van Hecke (2005), Diller (2007), Trim (2007), Geeraerts & Gevaert (2008), Allan (2008).

### 3.3. Further perspectives

The 'anger' example shows that an adequate analysis of the motivation behind cultural phenomena in general and language in particular has to take into account the diachronic

dimension. Cultural models, i.e. the more or less coherent sets of concepts that cultures use to structure experience and make sense of the world are not reinvented afresh with every new period in the culture's development. Rather, it is by definition part of their cultural nature that they have a historical dimension. It is only by investigating their historical origins and their gradual transformation that their contemporary form can be properly understood.

For Conceptual Metaphor Theory, that means two things. On the one hand, diachronic studies of linguistic conceptualization patterns may shed an interesting light on the development of cultures. On the other hand, it is important not to come to the rash conclusion of the presence of a conceptual metaphor. After all, the humoral doctrine was initially a literal, physiological theory—a wrong one, given our current knowledge of anatomy and physiology, but a literal theory nevertheless, and not just a metaphor. It is only when the original theory as a motivating context disappears that the lexical relics of the humoral doctrine become metaphorical expressions, or even worse, dead metaphors that evoke no specific concept whatsoever. An expression like *full-blooded* may safely be categorized as metaphorical to the extent that the concept 'blood' evokes vigour, strength and dynamism in other expressions of the language as well: *bloodless* and *new blood* are used in contexts in which a link with anatomy and physiology is definitely absent and in which there is no doubt that *blood* as a sign of life is used non-literally. But the Dutch dialect word *valling* no longer evokes the verbal concept *vallen* 'to fall' in any way: it is a semantically empty relic. (The danger of underestimating the importance of dead metaphors was raised early on in the history of Conceptual Metaphor Theory; see Traugott 1985.)

This means that the study of diachronic changes of conceptualization faces a double danger of over-metaphorization. On the one hand, with regard to older stages of the language, we may be tempted to interpret expressions as metaphorical that were taken literally at the time. Unless we are aware of the importance and the scientific status of the humoral theory in the Elisabethan era, we might think that the Shakespearean expressions have the same metaphorical status as *to make one's blood boil* in contemporary English. On the other hand, with regard to the present-day situation, metaphor researchers may be tempted to overstate the presence of live metaphor at the expense of dead metaphors. These dangers can only be overcome if reliable methods can be developed to determine metaphoricity in contrast with literal use. At present no such generally accepted set of criteria exists.

Next to the double-sided problem of literalness, there is another methodological issue that needs to be raised in connection with diachronic metaphor studies. If metaphors are interpreted as a mapping from source concepts to target concepts, then current metaphor studies seem to have a tendency to start from source concepts rather than target concepts. A typical kind of research, for instance, would ask the question to what extent the heart is seen as the seat of the emotions, i.e. to what extent the source concept 'heart' conceptualizes the target concept 'emotion' (see Sharifian et al. 2008). However, the recognition that source concept X conceptualizes target concept Y does not necessarily imply that target concept Y is conceptualized by source concept X, at least not if the latter statement implies that Y is universally or predominantly conceptualized in the light of X. A lot of the research inspired by Conceptual Metaphor Theory, however, seems to rely precisely on such an unwarranted shift of interpretation. Studies on 'the conceptualization of Y in language Z' more often than not content themselves either with focusing on a particular X, or at most with listing various X's that appear in the expression of Y in Z, without

asking the critical question what weight these metaphorical expressions carry with regard to each other, and with regard to alternative expressions of Y. Target concept Y may very well be conceptualized by source concept X, but if it is *not only* conceptualized by X, you will want to know exactly what the impact of X is in comparison with the other types of expression.

To illustrate the danger of ignoring the relative salience of alternative expressions, Geeraerts & Gevaert (2008) present a case study that involves *heart* as the seat of feeling and thought in Old English. They show that there is clear evidence that feelings and thoughts are indeed conceptualized as being metaphorically situated in the heart, but at the same time, they point out that this perspective is very much secondary with regard to an alternative, more literal one that involves *mood* rather than *heart*. The apparent necessity to take into account the relative position of competing expressions involves a comparison of the relative weight of the alternatives. Such an approach is known as an *onomasiological* one. But Cognitive Linguistics has more to say about onomasiology, as we shall see in the next section.

## 4. Diachronic onomasiology

### 4.1. Introducing diachronic onomasiology

Although it has hardly found its way to the canonical English terminology of linguistics, the distinction between onomasiology and semasiology is a traditional one in Continental structural semantics and the Eastern European tradition of lexicological research. The following quote from Baldinger (1980: 278) illustrates the distinction quite nicely: “Semasiology [...] considers the isolated word and the way its meanings are manifested, while onomasiology looks at the designations of a particular concept, that is, at a multiplicity of expressions which form a whole.” The distinction between semasiology and onomasiology, then, equals the distinction between *meaning* and *naming*: semasiology takes its starting-point in the word as a form, and charts the meanings that the word can occur with; onomasiology takes its starting-point in a concept, and investigates by which different expressions the concept can be designated, or named.

Now, in order to understand the specific impact of Cognitive Linguistics on onomasiological research, an additional distinction has to be introduced, viz. that between what may roughly be described as the *qualitative* versus the *quantitative* aspects of linguistic semantic structure. The distinction may be introduced by considering semasiological structures first. Qualitative aspects of semasiological structure involve the following questions: which meanings does a word have, and how are they semantically related? The outcome is an investigation into polysemy, and the relationships of metonymy, metaphor etc. that hold between the various readings of an item. Quantitative aspects of lexical structure, on the other hand, involve the question whether all the readings of an item carry the same *structural weight*. The semasiological outcome of a quantitative approach is an investigation into prototypicality effects of various kinds, as will be obvious to anyone who has followed the developments in semasiological research of the last two decades: prototypicality research is basically concerned with differences of structural weight among the members or the subsenses of a lexical item. The qualitative perspective is a much more traditional one in semasiological lexicology than the quantitative one,

which was taken up systematically only recently, with the birth and development of prototype theory.

The distinction between qualitative and quantitative aspects of semantic structure can be extrapolated to onomasiology. The qualitative question then takes the following form: what kinds of (semantic) relations hold between the lexical items in a lexicon (or a subset of the lexicon)? The outcome, clearly, is an investigation into various kinds of lexical structuring: field relationships, taxonomies, lexical relations like antonymy and so on. The quantitative question takes the following onomasiological form: are some categories or mechanisms cognitively more salient than others, that is, are there any differences in the probability that one category rather than another will be chosen for designating things out in the world? Are certain lexical categories more obvious names than others?

The terms *qualitative* and *quantitative* as used here are not in all respects adequate, to be sure. Fundamentally, what is at issue here is the distinction between the mere presence of an item within a structure and the structural weight of that item, or, if one wishes, between the *presence* of an item and the *preference* language users may have for that item. The terms *quantitative* and *qualitative* are only used to avoid cumbersome paraphrases expressing this distinction.

The novelty of Cognitive Linguistics in the domain of onomasiology lies mainly on the quantitative side, but we should first say something about the older strands of onomasiological research. A substantial part of onomasiological research is occupied by the study of lexicogenetic mechanisms. *Lexicogenesis* involves the mechanisms for introducing new pairs of word forms and word meanings—all the traditional mechanisms, in other words, like word formation, word creation, borrowing, blending, truncation, ellipsis, folk etymology and others, that introduce new items into the onomasiological inventory of a language. Crucially, semasiological change is a major mechanism of lexicogenesis, i.e. of introducing new pairings of forms and meanings. Now prestructuralist semantics—apart from coining the term *onomasiology* itself (Zauner 1902)—has introduced some of the basic terminology for describing lexicogenetic mechanisms. Although basically concerned with semasiological changes, the major semasiological treatises from Bréal (1897) and Paul (1880) to Stern (1931) and Carnoy (1927) do not restrict themselves to strictly semasiological mechanisms like metaphor and metonymy, but also devote attention to mechanisms of onomasiological change like borrowing or folk etymology (compare Kronasser 1952 and Quadri 1952 for overviews of semasiological and onomasiological research respectively).

Structuralist semantics insists, in the wake of de Saussure himself, on the distinction between semasiology and onomasiology. In the realm of diachronic linguistics, this shows up in Ullmann's classification of semantic changes (1951, 1962), or in Baldinger's argumentation (1964) for studying the interplay between semasiological and onomasiological changes. More importantly, the bulk of (synchronic) structuralist semantics is devoted to the identification and description of different onomasiological structures in the lexicon, such as lexical fields, taxonomical hierarchies, lexical relations like antonymy and synonymy, and syntagmatic relationships (compare Lutzeier 1995).

Both the prestructuralist attention for lexicogenetic mechanisms and the structuralist attention for onomasiological structures in the lexicon are examples of a 'qualitative' approach. Cognitive Linguistics, in contrast, devotes specific attention to quantitative aspects of onomasiology. With regard to the onomasiological structures in the lexicon, the

best-known example to date is Berlin and Kay's basic level model (Berlin & Kay 1969; Berlin 1978), which involves the claim that a particular taxonomical level constitutes a preferred, default level of categorization. The basic level in a taxonomy is the level that is (in a given culture) most naturally chosen as the level where categorization takes place; it has, in a sense, more structural weight than the other levels.

But obviously, the basic level approach belongs to synchronic linguistics rather than diachronic onomasiology. For a contribution of Cognitive Linguistics to the latter, we have to turn to the study of lexicogenetic mechanisms.

## 4.2. Illustration and overview

Cognitive semantics introduces a 'quantitative' perspective into the study of lexicogenetic mechanisms. Within the set of lexicogenetic mechanisms, some could be more salient (i.e. might be used more often) than others. Superficially, this could involve, for instance, an overall preference for borrowing rather than morphological productivity as mechanisms for introducing new words, but from a cognitive semantic perspective, there are other, more subtle questions to ask: do the ways in which novel words and expressions are being coined, reveal specific (and possibly preferred) ways of conceptualizing the onomasiological targets? An example of this type of research (though not specifically situated within a cognitive semantic framework) is Alinei's work (e.g. 1996) into the etymological patterns underlying the European dialects: he argues, for instance, that taboo words in the European dialects may be motivated either by Christian or Islamic motifs, or by pre-Christian, pre-Islamic heathen motifs; the 'quantitative' perspective then involves the question whether one of these motifs is dominant or not. On a broader scale, the etymological research project started by Koch and Blank (Koch 1997; Blank & Koch 1999, 2003), intends to systematically explore motivational preferences in the etymological inventory of the Romance languages. In comparison with much of the metaphor-based research that was introduced in the previous section, the approach put forward by Blank and Koch takes into account all possible pathways of lexicalization (and not just metaphor).

Descriptively, the approach takes the form of overviews like that in Tab. 100.3, adapted from Blank (2003). The table charts the different names for the target concept *match* in a number of European languages, as identified in the second row. Each of these names is itself derived from a source form, as may be found in the final row. Source form and target form are related in specific ways, specified in the third row of the table. The relationship involves both a formal process and a semantic relation. The English target form *match*, for instance, is related by a process of semasiological change to the older reading *match* 'wick'. Semantically, the relationship between 'wick' and 'short, slender piece of wood or other material tipped with a chemical substance which produces fire when rubbed on a rough or chemically prepared surface' is one of metaphorical similarity. German *Streichholz*, on the other hand, is related to the verb *streichen* and the noun *Holz* through a process of compounding; semantically, the relationship between target form and source form is metonymical. Needless to say, the source forms may often themselves be further analysed as target forms: *allumette* 'splinter designated to transport fire', for instance, is related by a process of suffixation and a semantic relationship of metonymy to the verb *allumer* 'to light' and the suffix *-ette*.

Tab. 100.3: ‘Match’ in English, French, German, and Spanish

| <i>target concept</i>                                                                                                                                       | <i>target form</i> | <i>process/relation</i> | <i>source form</i>                                    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|-------------------------|-------------------------------------------------------|
| match                                                                                                                                                       | English            | semantic change /       | English                                               |
| ‘short, slender piece of wood or other material tipped with a chemical substance which produces fire when rubbed on a rough or chemically prepared surface’ | <i>match</i>       | metaphorical similarity | <i>match</i> ‘wick’                                   |
|                                                                                                                                                             | French             | semantic change /       | French <i>allumette</i>                               |
|                                                                                                                                                             | <i>allumette</i>   | taxonomic subordination | ‘splinter for the transport of fire’                  |
|                                                                                                                                                             | German             | compound /              | German <i>streichen</i> ‘to rub’ + <i>Holz</i> ‘wood’ |
|                                                                                                                                                             | <i>Streichholz</i> | metonymy + metonymy     |                                                       |
|                                                                                                                                                             | Spanish            | loan + conversion /     | Old Greek <i>phosphóros</i>                           |
|                                                                                                                                                             | <i>fósforo</i>     | metonymy                | ‘fire-bringing’                                       |
|                                                                                                                                                             | Spanish            | suffixation /           | Spanish <i>cera</i> ‘wax’ +                           |
|                                                                                                                                                             | <i>cerilla</i>     | taxonomic subordination | <i>-illa</i>                                          |

If sufficient materials of the form illustrated in Tab. 100.3 are available, it will be possible to compare the relative salience of different lexicogenetic mechanisms, not just on the abstract level where, for instance, the importance of metonymy in general would be gauged against the importance of metaphor in general, but more importantly also on a more fine-grained level where the conceptualization of a specific target concept can be investigated: “Combining diachronic lexicology with onomasiology and applying it to more than just one or a few languages allows us to show, in an empirically justified way, which conceptualizations are proper to a single or very few speech communities versus those that can be found universally and thus may match a biological predisposition of perceiving the world. Cognitive onomasiology hence can procure us deeper insight into the way our mind works.” (Blank 2003: 44).

Beyond the work of Blank, Koch, and their associates (see e.g. Gévaudan, Koch & Neu 2003; Gévaudan 2007; and compare Grzega 2002), this type of cognitive onomasiology, in spite of its obvious interest, has not yet given rise to a major wave of research.

### 4.3. Further perspectives

The two descriptions of onomasiology in the Baldinger quotation are not exactly equivalent. On the one hand, studying ‘a multiplicity of expressions which form a whole’ leads directly to the *traditional, structuralist conception of onomasiology*, i.e. to the study of semantically related expressions (as in lexical field theory, or the study of the lexicon as a relational network of words interconnected by links of a hyponymical, antonymical, synonymous nature etc.). On the other hand, studying ‘the designations of a particular concept’ opens the way for a *contextualized, pragmatic conception of onomasiology*, involving the actual choices made for a particular name as a designation of a particular concept or a particular referent. This distinction can be further equated with the distinction between an investigation of *structure*, and an investigation of *use*, or between an investigation of *langue* and an investigation of *parole*. The structural conception deals with sets of related expressions, and basically asks the question: what are the relations among the alternative



expressions? The pragmatic conception deals with the actual choices made from among a set of related expressions, and basically asks the question: what factors determine the choice for one or the other alternative?

Developing diachronic onomasiology on the level of actual usage, then, should be a major area for further research in historical Cognitive Linguistics. To give an example of the kind of research involved, we may cite some of the factors that have been identified in Geeraerts, Grondelaers & Bakema (1994) and Geeraerts, Grondelaers & Speelman (1999) as determinants of lexical choices. Using corpus-based methods, these studies established that the choice for one lexical item rather than the other as the name for a given referent is determined by the semasiological salience of the referent, i.e. the degree of prototypicality of the referent with regard to the semasiological structure of the category; by the onomasiological entrenchment of the category represented by the expression; and by contextual features of a classical sociolinguistic and geographical nature, involving the competition between different language varieties. While these studies concentrate on synchronic variation and short term lexical changes (see also Tafreschi 2006), other studies starting from cognitive semantic models have been devoted to long term onomasiological changes: Dekeyser (1990, 1995), Kleparski (1997), Geeraerts (1999), Molina (2000).

Pragmatic onomasiology yields an integrated picture of semantic change. To begin with, pragmatic onomasiology combines the study of actual structures with that of latent mechanisms: the *input* for any onomasiological act (the act of naming, the act of choosing a category) is always both the set of already available expressions, and the set of expressions that is virtually available through the presence of lexicogenetic mechanisms. Choosing an expression can in fact take the form of selecting an option that is already there, or of creating a new alternative on the basis of one of the mechanisms.

Further, onomasiological change in the language at large cannot be understood unless we take into account pragmatic onomasiology: changes are always mediated through the onomasiological choices made on the level of *parole*. Words die out because speakers refuse to choose them, and words are added to the lexical inventory of a language because some speakers introduce them and others imitate these speakers; similarly, words change their value within the language because people start using them in different circumstances. Structural change, in other words, is the *output* of processes that are properly studied in the context of pragmatic onomasiology. Also, this pragmatic, *parole*-based perspective automatically takes the form of a sociovariational investigation: in choosing among existing alternatives, the individual language user takes into account their sociolinguistic, non-referential value, and conversely, the expansion of a change over a language community is the cumulative effect of individual choices. In this sense, it is only through an investigation into factors determining these individual choices, that we can get a grasp on the mechanisms behind the invisible hand of lexical change.

The overall picture, then, is given in Fig. 100.3. The boxes to the left and to the right refer to the distinction between an interest in onomasiological structures on the one hand, and an interest in lexicogenetic mechanisms on the other. Within each box, the boldface captions identify the 'qualitative' aspects, whereas the other captions identify the 'quantitative' approaches. The arrows pointing away from the boxes indicate that both boxes constitute input for the processes that play a role at the pragmatic level: an act of naming may draw from the potential provided by the lexicogenetic mechanisms, or it may consist of choosing among alternatives that are already there. The arrows pointing towards the boxes indicate how the pragmatic choices may lead to change. These processes will

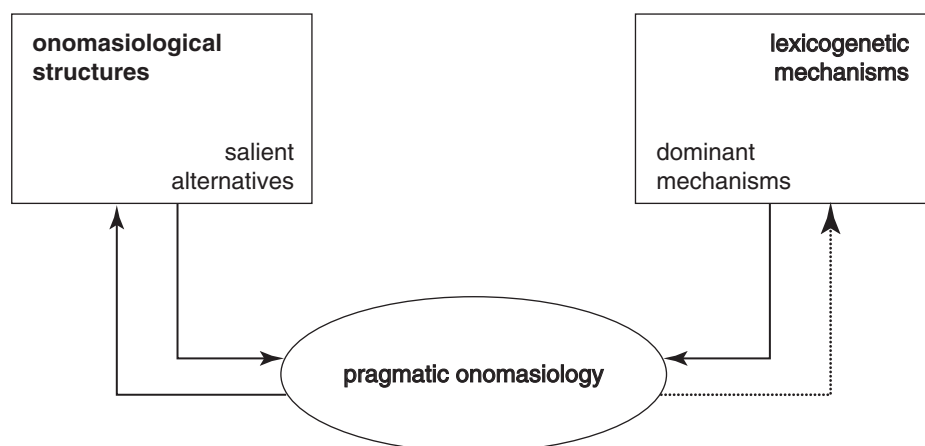


Fig. 100.3: The central position of pragmatic onomasiology

primarily affect the actual synchronic structures, through the addition or removal of senses or items, shifts in the variational value of expressions, or changes in the salience of certain options. Secondly (hence the dotted arrow), a change may affect the lexicogenetic mechanisms, for instance when a particular lexicalization pattern becomes more popular.

Onomasiological research at the level of *parole*, in other words, is central to the whole onomasiological enterprise; it mediates between what is virtual and what is actual, and it combines the traditional ‘qualitative’ approaches and the recent ‘quantitative’ innovations.

## 5. Rounding off

If the picture drawn in Fig. 100.3 indeed offers a comprehensive view of an integrated model of semantic change, it should be clear that the specific strands of investigation that we have identified as typical for Cognitive Linguistics contribute considerably to filling out the overall model. First, given that the semasiological extension of a given expression is also an onomasiological mechanism for introducing new form/meaning pairs, prototypicality as an architectural feature of semasiological extension sheds new light on one of the major lexicogenetic mechanisms. Second, given that conceptual metaphors and cultural models at large are one specific type of onomasiological structure (they combine various expressions on the basis of an underlying common source/target pattern), the study of historical changes in the dominant conceptualization of a given target reveals how the salience relationship between alternative onomasiological structures may change over time. Third, the comparative study of onomasiological mechanisms may reveal differences of cognitive salience among alternative forms of lexicogenesis. And fourth, the gradual emergence of a *parole*-based form of onomasiological research opens the path to an integration of these various forms of research.

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Dirk Geeraerts, Leuven (Belgium)

## 101. Grammaticalization and semantic reanalysis

1. Grammaticalization as a conspiracy of changes
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### Abstract

*The article starts by describing grammaticalization—a kind of language change—on basis of examples and characterizations in earlier literature on language change. I argue that a full understanding of grammaticalization can only be achieved when we take compositional semantics and the syntax-semantics interface into account. The analysis of cases of grammaticalization as cases of semantic reanalysis not only allows to describe more precisely the synchronization of changes in meaning and structure. It also reveals why the resulting new units in language (morphemes, constructions, words) are often ‘abstract’ and in what sense such changes overwhelmingly but not necessarily are unidirectional. Section 4 offers a detailed account of the semantic reanalysis of German fast<sub>1</sub> (‘solid, tight’) to fast<sub>2</sub> (‘almost’) which illustrates the general principles of sections 2 and 3. After contrasting the present analysis of grammaticalization with earlier proposals in the literature (section 5), section 6 addresses the reasons for semantic reanalysis. I propose that one driving factor is the urge to avoid accommodation of presuppositions which are costly and implausible. This I call the strategy to “Avoid Pragmatic Overload”, an interpretive strategy of the hearer.*

### 1. Grammaticalization as a conspiracy of changes

Research in grammaticalization was inspired by the question “where does grammar come from?”. While it is almost tautological that any communication system requires signals for entities, properties, relations (“content words”), grammatical structures don’t seem to be required by signalling systems as such. Nevertheless, practically all natural languages

include grammatical structure of surprising complexity. Moreover, there is no correlation between the level of cultural achievements of a society and the level of grammatical complexity of the society’s language. These observations suggest that our universal linguistic abilities drive us to collectively enrich signalling systems of content words with grammatical infrastructure. The present article takes a closer look into the semantic processes involved in these developments.

The prototypical instance of language change called ‘grammaticalization’ is a change where a word with independent content, preferably of one of the main lexical categories A, V or N, develops a new use with a comparatively more dependent, more abstract content, changed word class, typically of a functional nature, e.g. auxiliary, modal, preposition, particle or other functional word or even affix. The development of Latin and French future tense forms is often presented as a typical model case of grammaticalization.

(1) Expression of Future tense: *we will sing*

| PRE-LATIN                                              | LATIN                                           | FRENCH                                         |
|--------------------------------------------------------|-------------------------------------------------|------------------------------------------------|
| <i>*kanta b<sup>h</sup>umos</i> →<br>sing be-2Pl.pres. | <i>canta-bimus</i><br>sing-2Pl.fut.             |                                                |
|                                                        | <i>cantare habemus</i> →<br>sing have-2Pl.pres. | <i>chante-rons</i><br>sing-2Pl.fut.            |
|                                                        |                                                 | <i>allons chanter</i> → ?<br>go-2Pl.pres. sing |

The semantic link between main verb (‘sing’) and embedding verb (‘be’, ‘have’, ‘go’) changes during the development. The grammatical status of the latter verb changes (from embedder to auxiliary verb), later also its morphological status (from independent word to affix). While it is usually a larger part of sentences which undergoes restructuring in such developments, it is often possible to spot one participant which is most involved, for instance the verb ‘have’ in the Latin > French change which turns from embedding verb via auxiliary to inflectional affix. ‘Grammaticalization’ is often used as if it affected exactly one word, clitic, or syllable. I will frequently talk about *items* as a cover term for ‘construction’, ‘word’, ‘clitic’, ‘affix’; firstly because grammaticalization processes are assumed to affect all these parts of speech, and secondly because changes can turn for instance a ‘word’ into an ‘affix’, still the object will remain an ‘item’.

The first studies in grammaticalization concerned the origin of grammatical structures like case endings, tense and aspect systems, determiners or classifiers. As the field broadened its focus, the need arose to replace the intuitive characterization of an item changing from “something less grammatical” into “something more grammatical” by a more specific characterization. One of the most sophisticated models, and one that is still in use (e.g. Fischer 2007) was developed by Lehmann in (1995/2002). Lehmann proposes three parameters of grammaticalization, each being realised in a syntagmatic and a paradigmatic dimension. The following table of criteria emerges (Lehmann 1995/2002: 110, Tab. 4):

Tab. 101.1: Lehmann’s parameters of grammaticalization

|                    | <i>paradigmatic</i>         | <i>syntagmatic</i>         |
|--------------------|-----------------------------|----------------------------|
| <i>weight</i>      | integrity                   | structural scope           |
| <i>cohesion</i>    | paradigmaticity             | bondedness                 |
| <i>variability</i> | paradigmatic<br>variability | syntagmatic<br>variability |

Grammaticalization, according to Lehmann, is characterised by an *increase in cohesion* along with a *decrease in weight and variability* from older item to newer item. The system is to be read as a cluster of correlated features rather than a list of necessary and sufficient criteria. Cases of grammaticalization should show sufficiently many, but need not exhibit all of the listed tendencies.

The paradigmatic weight of a sign, or its integrity, measures its distinctness and independence of other signs both in terms of phonology and semantics. Hence both phonological reduction and semantic generalization (see below on bleaching) constitute a loss in integrity, according to Lehmann. The paradigmaticity of a sign reflects the degree to which it functions as part of a paradigm of signs of complementary distribution in certain contexts. Grammaticalization frequently involves a trend for an item to turn into part of a paradigm of fixed semantic and structural function. Paradigmatic variability, finally, concerns the question whether an item can be freely replaced by other signs of the same paradigm, or be left out altogether. A loss in paradigmatic variability means an increase in obligatoriness of a sign in certain contexts.

The syntagmatic weight of a sign, according to Lehmann, is its structural scope. He discusses various examples where either semantic scope or syntactic scope is at stake, the prime cases being former independent items that turn into affixes or clitics. The criterion of *reduced scope* is however easily challenged by all those cases where content words develop into propositional operators (most prominently the modal verbs in English), an observation that was taken up in Tabor & Traugott (1998). Syntagmatic bondedness measures the degree to which an item is dependent on the presence of other signs, or attaches to them in a morphophonologically significant manner. Syntagmatic variability, finally, reflects the degree to which an item has to hold a fixed position or can be freely moved around in the clause.

Lehmann demonstrates that typical traditional case studies in grammaticalization show the predicted kind of shifts in at least *some*, sometimes *most* of the given parameters. He suggests that an instance of language change should be called grammaticalization exactly if it shows enough of increased cohesion or decreased weight and variability, syntagmatically or paradigmatically.

A synopsis of known patterns of change revealed several typological near-universals of grammaticalization. Perhaps the most prominent and controversial is the unidirectionality hypothesis, the observation that the changes at stake tend to adhere to one direction. There are no known cases of inflexion affixes developing into content words, of tense forms being reinstalled as full verbs etc. The universal trends are often summarized in so-called *clines*, a small number of attested possible roads through the major grammatical categories, like the following:



- (2) content word > function word > clitic > affix >  $\emptyset$   
 verb > preposition > affix >  $\emptyset$

Another observation concerned the fact that even at a more fine-grained level, similar or identical developments can be found repeatedly in different languages. Many languages, for instance, possess future tense forms that are based on a verb of volition/desire (type *will* future), future tenses that rest on the verb *to go*, complementizers based on deictics or the verb *say*, prepositions that derive from nouns for *back* and *front* etc. A very inspiring survey of attested pathways of grammaticalization was compiled by Heine & Kuteva (2002). Observations like these suggested that *grammaticalization* could be an independent mode of language change, subject to its own laws and generalizations, a linguistic process that is driven by autonomous rules that deserve investigation.

The main problem in developing a theory of grammaticalization consists in the fact that no given instance of language change carries the label “grammaticalization” on its sleeve. Hence if some instance of change looks similar to other cases of grammaticalization but contradicted some universal, it is never clear whether this means that the universal was falsified, or that the change was not an instance of grammaticalization in the first place. The emergence of discourse adverbials and other sentence level operators offers a typical battlefield in this debate. We know a wide range of pragmatic and logical markers which derive from content words, often along universal pathways. For instance, the complementizer *while* as well as German *weil* (‘because’) both derive from the noun *weile* (‘time’) used as a free genitive (*der Weile*<sub>GEN</sub> = ‘at that time’, see König & Traugott 1988, Traugott & König 1991). In terms of semantic development, we see a move from an independent concept to an abstract temporal or causal relation. The scope of the item, however, clearly increases in the development, and its status with respect to paradigmaticity is somewhat unclear—after all, there is no grammatical requirement to use temporal or causal subordinate clauses. So it is unclear whether this change is an instance of grammaticalization or not! Similarly, the content adjective *butan* (‘outside’) develops into the contrastive conjunction *but* (Merin 1996), and the prepositional phrase *in dede* (‘in action’, ‘in what people do’) turns into the discourse marker *indeed* (the Oxford English Dictionary OED offers rich track records of carefully dated uses of *but*, *indeed* and other functional words). Likewise, proximative particles like German *fast* (‘almost’), which developed from the adjective *fast* = ‘immovable, solid’ (like the English adjective *fast* = ‘speedy’) are hardly part of the core grammatical system and yet, the changes in grammatical category as well as the loss of “concrete” meaning seems to put all these examples close to other instances of grammaticalization. Similarly, discourse particles arise by a change of category as well as a change towards a more abstract meaning while it is dubitable whether they are “more part of the grammar” after the change. As an example, consider the adjective *even/eben* (≈ ‘flat’, ‘smooth’) in English and German. In Modern High German, it developed a use as a modal where it serves to add a consoling undertone to the assertion:

- (3) *Peter ist ein Junggeselle.* (‘Peter is a bachelor’; neutral statement)  
*Peter ist eben ein Junggeselle.* (‘Peter is a bachelor, you can’t help it’; justifying or excusingly)

The grammatical category of *eben* changes from adjective to particle (= a typical “elsewhere” category). In its new sense, it does not denote a specific property of Peter (Peter

is not a “flat bachelor”) but adds a speaker comment aside of the at-issue content of the sentence (Potts 2005). Should this and similar language changes be classed as grammaticalization?

Emergent discourse particles are easy to find and occur in considerable number (Abraham 1991, Brinton 1996, Wegener 2002, Mosegaard Hansen & Rossari 2005 among others). What they share with other instances of grammaticalization is that an item with a comparatively more concrete meaning is reinterpreted to yield a more general, abstract item, accompanied by a change in the grammatical category and new distribution patterns. Unlike in classical grammaticalization, however, the resulting item is *not* part of the core grammar. Discourse particles specifically are clearly outside the range of what is classically considered as ‘grammar’. They have to observe only very general syntactic restrictions, they are classically omissible (at least in terms of grammatical requirements), they are usually neglected in grammars as well as grammar theories, they have high scope over the full assertion (Tabor & Traugott 1998), they often do not contribute to the propositional content of the assertion, etc. (cf. also article 76 (Zimmermann) *Discourse particles*). So, accepting them as cases of ‘grammaticalization’ in the sense of Lehmann would evidently lead the Lehmann parameters to collapse.

However, leaving aside the degree of fit to Lehmann’s parameters, scholars who work on the emergence of discourse particles repeatedly voice the intuition that particles emerge, like other “grammatical stuff”, when words as part of an utterance lose their old sense and are re-assigned a new sense because the speaker apparently seemed to intend to convey just this extra bit of meaning (in the case of *eben*: wanted to console the listener). Different authors have adopted different positions with respect to this challenge. Many just take an agnostic stance (e.g. Fischer & Rosenbach 2000; Mosegaard Hansen & Rossari 2005), allowing for a ‘narrow’ and a ‘wide’ sense of grammaticalization. Others, most prominently Traugott, adopt a more interesting strategy. Traugott advocates the more inclusive class of changes (i.e. including the cline towards discourse particles) by postulating *subjectification* as an independent mode of semantic change (Traugott & Dasher 2002). She proposes that this mode of semantic change is shared by both typical instances of grammaticalization (e.g. the development of the English modals, Traugott 1989) and the cline to discourse particles. I will come back to this below.

The problem eventually boils down to the question: Do Lehmann’s criteria – or similar lists – have the status of a *definition for grammaticalization* or of an independent *observation about grammaticalization*? In a very balanced special issue of Language Sciences in 2001, the papers Campbell (2001), Janda (2001), Joseph (2001), Newmeyer (2001) and Norde (2001) focus on exactly this question, and convincingly argue that cases of grammaticalization come about by the felicitous conspiracy of independent modes of language change in phonology, morphosyntax, and semantics. Specifically, Newmeyer (2001) offers a rich and well-chosen range of examples that reveal grammaticalization as the epiphenomenal result of semantic changes, structural reanalysis and phonological reduction. I will rest my discussion on this view, and will hence focus on the semantic processes of change that can be observed *predominantly, but not exclusively* in grammaticalization. In spite of the long tradition of research in diachronic linguistics, I think that the nature of semantic change as it accompanies syntactic reanalysis has not been fully understood so far. The semantic reorganization that is required in grammaticalization essentially operates at the syntax-semantics interface. Grammaticalization entails changes in the syntactic structure of the sentence, and as syntactic structure—as we believe—guides semantic



composition, it is to be expected that the compositional structure of the sentence needs to change as well, including the functional structure of the items involved. The investigation of semantic composition, and specifically the functional parts of semantic composition, has been focussed by the so-called “formal” semantic approaches. Truth conditional semantics has developed a level of exactness, explicitness and sophistication in the semantic analysis of meaning composition which has never been reached, as I think can fairly be said, by traditional frameworks of semantic description. I will propose that *semantic reanalysis* is at the heart of most instances of grammaticalization, and I will argue that none of the more traditional modes of meaning change that have been used in the debate captures exactly this process. I will then move on to illustrate semantic reanalysis in different types of language change, including but not restricted to cases of grammaticalization. For example, semantic reanalysis also underlies most changes from adverb to discourse particle, or prepositional phrase to discourse adverbial—so, this approach in some sense follows Traugott’s argumentation (Traugott & Dasher 2002), however on the basis of a different mode of change. While Traugott takes subjectification as the driving force in grammaticalization, I will argue that the concept is not necessary to explain the common traits of many instances of structural reanalyses.

## 2. The semantic side to grammaticalization

Is grammaticalization a gradual process or discrete change? In this debate, authors standardly adopt the following two equations: Structural change = discrete change, and semantic change = gradual change (see for instance Fischer & Rosenbach’s 2000 opposition of formal vs. functional approaches to language change in the introduction; Fischer 2007; Hopper & Traugott 1993), in turn concluding that any change that looks gradual must be semantically motivated. I want to challenge the assumption that semantic change be necessarily gradual, and suggest that the impression of “gradual change” is an epiphenomenon of semantic interpretation and pragmatic enrichment.

First note that the meanings of words and sentences of earlier stages are only accessible as part of texts in old documents. We see the surface structure of the data, but we get neither a syntactic nor a semantic analysis (and, apart from translated text, no independent paraphrase). In the investigation of sources, researchers often report an intermediate stage of “gradual shift”. Looking into matters in more detail, one finds that some of the utterances that contain the item-under-change seem to favour an analysis in terms of the *old* use of the item. Some of the sentences are plainly synonymous under the older or newer use of the item, and some seem to favour an interpretation in terms of the *new* use although they could still be possibly interpreted in terms of the older stage of the item. (So at the time, without knowledge of future developments, the hearer/reader might just have faced a quirky sentence.)

This gradual approximation of a new stage has been taken as evidence that language change in general be gradual. With the advent of more fine-grained structural descriptions, syntacticians proposed to analyze allegedly gradual shift from one major grammatical stage to another as a series of discrete steps between more finely distinguished grammatical stages. At the level of meaning, however, the terminology in use so far did not allow, nor suggest, similar series of small, discrete steps. Consequently, the claim that changes are gradual iff they are semantic changes is still unchallenged in the community. I think that this equation is severely mistaken.

The first problem seems to be that the difference between sentence meaning and word meaning is severely blurred in the debate. This can lead to the expectation that two sentences with more or less the same “message” on basis of more or less the same words entail that the word meanings be likewise identical, more or less. So, the common meaning of sentences like the following are taken as indication that meaning changes can be ignored.

- (4) *Evans did not walk*  
       *Evans did not walk a step*  
       *Evans did not understand ‘a step’*

The first two sentences exhibit a minimal pair of negative sentences with and without emphatic component (*‘a step’*); the third one shows a fictitious extension of the emphatic use of *‘a step’* to other contexts. In view of the fact that all three sentences are negations and contain *not*, one might conclude that the word *‘a step’* doesn’t play a role in the examples at all. This diagnosis has actually been proposed by Haspelmath (1999) who observes:

One of the most widely discussed aspects of grammaticalization, the fairly dramatic semantic changes, has not been mentioned [in Haspelmath’s paper] explicitly at all so far. The reason is that I am not sure that semantic grammaticalization is as central to the process as has generally been assumed. ( . . . ) For instance, the emphatic negation marker *pas* in older French has lost its pragmatic markedness and has become the normal negation marker, without any semantic changes in the narrow sense having taken place. (Haspelmath 1999: 1062)

This quote suggests that the semantic side of grammaticalization is virtually nonexistent and hence does not pose an interesting object for study at all. While Haspelmath rightly observes that the overall *sentence* meaning of the crucial examples does not change, he fails to acknowledge that the meaning change at the *word level* is considerable. We will see examples later where the meaning of an utterance before and after semantic reanalysis is practically identical even though the meanings of its parts have changed drastically. This observation is, of course, neither new nor surprising, and moreover is the exact analogue to structural reanalysis. The process was described by Langacker (1977: 58) as follows: “change in the structure of an expression or class of expressions that does not involve any immediate or intrinsic modification of its surface manifestation”.

Another problem lies in the fact that a concept-based semantic analysis usually fails to represent the functional structure of words, structure that subsequently has to be relegated to constructions (e.g. Traugott 2008). Practically all literature on language change shares this feature. Hence, the terminological frameworks in use simply do not allow to represent many changes at the compositional level, changes that can severely alter the meaning of an item even on the basis of more or less the same conceptual ingredients (see the case study on *fast* in section 4). Isolated articles like von Stechow (1995), Kempson & Cann (2007), Merin (1996), or Zeevat & Karagjosova (2009) pose exceptions to this generalization. Generally, changes that yield functional words need to be described in terms of a semantic framework that can express the meaning of functional words. Concept-based semantic frameworks are notoriously vague at this point, supporting the misconception that semantic changes can not be discrete.

The present article aims at defining and defending the notion of semantic reanalysis. In the next section, I will characterize this process and point out differences to the modes of semantic change that were proposed in the literature, including

1. generalization or bleaching, going back to Paul (1880) and von der Gabelentz (1901)
2. metaphor (most prominently proposed by Heine, Claudi & Hünemeyer 1991; Bybee, Perkins & Pagliuca 1994; and Sweetser 1990)
3. metonymy (e.g. in Hopper & Traugott 1993), soon made precise as
4. shift from implicature to literal content (with the side effect of strengthening, not predicted by the first two approaches)
5. semantic rearrangement of atoms of meaning, Langacker (1977)
6. subjectification, proposed by Traugott (1989), Traugott & Dasher (2002)

These earlier proposals can be criticised more succinctly once we know what an alternative proposal could look like.

### 3. Semantic reanalysis

I will start this section by taking a closer look at some examples. The first case concerns the reanalysis of a German adjective *voll* ('full') into the head of a complex determiner phrase that denotes quantities. The following two sentences illustrate the shift, which is one of those cases of grammaticalization that are currently under way (Sahel 2007; Traugott 2008 offers a description of the similar shift of *a lot of* in English). Both uses are part of Modern High German but the one in (6) is newer and derives from the older one in (5).

- (5) *Ein Glas voll Weines stand auf dem Tisch.*  
a glass full of-wine stood on the table
- (6) *Ein Glas voll Wein muss in die Soße.*  
a glass-full of wine must into the sauce

Simplifying the actual patterns a little bit, the contrast is the following: In (5), the referent of the subject argument is a glas. Reference is also made to wine, but only as part of the AP modification of the glas. The glas is available as discourse referent. The adjective *voll* assigns genitive case to its complement DP (*Weines*), and the adjective phrase modifies the head noun (*Glas*) of the subject DP. In (6), the referent of the subject DP is the wine, whereas no referent is introduced by *Glas*. Both the container noun (*Glas*) as well as the whole DP show nominative case, i.e. receive case by the verb. No genitive case is assigned. For ease of exposition, I will concentrate on these two kinds of use which were brought to my attention by Sahid Sahel.

In the use in (5), the adjective *voll* actually carries a highly complex functional load based on the conceptual core FILL, the relation of some container *x* being filled with substance or objects *y*. I will use FILL(*x,y*) for this binary relation. The adjective phrase *voll DP<sub>GEN</sub>* arises by combining a complex noun NP with the FILL relation to yield a property. The following lambda term specifies the contribution of *voll* in uses like (5). (Note that the existential quantification over *Wein* is provided by the adjective; alternative formalizations could be envisaged.)

$$(7) \quad [[voll_{adj}]] = \lambda Q \lambda x [\exists y (FILL(x, y) \wedge Q(y))]$$

As a consequence, the adjective *voll* can combine with a property *Q*, leading to the property of being filled with some *Q*-object or substance (e.g. ‘*voll Milch*’).

In the relevant use of (6), *voll* has likewise a complex functional load, but a different one. Now it has to combine with an existential noun phrase that denotes a potential container, like *eine Hand*, *mehrere Gläser* etc. It moreover has to combine with a numeral (*ein*, *zwei*, ...) which agrees with the container noun. The result is a generalized quantifier. The lambda term in (8) offers a first approximation.

$$(8) \quad [[voll_{measure}]] = \lambda D \lambda P \lambda Q [\exists y (\Diamond [D(\lambda x. FILL(x, y)) \wedge P(y) \wedge Q(y)])]$$

The rationale behind this semantic building block does not reveal itself easily. It can best be understood if we consider the intended result. Combined with a measure NP (e.g. ‘*ein Glas*’) and a noun that denotes a substance (‘*Wein*’), the result should denote a complex NP meaning (‘there is wine that could possibly fill a glas, which does *P*’). The combination proceeds as follows:

$$\begin{aligned} (8') \quad & a. \quad [[ein\ Glas]] = \lambda Q. \exists z [GLAS(z) \wedge Q(z)] \\ & b. \quad [[ein\ Glas\ voll]] = \\ & \quad \lambda D \lambda P \lambda Q' [\exists y (\Diamond [D(\lambda x. FILL(x, y)) \wedge P(y) \wedge Q'(y)])] (\lambda Q [\exists z (GLAS(z) \wedge Q(z))]) \\ & \quad = \lambda P \lambda Q' (\exists y [\Diamond [\lambda Q [\exists z (GLAS(z) \wedge Q(z))] (\lambda x. FILL(x, y)) \wedge P(y) \wedge Q'(y)])] ) \\ & \quad = \lambda P \lambda Q' (\exists y [\Diamond [\exists z (GLAS(z) \wedge FILL(z, y))] \wedge P(y) \wedge Q'(y)]) \\ & c. \quad Wein \rightarrow \lambda w. WINE(w) \\ & d. \quad ein\ Glas\ voll\ Wein \rightarrow \\ & \quad \lambda P \lambda Q' (\exists y [\Diamond [\exists z (GLAS(z) \wedge FILL(z, y))] \wedge P(y) \wedge Q'(y)]) (\lambda w. WINE(w)) \\ & \quad = \lambda Q' (\exists y [\Diamond [\exists z (GLAS(z) \wedge FILL(z, y))] \wedge \lambda w. WINE(w) (y) \wedge Q'(y)]) \\ & \quad = \lambda Q' (\exists y [\Diamond [\exists z (GLAS(z) \wedge FILL(z, y))] \wedge WINE(y) \wedge Q'(y)]) \end{aligned}$$

The result denotes the generalized quantifier that holds true of those properties *Q'* such that there is something *y* that is wine, that can possibly be filled into one glass, and that has *Q'*. Note that as a consequence of the modal embedding of the container statement, the resulting semantic representation is still based on our old predicate *FILL* but we can explain that no real glas is referred to (and hence, no real glas has to be thrown into the sauce in sentence (6)). Let me repeat the old and new representation of *voll* below:

$$\begin{aligned} (7) \quad & \text{old: } [[voll_{adj}]] = \lambda Q \lambda x [\exists y (FILL(x, y) \wedge Q(y))] \\ (8) \quad & \text{new: } [[voll_{measure}]] = \lambda D \lambda P \lambda Q' [\exists y (\Diamond [D(\lambda x. FILL(x, y)) \wedge P(y) \wedge Q'(y)])] \end{aligned}$$

I think that this example nicely illustrates that the new measure head *voll* still rests on the property of *x* being filled with *y*, but integrates this property with the denotations of its sister constituents in a radically different manner. The full development of classifiers of the *N-voll* type would deserve an investigation in its own right. Interestingly, there are instances of the older meaning with the newer case assignment pattern; i.e (8) could *sloppily* be used to refer to a glas which has the property of being filled with wine. Obviously, many sentences are such that the two readings are practically synonymous. For instance,

*Eine Flasche voll Wein stand auf dem Tisch* (A bottleful / bottle full of wine was standing on the table) can only be true if the container is also present; otherwise the wine would not stand but float on the table. I will moreover leave it open whether *N-voll* ('N-full') turns into a complex quantifier at a certain point and loses all internal structure, as orthography may suggest.

Consider once again possible ambiguous uses of *N-voll* as the one above. Observations like these are typically referred to as "gradual meaning change" in the literature. A concept-only semantic analysis would presumably not see much difference in terms of content at all; the different combinations would perhaps be relegated (without analysis) to constructions. The semantic values in (7) and (8) explicate the combinatorial structure of either item and reveal that the change in meaning is considerable.

In other cases, we do find a real redistribution of conceptual content. The following steps recapitulate the development of *go* + *progressive* + *implicatures* into *going-to* as a future tense. In this case, the reanalysis has to refer to sentence level because I will assume that implicatures arise at the sentence level.

(9) *Emil is going to visit a priest.*

I will start with the semantic analysis of (9) in terms of the older movement reading of *go*.

- (10) a.  $[[go-]]$   
 $= \lambda e \lambda x Go(x, e)$
- b.  $[[to\ visit\ a\ priest]] = \lambda e \lambda x \exists e' (GOAL(e, e') \wedge \exists y (PRIEST(y) \wedge VISIT(x, y, e')))$

This is the goal-oriented interpretation of the *to* phrase, which provides a relation between people  $x$  and events  $e, e'$  such that there is some priest  $y$  whom  $x$  visits in  $e'$ , and  $e'$  is the GOAL of some further event  $e$ . (I take a short-cut and will not use a PRO to mediate between matrix subject and the subject of the infinitival clause). Next, the two relations can be intersected.

- c.  $[[go- to\ visit\ a\ priest]] =$   
 $\lambda e \lambda x (Go(x, e) \wedge \exists e' (GOAL(e', e) \wedge \exists y (PRIEST(y) \wedge VISIT(x, y, e'))))$

We can now turn to the integration of the progressive aspect, which I will analyse in Reichenbachian terms as locating the event time  $\tau(e)$  around the current reference time  $R$ .

- d.  $[[PROGRESSIVE\ go- to\ visit\ a\ priest]] =$   
 $\lambda x (\exists e (R \subset \tau(e) \wedge$   
 $Go(x, e) \wedge \exists e' (GOAL(e', e) \wedge \exists y (PRIEST(y) \wedge VISIT(x, y, e')))))$

Next, we integrate the tense information.

- e.  $[[PRESENT\ PROGRESSIVE\ go- to\ visit\ a\ priest]] =$   
 $\lambda x (R = S \wedge \exists e (R \subset \tau(e) \wedge$   
 $Go(x, e) \wedge \exists e' (GOAL(e', e) \wedge \exists y (PRIEST(y) \wedge VISIT(x, y, e')))))$

Finally, we will apply this predicate to the subject of the sentence, the denotation of the name *Emil*.

- f.  $[[\text{Emil PRESENT PROGRESSIVE go- to visit a priest}]] = \exists e( R = S \wedge R \subset \tau(e) \wedge \text{Go}(\text{EMIL}, e) \wedge \exists e'(\text{GOAL}(e', e) \wedge \exists y(\text{PRIEST}(y) \wedge \text{VISIT}(\text{EMIL}, y, e'))))$

The literal content of example (10), represented in (10f), allows the default inference that the planned visit is imminent, assuming some world knowledge about Go and its goals. We can now proceed to the reanalysis process. The first step consists in an inference that hearers might standardly draw when presented with content like (10f). (11) captures the belief that ‘seen from now, the proposition that Emil visits a priest will be true soon’ or so. A similar step is assumed in most accounts of the development of *going to* future in English. My explication of semantic reanalysis will just make use of this “understood message” in a richer and more elaborate sense, as will become clear presently.

(11) Default inference:

$$\exists p(\text{IMMINENT}(\text{now}, p) \wedge p = \wedge[\exists y \exists e'(\text{PRIEST}(y) \wedge \text{VISIT}(\text{EMIL}, y, e'))])$$

The modal relation IMMINENT is supposed to hold true for those propositions which are bound to become true in the future, as far as we can tell at the time *now*. Interestingly, the inference (11) is not as yet temporally anchored, and hence the proposition in (11) does not lend itself to become the literal content of a sentence. The hearer who has decided to understand (10) as denoting something like (11) will first have to guess a reference time for (11), proceeding to (12). The move from (11) to (12) reflects the difference between a listener who subconsciously reasons “hm, (9) might entail something like (11)” to the listener who believes “hm, the speaker uttered (9) which *literally means something like* (11)—or, rather (12)”.

$$(12) (R = S \wedge \exists p(\text{IMMINENT}(R, p) \wedge p = \wedge[\exists y \exists e'(\text{PRIEST}(y) \wedge \text{VISIT}(\text{EMIL}, y, e'))]))$$

Now we can reason backwards, trying to build up (12) from the linguistic material in (9), leaving as much unchanged as possible. Hence, we leave the parts in (13) untouched.

- (13) a.  $[[\text{visit}]] = \lambda y \lambda e' \lambda z(\text{VISIT}(z, y, e'))$   
 b.  $[[a \text{ priest}]] = \lambda Q \exists y(\text{PRIEST}(y) \wedge Q(y))$   
 b.  $[[\text{Emil}]] = \text{Emil}$   
 c.  $[[\text{PRESENT}]] = (R = S)$

Yet, the derivation of (12) from (9) leaves a semantic chunk that is not as yet provided by any part of the sentence. Luckily, however, we also have a remnant phrase. At this point, the missing link depends on the assumed syntactic structure of the resulting construction. I will assume, conservatively, that the order of combination was still such that the *be going to* chunk is combined with the VP, and only then the subject NP enters the computation.

- (14) remnant material  $\Leftrightarrow$  missing meaning  
 $[[be \text{ going to}]] \quad \lambda P \lambda x[\text{IMMINENT}(R, \wedge P(x))]$

The futurate meaning (14) will take scope over the proposition  $p$  which arises by interpreting the root clause; the PRESENT tense takes scope over the constituent in (14). The composition of the parts in (13) and (14) can now proceed in the regular way, and will, as shown in (15), yield exactly the target proposition in (12). (If the reader attempts to do the composition of (13a) and (13b), note that it gives rise to the notorious type mismatch for object quantifiers. Presenting a full semantic derivation of the example would burden the article unnecessarily; for a standard treatment see Heim & Kratzer 1998.)

- (15) a.  $[[\text{visit a priest}]] =$   
 $\lambda z \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(z, y, e') )$   
 b.  $[[b\text{-going to visit a priest}]] =$   
 $\lambda P \lambda x [ \text{IMMINENT}(R, \wedge P(x)) ] ( \lambda z \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(z, y, e') ) ) )$   
 $= \lambda x [ \text{IMMINENT}(R, \wedge \lambda z \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(z, y, e') ) (x)) ]$   
 $= \lambda x [ \text{IMMINENT}(R, \wedge \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(x, y, e') ) ) ]$   
 c.  $[[\text{Emil b-going to visit a priest}]] =$   
 $= \lambda x [ \text{IMMINENT}(R, \wedge \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(x, y, e') ) ) ] (\text{EMIL})$   
 $= [ \text{IMMINENT}(R, \wedge \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(\text{EMIL}, y, e') ) ) ]$   
 d.  $[[\text{Emil PRESENT b-going to visit a priest}]] =$   
 $( R = S \wedge [ \text{IMMINENT}(R, \wedge \exists e' \exists y ( \text{PRIEST}(y) \wedge \text{VISIT}(\text{EMIL}, y, e') ) ) ] ) )$

The analysis rests on the assumption that the subject has always scope over the future operator. This assumption is corroborated by corpus studies on the early uses of *going to* (see Krug 2000), which show that impersonal subjects, subjects in the scope of the future operator, and expletive subjects do not occur at an early stage (around 1600). The present analysis hence requires that we assume a further generalization of *going to* to a propositional operator for these cases. This illustrates how small discrete steps of change can create the impression of gradual semantic shift.

Taking stock, we find the following changes at the structural and semantic level. At the structural level, the status of the auxiliary *be*, and the gerund *-ing* have changed. In the conservative interpretation in (10), they contribute the progressive aspect. In the reanalysed interpretation in (15), they are part of the phrasal *be going to* construction. The structural status of the particle *to* likewise changed. In the older analysis, it figured as part of the embedded infinitive clause. In the reanalysed interpretation, it is an unanalysed part of the phrasal *be going to* construction. In the present case, hence, there is no continuity in the parts of the sentence such that we could spot one item that carries the change. However, we can—as is often done—at least parallel the meaning of the older *be going* and the newer *be going to* in the given sentences.

- (16)  $[[be\ going]]_{\text{OLD}} \rightarrow \lambda e \lambda x ( R \subset \tau(e) \wedge \text{Go}(x, e) )$   
 $[[be\ going\ to]]_{\text{NEW}} \rightarrow \lambda P \lambda x [ \text{IMMINENT}(R, \wedge P(x)) ]$

Comparing old and new in (16), we can trace all changes that have been proposed in the literature. A simple intransitive turns into an aspectual which relates a proposition (to be built up from VP and the subject) to the time of reference, stating that the proposition is bound to become true, as far as can be said at the reference time  $R$ .

The crucial observation is that the new meaning did not arise in any way by looking hard at the old meaning in (16), extending it in a metaphoric sense, sensing metonymic



relations between walking and futurity, generalizing the notion of walking, or anything the like. (16)<sub>NEW</sub> arose by attributing a missing chunk of meaning to a suitable chunk of form. This was done in (14), and the motivation for (14) is simply to come from (13) to (15d) in a compositional manner. If you find this spooky, acknowledge that we perform similar tasks in very innocent situations. Suppose that your spouse enters the flat, accompanied by a dark stranger that you have never seen before, and you hear him say (17):

(17) “Meet my old school mate Toni!”

You will infer in this situation that you are supposed to meet the stranger, and the best compositional way to derive this proposition from the sentence in (17) is by assuming that the word *Toni* refers to the dark stranger. What is special about the guessed correspondence in (14), in contrast to (17), is that the intended denotation is not conveyed by an act of ostension (= pointing to things in the world). The denotation in (14) only becomes salient as filling the gap between two other denotations; it’s a spandrel, so to speak. The concept *Toni*, in contrast, could be conveyed without further linguistic knowledge by simple deixis. The intended denotation in (14) is “waiting for a property concept, waiting for an individual concept, attributing former to latter and stating the imminence of the resulting proposition”. Such a denotation can *necessarily* only arise after speakers have mastered the art of functional and syntactic composition.

Another advantage of this analysis lies in the fact that it can help to resolve the tension between gradual changes at the surface, and discrete steps of change, as assumed in reanalysis. Old and New denotation in (16) are not similar at all, and the analysis implies that the latter arose in one step, without any gradual intermediate stages. Meaning change in semantic reanalysis is discrete. This does not contradict the justified observation that *sentences* can receive very similar interpretation in the old, and the new analysis (particularly if we count in pragmatic implicatures).

After these examples, I will now turn to a general characterization of semantic reanalysis. Consider an utterance *u* with speaker *S* and interpreter *H*. I will refer to the language system (lexicon, grammar, phonological forms) before utterance *u* as the “old” language system. The language system of the interpreter *H* after having parsed *u* will be an instance of the “new” language system (so we restrict attention to utterances where something changes).

- i. The utterance *u* is uttered, and can be understood, in terms of a structural analysis in terms of the *old language system*. In this interpretation, it will convey some proposition  $\phi_{old}$  as its literal content.
- ii. There are several dimensions in which *u* can transcend this old state. On the semantic side, the utterance *u* can be understood in the utterance context with a richer or different meaning  $\phi_{new}$ .  $\phi_{new}$  may come about as  $\phi_{old}$  plus implicatures.  $\phi_{new}$  may also come about by interpretative processes outside the core language system, in the extreme case by chance guessing.  
On the syntactic side, the hearer may see the possibility for a different structural analysis of the utterance (see the *voll* example). Both changes can co-occur.
- iii. The hearer hypothesizes a second possible syntactic/semantic analysis for *u*. All parts of the utterance need to contribute denotations such that the regular semantic composition (possibly with a new structural backbone) of these parts yields  $\phi_{new}$ .



- iv. Most parts of the sentence contribute conservatively in iii., that is according to their old lexical entry. Some parts can be attributed a new meaning by the interpreter in order to achieve iii. Specifically, the hearer will assume that some parts should contribute *those* denotations that are missing in order to come to the understood meaning  $\phi_{\text{new}}$  in a compositional manner.

These steps pertain to single utterance interpretations. Evidently, the occurrence of just one single situation of this type is not sufficient to make a language change. However, if a suitable number of utterance situations support the hypothesized “new” meanings for old word forms in iv., the new entry is permanently adopted into the lexicon of the speaker community. Note that the described utterance situation is a true turning point. The speaker of *u* is still confidently using the *old language system*. The interpreter derives a hypothetical *new* language system on basis of this utterance. This narrow conception of semantic reanalysis, hence, does *not* rest on creative intentions of the speaker *S* in the above utterance situation.

Another aspect of this analysis is that semantic reanalysis is not necessarily restricted to shifts from content word to grammar. Semantic reanalysis can recruit parts of a sentence for denotations that are considered ‘grammar’, but the process can equally well couple an item with information about the current discourse moves, information about logical coherence, scalar information, and in rare cases even independent conceptual content. (For instance, novels by A. McCall Smith use a version of English where the adverbial *late* ‘former’ has turned into an adjective *late* ‘dead’ with both attributive and predicative use.) The result may be of a kind that suggests a radically different word class for the new item, or only mild changes. I will review more examples below.

It is still open what leads the interpreter *H* to hypothesize a new semantic derivation for the utterance. The mere presence of implicatures can’t be sufficient, because we know a wide range of conventionalized implicatures that have resisted semantic reanalysis over long periods. Little can be said about cases of simple error. Many actual instances of semantic reanalysis suggest that the urge to *Avoid Pragmatic Overload* often plays a rôle: Assume that *u* in the old sense  $\phi_{\text{old}}$  requires unwarranted presuppositions. The speaker makes his utterance under the assumption that the interpreter will accommodate them. The interpreter may see this possibility but considers the required accommodations implausible. As an interpretive alternative, *H* hypothesizes a new message  $\phi_{\text{new}}$ , leading to reanalysis. A survey of examples suggests that this constellation might typically arise for “fashion words” associated with high status. Fashion words are cognitively salient and tend to be over-used, with the side effect of not always perfectly matching the intended message. It would be a fascinating task to find out whether this kind of “premium access” bears similarity to priming and can block lexical access to other, semantically more appropriate items. Suitable psycholinguistic investigations would lead to a better understanding of the synchronic mental processes that feed language change.

#### 4. More examples

We have seen an example for structure-driven semantic reanalysis at the beginning of section 3. Another nice example is the reanalysis of the participle (genitive) *währendes* into a preposition. The Deutsches Wörterbuch (Grimm 1885–1962, DW) attests the following context of change.

- (18) a. währendes Krieges  
           lasting<sub>GENITIVE</sub> war<sub>GENITIVE</sub> “while the war was lasting”
- b. während des Krieges  
           during<sub>PREP</sub> the<sub>GENITIVE</sub> war<sub>GENITIVE</sub> “while the war was lasting, during war”

In this case, reanalysis is presumably driven by structural factors. The original (18a) was a free genitive NP in an appositive sense, an increasingly rare construction that has survived only in few fixed collocations in German ([*stehenden Fußes*]<sub>GEN</sub> “standing foot’s” = ‘immediately, without even sitting down’, [*blutenden Herzens*]<sub>GEN</sub> “bleeding heart’s” = ‘with bleeding heart’). The homonymy of *d+es* (genitive affix) and *des* definite article (masc.) offered the basis of a new analysis as a prepositional phrase, at least for nouns of masculine gender.

The earlier participle belongs to the verb *währen* (‘go on for a long time’, ‘continue’) Definiteness of the NP (*Krieges*) and temporal co-occurrence (of ‘war’ and the events in the main clause for (18a)) is part of the meaning of the free genitive appositive, which introduces concomitant circumstances in a general sense.

The newly emerging preposition *während* requires a complement that denotes an event or a time interval, and turns it into a temporal modifier for events (or time frames). The new preposition follows the compositional pattern of other prepositions and therefore allows for more types of argument NPs, e.g. NPs that denote time intervals and even quantified NPs as arguments (e.g. *während der meisten Sitzungen* = ‘during most of the sessions’ would not have an analogue in the old construction). The new meaning of the PP is also more concise than the denotation of the older appositive, in that unspecific concomitance is replaced by succinct temporal inclusion. For a formal spell-out of the semantic steps, see Eckardt (2011).

Sometimes, metaphoric extension and semantic reanalysis work hand in hand. A recent study by Heine & Miyashita (2006) traces the development of *drohen zu* in German to become a marker of unwelcome-futurate. They distinguish four different current stages, illustrated below.

- (19) *Karl droht seinem Chef, ihn zu verklagen.*  
       Karl threatens to.his boss him to sue  
       ‘Karl threatens to sue his boss’ (volitional)
- (20) *Uns droht nun eine Katastrophe.*  
       to.us threatens now a disaster  
       ‘A catastrophe is treating’
- (21) *Das Hochwasser droht die Altstadt zu überschwemmen.*  
       The flood threatens the old-town to flood  
       ‘The flood threatens to flood the old town.’
- (22) *Mein Mann droht krank zu werden.*  
       my husband threatens sick to become  
       ‘My husband is about to become sick’

Clearly, the old lexical verb *drohen* (‘threaten’), description for a kind of verbal or non-verbal aggression, has been extended to a so-called semi-modal (Eisenberg 1999). I

propose that two semantic shifts interact in this case. First, there is clearly a metaphoric component that allows to extend the behavioral concept *threat* to inanimate subjects. When we talk about a “threatening thunderstorm”, we conceptualize the black clouds that approach at the horizon as an animate subject which volitionally causes the emotional impression that we feel. To the extent that the metaphor of some animate threatening agent is implausible, hearers will consider the more plausible *new* structural analysis of the clause, one that takes the denoted state of affairs in total as the threat. In terms of syntax, *drohen* is then close to a modal verb (or semi-modal). In terms of meaning, *drohen* denotes a modal of *unwelcome futurate* and takes scope over the rest of the sentence. It is at this point that structural and semantic reanalysis takes place. After the change, sentences like (22) are truly structurally ambiguous. (22) in the old meaning of *drohen* states that my husband—somewhat irrationally—utters a threat to the end that he will volitionally become sick. (22) in the new sense of *drohen* states that there is a state of affairs ‘my husband sick’ which is presently imminent, and which the speaker does not like. This turns *drohen* into something like an anti-buletic modality. Like all threats, *drohen* leaves it open whether the state of affairs is likely to become true, or just possible. After all, we utter threats in order to influence other peoples’ behaviour—the ideal threat is the one that we need not exert.

The old Germanic adjective *fast* in the sense of ‘firm’, ‘solid’, ‘immovable’ has been subject to an interesting development in German. In modern German, its descendant *fast* is an proximity adverb ‘almost’ (while the umlaut variant *fest* still carries the original sense). The German proximity adverb *fast* derives from the degree comparative *fast* = *hard*, *very much*, . . . like in English “grip fast” (which, in English, turned into the adjective for *with high speed*, see the extremely comprehensive study by Stern 1921). How can a word that denotes “very much so” turn into a word that means “almost, but not actually”? The authors of DW (Grimm 1885–1962: Vol.3, 1348–1350) offer a very detailed database for the stages of the development.

The old use *fast* in the sense of “tight”, “firmly” was used for physical or metaphorical links between things (used c1500–c1700):

- (23) a. *sölh pflicht halt fast*  
           this duty hold fast  
       b. *halt fast den pfluog*  
           hold the plough fast / tightly

From this intensifying use with verbs that report maintenance of contact, *fast* was extended to a generalized degree adverb, roughly like *very*, *much*<sub>adv</sub>. (It is from this point that *fast* in English was reduced again to high degrees of speed for movement verbs).

- (24) *dis ler und trost mich* FAST ERQUICKT  
       this lesson and consolation revives me very much  
       (25) *wenn du gleich* FAST *danach* RINGEST, *so erlangest du es doch nicht*.  
           even if you struggle for it hard, you will not attain it

It is also in this sense that we find it with participles and adjectives, such that *fast schön* at that time meant ‘very beautiful’, and *not* like ModHG “almost beautiful”.

Interestingly, the DW faithfully reports on examples where “die bedeutung sehr in die von *ferre* (= Latin *almost*) ausweich(t)”, i.e. where the meaning strongly tends to ‘almost’ rather than ‘very’. The quoted examples offer very nice evidence in which sense the intensifying ‘very’ sense became shift.

- (26) *weil er fast hundertjeric war*  
he was *very much?*/ *almost?* hundred years old
- (27) *kamen darauf fast um zwo uren*  
(they) arrived there *very much?*/ *almost?* at two o’clock /sharp?
- (28) *das fast nicht ein balken vergessen war*  
that *very much?*/ *almost?* not a single log was forgotten

In the long run, the two different readings were correlated with the stem-umlaut difference and *firmly* was conventionally expressed by *fest* whereas *fast* was reserved for the new meaning *almost*. I will use *fast<sub>deg</sub>* to refer to the degree adverb, whereas *fast<sub>prox</sub>* will be used for the proximity adverb.

In order to understand the change that occurred in the wake of examples like (26) to (28), let us look at the older meaning of *fast* in the sense of *very much*. Without aiming at a full analysis of modern *very much* or *sehr*, I propose the following representation: *fast<sub>deg</sub>* can combine with a scaled property *P* and states that the event/entity talked about is at the high end of the scale.

- (29) *fast<sub>deg</sub> hungri*  
“be hungry to a degree which is high on the scale of possible degrees of hunger-ness”

It still contrasts with “absolutely” or “extremely”, hence it is plausible to allow for higher values on the *P* scale.

- (30) *fast<sub>deg</sub> hungri*  
“be hungry to a degree which is high on the scale of possible degrees of hunger-ness, with (possibly) some higher degrees”

Let us assume that the degrees are represented as a linear order  $<$ . This leads to the following representation for older *fast<sub>deg</sub>*:

- (31) *fast<sub>deg</sub>*  
FAST( $\lambda x \lambda s P(s, x)$ )  
:=  $\lambda x \lambda s [P(s, x) \wedge \text{MOSTy}(P(s, y) \rightarrow y < x) \wedge \exists z (P(y, z) \rightarrow x < z)]$

In prose, *fast<sub>deg</sub>* takes a property *P* as its argument, and maps it to that subproperty which comprises those entities which have the property *P*, and are more *P-ish* than most but not all other entities in terms of the relevant ordering. This is reflected by the use of the ordering relation  $<$  which is supposed to cover up for more intricate ways to determine the

degree of *P*-ness of a given object *a*. The semantic representation predicts that *fast<sub>deg</sub>* can only apply to *gradable* properties *P*. (As an aside, note that the given definition needs to be complemented by a clause which ensures that FAST-P denotes a convex area on the scale. I would like to thank Hans-Martin Gärtner for clarifying discussions, for details see Eckardt 2007.)

The quotes in (26)–(28) and similar ones in the DW have in common that the pragmatic support for the use of *fast<sub>deg</sub>* in the *very much* sense is lacking. Consider an example like (26). The property of “*being 100 years old*” does not commonly refer to degrees. Degrees can, perhaps, be introduced, like in contexts where different 100 year olds show typical properties of the very old to various degrees. In such a situation, one might state that “Jones is so very much a 100 yearer”. The incompatibility between *fast* and the property *be 100 years old* hence is a conceptual one, not one of grammar. However, nothing in the quoted contexts seems to have warranted such a scale. An utterance like (26') in a context without support for a suitable scale creates a *pragmatic overload*.

(26') Er war *fast<sub>deg</sub>* 100 Jahre alt.

The speaker might have trusted in the intensifying use of *fast<sub>deg</sub>*. We can but guess. He might have had the intention to refer to a scale ranging from “*around 100 years*”, to “*very close to 100 years*” and culminating in “*exactly 100 years*”. This is indeed a scale, and one that would predict that “*very much 100 years old*” in this sense means “*exactly 100 years old*”. The use of such a scale would have warranted a conservative use of *fast<sub>deg</sub>*, but one that the contemporary reader (as well as the authors of the DW) did not find very plausible. A pretty insalient scale would have to be accessed in order to get this reading. Instead, listeners hypothesized a pragmatically leaner reading which rests on a new meaning: *fast<sub>prox</sub>*. And in fact, the reanalysis is minimal. In order to see this, we need to consider a semantic representation of the proximal adverbs. In (32), we see a suitable denotation *Almost* for *fast* in its new, ‘almost’ sense (a detailed discussion is offered in Eckardt 2007; for a fuller record of data in the change of *fast* see Eckardt 2011).

- (32) a. *Almost* is an operator that can combine with property concepts of arbitrary arity, including zero (i.e. propositions). The argument will be written as  $\lambda\bar{x}\lambda sP(s,\bar{x})$  where  $\bar{x}$  is a vector of variables. This reflects that *Almost* can combine with propositions, relations, properties; in other words: the new item is very flexible in semantic composition.
- b. The operator *Almost* poses the following presuppositions on its argument and context of use:
- There is a conceptually salient SUPERPROPERTY of *P*,  $\Pi$  such that  $\lambda\bar{x}\lambda sP(s,\bar{x}) \subset \lambda\bar{x}\lambda s\Pi(s,\bar{x})$
  - The elements of the superproperty can be compared in terms of a PRE-ORDER  $<_{\Pi}$ : For any  $a, b, c$  and  $s, s', s''$  such that  $\Pi(s,a)$  and  $\Pi(s',b)$  and  $\Pi(s'',c)$ :  
transitivity:  $\langle \bar{a}, s \rangle < \langle \bar{b}, s' \rangle \wedge \langle \bar{b}, s' \rangle < \langle \bar{c}, s'' \rangle \rightarrow \langle \bar{a}, s \rangle < \langle \bar{c}, s'' \rangle$   
asymmetry:  $\langle \bar{a}, s \rangle < \langle \bar{b}, s' \rangle \rightarrow \neg(\langle \bar{b}, s' \rangle < \langle \bar{a}, s \rangle)$
- c. The argument taken by *almost* has to cover the maximal part in  $\Pi$  with respect to the order. MAXIMALITY OF *P*: for all  $\bar{x}, \bar{y}, s, s'$ :  $P(s, \bar{x}) \wedge \Pi(s', \bar{y}) \rightarrow \langle \bar{y}, s' \rangle \leq \langle \bar{x}, s \rangle$

In prose, *ALMOST* applies to a property  $P$  by making reference to a superproperty of  $P$ , like for example  $P =$  ‘be 100 years old’ with superproperty ‘be  $n$  years old, for some  $n$ ’. The superproperty here is naturally ordered by  $n$  (so, ‘be 5 years old’ would count less than ‘be 10 years old’ etc.)

If all these requirements are supported either by world knowledge or contextual background, *almost* can apply and maps  $P$  to the property *ALMOST*( $P$ ).

- (33) *ALMOST* ( $\lambda\bar{x}\lambda sP(s,\bar{x})$ )  

$$:= \lambda\bar{x}\lambda s[\text{MOST}(\bar{y},s')(\Pi(s',\bar{y}) \rightarrow \langle \bar{y},s' \rangle < \langle \bar{x},s \rangle) \wedge$$

$$\forall \langle \bar{z},s'' \rangle (P(s'',\bar{z}) \rightarrow \langle \bar{x},s \rangle < \langle \bar{z},s'' \rangle)]$$
 ‘all those  $x$  that are high in the superproperty, though they do not reach the maximal  $P$  region’; in our example ‘all those  $x$  of high age but below 100’.

The present analysis of *almost* reveals that an intensifier *very* (see (31)) only needs minimal adjustments in meaning in order to turn into the proximal adverb, and it moreover predicts that such adjustments should be made in response to exactly those uses that define the turning point. It turns out that the conceptual core of the item did not change much. Confronted with examples like (26) that lack a scale, hearers addressed a scale on a derived superproperty  $\Pi$  instead of the original property  $P$ , and applied just the old denotation of *fast*<sub>deg</sub> to that superproperty. (34) reveals that the actual meaning change at the level of the modifier was really minimal.

- (34) *fast*<sub>prox</sub>( $P$ ): = *fast*<sub>deg</sub>( $\Pi$ )

In other words, *fast*<sub>deg</sub> modifies a scalar property  $P$  exactly in the same way as *fast*<sub>prox</sub> modifies a derived scalar property  $\Pi$ . It should be noted that *ALMOST* is *not* the widely used modal analysis that goes back to Sadock (1981). Among other disadvantages of the Sadock analysis, only the operator presented here allows to understand the semantic relation to older *fast*<sub>deg</sub>.

## 5. What semantic reanalysis is not

*Generalization* or bleaching have been proposed to be the driving force in grammaticalization. Is semantic reanalysis the same as *generalization*? I would argue against this identification. Semantic reanalysis *can* lead to an increased range of application for some word. We saw an instance in the case of *drohen* where a property of persons turned into a propositional operator. Other modals show similar developments. Yet, the essence of semantic reanalysis lies in a changed compositional structure of sentences; extensions can, but need not happen. Grammatical meanings have also been claimed to be more abstract than content words, and hence arise by *bleaching*. I suggested in the discussion of the *going to* future that the denotations of grammatical words become salient as spandrels between content word meanings and clause meanings (Givón 2009: 316). This can explicate in which sense these meanings are abstract, without postulating a new type of meaning change. On somewhat different grounds, Traugott (1988) argues that grammaticalization involves enrichments as well as generalizations and hence *bleaching* alone does not suffice.

*Metaphor* was proposed to be the semantic shift in grammaticalization by Heine, Claudi & Hünemeyer (1991), Bybee, Perkins & Pagliuca (1994), Sweetser (1990), Stolz (1994) and others. We saw in the case of *drohen* that metaphor can be the first step of a development. However, I proposed that the grammaticalized form follows later, driven by avoidance of pragmatic overload when the original metaphor is used without conceptual support. Other examples of semantic reanalysis clearly show that metaphor need not figure in the process at all, like in the stories of *voll*, *fast*, *während*, *a lot of*, or *selbst*, *lauter* (Eckardt 2006), the *say*-based futures in Bantu languages (Uche 1996/1997; Botne 1998) and many other cases.

*Metonymy* was proposed by Traugott, and most detailed in Hopper & Traugott (1993) as the process accompanying grammaticalization. The authors identify the pairing of a certain syntactic structure with a certain *supposed* literal meaning as the true source of grammaticalization. In order to justify the classification as metonymy, the authors count the coupling of form and meaning as an instance of *contiguity*. Contiguity is the term traditionally used for conceptual closeness in metonymic shifts like from container to thing contained, from author to book, from disease to patient, etc. I think that semantic reanalysis differs substantially from metonymy because the two kinds of ‘closeness’ are distinct. Metonymy rests on contiguity relations between things in the world which hold true independently of language. Containers and the things contained are close concepts, no matter whether we talk about this fact or not. In contrast, semantic reanalysis rests on incidental ‘closeness’ between words and possible contents. For example, the closeness between the word *go* in the progressive form and the possible content: *imminent future* can only ever arise because people talk. To put it more drastically, a dog can master the contiguity between container and thing contained, but certainly not the contiguity between *going-to* and imminent future. (While I do not deny a dog’s understanding for fixed phrases like *we’re going to go out for a walk*, there is no evidence so far that dogs possess function words or morphemes.)

Traugott in collaboration with König, Schwenter, Dasher and others (Traugott 1988, 1989; Schwenter & Traugott 2000; Traugott & König 1991; Traugott & Dasher 2002) comes very close to the notion of semantic reanalysis; specifically when Traugott & Dasher (2002) point out that the reclassification of information from implicature to literal content of an utterance is the initiating step in the change. They also can capture the effect of *strengthening*, not predicted by analyses of grammaticalization in terms of generalization / bleaching.

As early as 1977, Langacker made a first attempt at describing semantic reanalysis as *semantic redistribution of atoms of meaning* over the parts of clauses. He discusses the origin of functional morphemes and words in several Indian languages. The approach was fraught by the problem that the relevant “conceptual chunks” that play a role in grammaticalization are arguably not atoms—most of them only become salient as spandrels. This might be the main reason why the proposal, otherwise very much in line with his characterization of structural, morphosyntactic reanalysis was never taken up in later years.

Finally, Traugott in a series of papers proposes *subjectification* as a general mode of meaning change. Subjectification is diagnosed when the speaker, hearer or other aspects of the utterance situation turn into parameters of the message. For instance, in the emergence of



epistemic readings for modals, Traugott points out that the modal base refers to the epistemic alternatives of the *speaker*. Hence the utterance (35) is more subjective in that the speaker relates the proposition to her epistemic base whereas (36) boldly asserts the proposition as true in the real world Portner (2009).

(35) *Tom must be Susan's new husband.*

(36) *Tom is Susan's new husband.*

Likewise, items that are reanalysed as discourse markers often convey a propositional attitude of the speaker, like in the following.

(37) *Tom is indeed a genius.*

(38) *Tom ist eigentlich ein angenehmer Mensch.*

Tom is actually an agreeable person

I think that these observations involve two interacting factors. One factor is semantic reanalysis, a process where—under suitable circumstances—*any* salient possible denotation can be coupled with an item. This part has nothing to do with a desire to express the subjective. On the other side, however, the numerous instances of emergent discourse particles offer strong evidence that emotional undertones may be *one strong source* for denotations that hearers find salient. Semantic reanalysis is a “denotation recruiting” process, drawing on several sources for new denotations: the new denotation can convey emotional information, or the spandrel consists of temporal information, or the spandrel consists of scalar information, or quantity information, and so on. Against this background, we can describe cases of semantic reanalysis without the need to sense subjectification as a justificational label all over the place (see e.g. the attempts in Visconti 2005 to diagnose subjectification in the emergence of *even* synonyms in Italian).

## 6. Avoid Pragmatic Overload

In the final section, we will consider the factors in utterance contexts that set reanalysis into motion. What is it that turns a potential change into an actual change? Proposals in recent years mostly are based on “conventionalization” (Lehmann 2002, Diewald 2002, Heine 2002) which, in the absence of a definition, suggests something like the adoption of a habit. This view does not explain why sentences *S* that were formed according to the rules of an older grammar  $L_{old}$  should ever be reanalysed in the first place. Sentence *S* under the older grammar was very well capable of expressing all the content that the speaker intended to convey. Hence, speakers could have maintained a habit of using certain phrases or constructions without any incentive to reanalyse anything, or “conventionalize” new language uses.

As an alternative to the habit view, I propose that the desire to *Avoid Pragmatic Overload* (APO) can start reanalysis (Eckardt 2009, 2011). In the present section, I will illustrate this proposal with some examples. Consider once again the development of *fast* to a proximity adverb. Examples like (26)–(28) turn up at a time when only the older (intensifying) reading should have been available. They violate the presuppositions of the intensifying adverb in that the modified properties are not gradeable. While unsupported presuppositions in general can be accommodated by the hearer, matters are different in the present



case. There is no salient scale for the property of “being 100 years old”; the speaker may have had some kind of scale in mind but whatever it was, it is not generally available. The hearer faces an instance of pragmatic overload. She could hypothesise suitable information and accommodate the unwarranted and unperspicuous presuppositions. Alternatively, she can believe that the speaker meant to use the words and phrases of the utterance in a different, novel way. Under this alternative assumption, the hearer will parse a reanalysed version of the original utterance. (To repeat: the changes are still effected by semantic reanalysis, but the hearer undertakes reanalysis as an alternative to a pragmatically overloaded reading.)

Uses of words or constructions that rely on unwarranted presuppositions can be observed in many other instances of change. I will list some examples, pointing out the unwarranted presuppositions without further discussion; for an extensive discussion see the respective references.

The change of *selbst* from intensifier (*-self*) to focus particle (*even*) was antedated by uses like (39). The intensifier presupposes that the associated referent can be conceptualized as the center in a range of peripheral objects. This is what is violated in (39); the bees do not make a good center in a periphery of happy entities, neither the range of alternatives mentioned (wind, field, flowers) nor any other (Opitz 1978; see Eckardt 2007: ch. 6 and Eckardt 2001).

- (39) *Bald kömpt der scharpffe Nord gantz vnverhofft gebrauset  
 Quer vber Feld daher / pfeiff / heulet / singt vnd sauset /  
 Vnd nimpt die Lilie mit Vngestümme hin;  
 Die liebliche Gestalt bricht nichts nicht seinen Sinn.  
 Das grüne Feld beginnt vmb seine Zier zu trawren /  
 Die andern Blumen auch muß jhre Schwester tawren /  
 Die BIENEN fliegen SELBST vor Schmerz vnd Trawrigkeit  
 Verjrrt jetzt hin / jetzt her / vnd tragen grosses Leyd.*

‘( . . . ) Soon comes the sharp north (wind) browsing quite unexpectedly / over the field, hissing, howling, singing and whistling / and takes the lily with violence / the lovely figure can not break his mind / The green field begins to mourn for its embellishment / the other flowers likewise must feel sorry for their sister / THE BEES THEMSELVES, FOR GRIEF AND SORROW, FLY ERRING NOW HERE NOW THERE / and carry great mourning.’

We can hence assume that APO motivated the reader to search for another interpretation of the crucial passage.

Another case is offered in Visconti (2005) who discusses a similar development of Italian *perfino*. The original meaning was ‘to-the-end’, localizing a given entity at the end-point of a presupposed temporal, spatial or abstract scale. The item developed a new use in the sense of ‘even’. (40) shows the crucial kind of examples at the turning point, quoted in Visconti as the stage between the older, and the ‘even’ scalar use.

- (40) *... in acqua, in neve, in grandine o pruina: a tutto il ciel s’inclina, perfino a quel che la natura sprezza.* (‘Water, snow, hail or frost: To everything bends the sky, even to that which nature despises.’) (Visconti 2005: ex. 17)

*perfino* in its older sense presupposes a scale of things and refers to its end point; however, the listed alternatives in the given example (water, snow, hail, frost) are not plausibly ordered on any motivated scale. In order to supply a scale against which the semantic contribution of *perfino* can be made, hearers seem to have resorted to the scale of likelihood. If we understand *perfino* relative to this scale, the resulting message will be that some referent is located at the endpoint of this scale. In other words, the state of affairs is reported as being the most unlikely among given alternatives—and hence APO leads straight to the *even*-use of *perfino*.

Another range of examples that create pragmatic overload can be found in the development of German *lauter* (*merely*; use around 1500) towards a quasi-determiner ‘many/only’. The unwarranted presupposition of *merely* in an example like (41) consists in the claim that *devils* be a minor variant of *saints*.

- (41) (...) *die barfuosser haben vil gelts außgeben dem Bapst, das sy den Franciscum iren Abgott auch moechten in des hibsche Register bringen, O ain kostliche eer das gewest wer,*  
 (...) ‘the barefooted friars (= Franciscans) spent much money to the pope that they might also get Franciscus, their idol, into that nice register, O a fine honour this would have been, ...’

|               |               |                |               |               |                  |
|---------------|---------------|----------------|---------------|---------------|------------------|
| <i>sodoch</i> | <i>lauter</i> | <i>Teuffel</i> | <i>solten</i> | <i>darinn</i> | <i>begriffen</i> |
| as yet        | lauter        | devils         | should        | therein       | comprised        |
| <i>seyn</i>   | <i>und</i>    | <i>kain</i>    | <i>haylig</i> |               |                  |
| be            | and           | no             | saints        |               |                  |

It is a subtle mismatch, but, as further developments showed, a substantial one. Rather than believing that devils could be conceptualized as fake-saints, the hearers hypothesized an instance of the newer ‘many’/‘only’ use of *lauter*, hence understanding that ‘only and many devils’ were on the list, instead of the intended but infelicitous ‘barely devils, no saints’.

These case studies suggest that the principle to *Avoid Pragmatic Overload* can indeed offer a plausible analysis for the initial phase of change. For instance, the authors of etymological dictionaries frequently offer examples at the turning point between older and newer meaning of a word that seem to fit the APO principle very well. A full analysis would need to start from attested older uses, and a tenable semantic/pragmatic analysis of these. Next, the actual uses in the crucial period need to be traced carefully in search for utterances where, to the best of our knowledge, we find that the item was used with unwarranted presuppositions that are moreover hard to accommodate. Driven by the APO principle, the reader may have searched for another plausible interpretation of the utterance, and often it can be seen that only minor supposed changes in structure and meaning yield a result that the hearers at the time must have found more convincing.

It is not an accident that the *Avoid Pragmatic Overload* principle echoes Lightfoot’s principle to avoid structural complexity, first formulated in Lightfoot’s (1979) reconstruction of the development of the modal system in English and echoed in later work (Lightfoot 1991, 1999, van Gelderen 2004). Lightfoot proposes that children at certain crucial

historical stages ignore the older complex syntactic structure of certain constructions in favour of a simpler new structural analysis. This analysis is still one of the most plausible assumptions in syntactic change, in spite of the problems that it raises for verification in historical data. It is assumed to operate during language acquisition, where virtually none is known for historical times. The principle to *Avoid Pragmatic Overload* can be understood as the semantic counterpart of Lightfoot's principle.

## 7. Summary

The present article took its start from grammaticalization, viewed as a special kind of language change. While the restructuring at the morpho-syntactic level is well-understood in many cases, the nature of the changes at the semantic side has only been tentatively addressed in traditional theories of language change. I argue that a compositional semantic theory is necessary to capture and investigate changes in the semantic composition of phrases and sentences that accompany morpho-syntactic restructuring. I introduced the core mechanisms in semantic reanalysis on basis of an example in section 3. While semantic reanalysis is of good service in analysing prototypical cases of grammaticalization, I argued in section 4 that this mode of change is by no means limited to changes that would classically count as grammaticalization. I presented more examples (*drohen*, *während*, *fast*) which illustrate the range of possible applications for semantic reanalysis. Section 5 argues why semantic reanalysis is not simply a new word for modes of semantic change that were proposed earlier in the literature. Specifically, I argued that it is different from *generalization*, *bleaching*, *metonymy* and *subjectification*. The final section addresses the question of *why* hearers would assume new compositions for old messages of old sentences—innovation seems surprising, given that the older language system must already have been capable of conveying exactly the same messages (by literal content plus entailments) in exactly the old words. I suggest that the point of innovation is often defined by cases where the intended entailments are costly to derive. I call these cases instances of *pragmatic overload*. According to this picture, innovation arises essentially due to hearer's laziness, or the attempt to *avoid pragmatic overload*.

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*Regine Eckardt, Göttingen (Germany)*



# XXI. Processing and learning meaning

## 102. Meaning in psycholinguistics

1. Introduction
2. Architectural issues and preliminaries
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### Abstract

*The psycholinguistic study of meaning is beginning to attract considerable interest. In the area of adult language comprehension, experimental methods familiar from the study of syntactic and intonational processing, such as comprehension time studies, have examined issues at the interface of syntax and semantics, such as those involving the processing of quantifier scope, the identification of implicit domain restrictions, and the complexity predictions of various theories of quantifiers. They have also been used to investigate the processing of non-quantificational phrases in discourse contexts, especially anaphoric phrases. ‘Visual world’ studies now supply evidence about processing language in the presence of rich visual contexts, and event related potential studies provide continuous qualitative measures of ongoing interpretation. Outside the domain of DPs, less processing research has been conducted, with the exception of studies of verb classes, and a handful of studies of aspect, tense, and scalar adjectives. The picture that emerges is one of ongoing interpretation of syntactic structure, constrained by world knowledge and discourse context from the beginning of interpretive processes, with particular attention allocated to focused phrases.*

### 1. Introduction

A psycholinguistic theory of adult semantic processing presumably must be concerned with actual linguistic structures and the mechanisms available for interpreting them. It must include a particular semantic theory, as well as spelling out assumptions about how semantics interfaces with syntax and with other relevant representations, such as a representation of intonation, and a mental model representation. One of the core questions in semantics proper is how the meanings of words, and the way they are combined syntactically, determines the meaning of novel phrases and sentences. A theory of semantic processing must say how this is done in ‘real time:’ what commitments are made when, what interpretations are favored, and why, and what counts as context for any given interpretive decision.

This chapter will take up topics in linguistically-guided semantic processing. It will be geared to language comprehension rather than to language production. Production and comprehension impose quite different processing demands and thus it would be dizzying to jump back and forth between the two systems. Further, the chapter will emphasize the processing of different kinds of Determiner Phrases, because this has been the focus of



much of the psycholinguistic literature on semantic processing. However, pointers to research on other topics in semantic processing will be presented in Section 5.

Section 2 provides a look at the interplay of semantics with syntax, and to a lesser extent with focus. It is an attempt to orient the reader with respect to important processing findings and with respect to architectural issues concerning the structure of the language comprehension system. Section 3 takes up the processing of quantifiers. What determines their preferred scope? How are restrictions on the domain of quantification identified? Do all quantifiers exhibit the complexity effects expected given Generalized Quantifier Theory? Under what circumstances are pragmatic implicatures generated due to the choice of one particular quantifier from among the various options on an entailment-scale? Section 4 takes up non-quantificational Determiner Phrases (DPs). It looks at 'anaphoric' DPs, DPs with an accommodated referent, the processing of plural DPs, and preferences for collective versus distributive interpretations. Section 5 provides pointers to other processing research, in particular research on verb classes, and Section 6 concludes.

## 2. Architectural issues and preliminaries

A theory of actual semantic processing should be sufficiently detailed to deliver an account of how an interpretation unfolds over time, and of how semantic processing is related to other kinds of processing, in particular, syntactic processing. In this section, it will be suggested that syntax normally takes the lead in processing, but with several caveats, as will be seen below.

Listeners and readers construct a syntactic analysis of a sentence as the words of the sentence are encountered. Generally the syntactically simplest analysis is pursued or given highest priority, other things being equal, see Frazier (1987), van Gompel et al. (2005). Usually, the syntax seems to lead interpretation (Lipka 2002), but there may be exceptions in the case of highly predictable or stereotypical relations, where expectations based on non-syntactic information may guide or even override the syntax (Kim & Osterhout 2005). For example, in highly circumscribed contexts, eye movements suggest the verb *eat* predicts *cake* and vice versa given a visual world with only one edible object (the cake) and only stereotypical relations expressed in the sentences (Altmann & Kamide 1999).

When utterances are only about a visually present world, (visual) context effects are strong and they may guide ongoing sentence analysis. Imagine a visual world containing a frog on a napkin and an empty napkin, as well as two irrelevant distracter objects. Eberhard et al. (1995) showed that in this one-frog scenario, when instructed to "*Put the frog on the napkin ... (into the box),*" listeners' eyes quickly moved to the frog-less napkin (the 'false goal'), indicating that they had interpreted the prepositional phrase *on the napkin* as the locative argument of *put*. But if a second frog was also present in the display, false-goal looks were largely eliminated. Presumably this was because the presence of a modifier *on the napkin* was needed in order to pick out the intended referent (or to justify the use of the definite determiner) in the two-frog scenario. The elimination of the looks to the false goal in the two-frog scenario has been taken to suggest that context directs sentence analysis. This is consistent with the referential theory of processing (Crain & Steedman 1985) which emphasizes the importance of referential factors during sentence processing. According to the referential model, referential success, and the avoidance of presupposition failure, is central to online comprehension. The processing system weeds out syntactic analyses on a word-by-word basis if the analysis gives rise to referential

failure or to an unsatisfied presupposition, assuming the existence of some alternative syntactic analysis that does not give rise to a violation.

“Semantic coercion” refers to interpretations, or interpretive processes, that are not supported by overt morphology or syntax (see article 25 (de Swart) *Mismatches and coercion*). Psycholinguists have examined aspectual coercion, *The frog jumped for an hour*, where *jumped* must be coerced into an iterative activity to combine with a durative phrase (Piñango, Zurif & Jackendoff 1991), and also complement coercion, where an event-taking verb may receive a non-eventive argument, as in *The author began the book*, Traxler et al. (2005). The studies showed an increase in processing times at the point of the trigger (the durative *for*-phrase or the non-eventive nominal *book*.) The timing of coercion effects has been taken as additional evidence that semantic interpretation lags behind syntactic analysis (Piñango et al. 2006). See also Harris et al. (2008) for a study of concealed questions.

It isn't really known at present how the interpretation of a phrase is influenced by its syntactic position. There is, however, some experimental support for Diesing's (1992) mapping hypothesis, which assigns existential interpretations to phrases internal to the VP, but presuppositional interpretations to phrases external to the VP. In English, where subjects are VP external, readers should prefer a presuppositional interpretation of the subject. Given a mini-discourse like *Five ships appeared on the horizon. Three ships sank.*, they should prefer a presuppositional interpretation of *three ships* (i.e., the interpretation where the referent of three ships is a subset of the already introduced five ships). In Frazier et al. (2005), this prediction was confirmed in a written interpretation study. Further, longer reading times were observed when *three ships* was later disambiguated to an existential (three new ships) interpretation than when it was disambiguated to a presuppositional (three of the five ships) interpretation. In English and in German, the preference for a presuppositional interpretation was stronger when the cardinal phrase appeared outside the VP than when it appeared inside the VP. In Korean, it was stronger with a topic marked phrase than with a nominative marked phrase. For similar evidence from Dutch, see Wijnen & Kaan (2006).

Typically only grammatical interpretations of sentences are considered by the processor. However, there are some interesting exceptions. For example, studies of negative polarity items suggest that the processing of sentences with unlicensed polarity items may be facilitated by the presence of a licenser even if the licenser appears in a structural position where it cannot license the polarity item (Drenhaus, Frisch & Saddy 2005). The reason for this ‘spurious licensing’ effect is not entirely clear and continues to be debated (Xiang, Dillon & Phillips 2009).

The standard assumption in linguistics is that only grammatical interpretations are computed and they are computed by interpreting the constituents and relations present in the syntactic tree. Psycholinguistic evidence fits with this view, but with certain limitations. Ungrammatical analyses or interpretations may play a role in processing when they correspond to a temporary analysis or an analysis considered before the correct analysis was identified. With stereotypical relations or in the presence of a rich visual context, the context may generate expectations before the syntactic analysis is available or even override the actual syntax (possibly because the comprehender assumes the speaker has made a speech error, e.g., in sentences like “*The fox shot the hunter.*”).

There is no general agreement about the structure of the language comprehension system. The assumption that a syntactic module exists would explain the speed and

automaticity of syntactic processing. However, to accommodate the evidence that semantic interpretation may guide syntactic analysis rather than follow it, one must assume that the syntactic module is defined by its representations, and not by temporal relations or some ordering of modules imposed by the language comprehension system.

Before leaving this section, attention allocation issues should be mentioned. Listeners and readers allocate attention unevenly through a sentence. 'Focus' (see article 71 (Hinterwimmer) *Information structure*) plays an important role in guiding attention. Comprehenders process focused information more quickly and deeply than unfocused information whether focus is conveyed intonationally, by the presence of a pitch accent (Cutler & Foss 1977), or semantically, by the nature of a preceding question (Cutler & Fodor 1979). Often unfocused material is not processed deeply. Indeed, it may be processed so shallowly that anomalies in unfocused positions are not detected reliably (see Sturt et al. 2004).

A contrastive focus conveyed by a pitch accent may immediately indicate that a contrast is intended by the speaker, resulting in quick eye-movements to objects that contrast along the relevant dimension. For example, in a visual world study, eye movements were launched to a big blue square, not a big yellow circle, given a display with a small blue square but no small yellow circle, and the instruction "*Touch the BIG . . .*" (see Eberhard et al. 1995).

Intonation probably defines the domains in which interpretation proceeds, as argued by Schafer (1997). Schafer (1997) showed that reanalyzing the meaning of a word takes longer across an intonational phrase boundary than across a phonological phrase boundary, as one would expect if incomplete interpretive processes are finished at the ends of intonational phrases, before proceeding to the analysis of new material. In a similar vein, Hirotsu (2004) argues that scopal elements must be bound by operators within the same major phrase as the scopal element, e.g., a bound pronoun and its binder.

There is a vast literature on processing ambiguous words (e.g., *bank*) and a growing literature on processing words with distinct senses (McElree, Frisson & Pickering 2006, Frisson & Frazier 2005). Due to space limitations, no attempt will be made to discuss that literature here. However, one study of lexical processing is particularly relevant. Van Berkum, Hagoort & Brown (1999) investigated whether a word 'meaning' was first integrated into the context provided in the sentence containing the word, and only later was integrated with the larger discourse context, or whether the meaning of a word is immediately related to the larger discourse context. In an Event Related Potential (ERP) study measuring electrical activity at the scalp, van Berkum, Hagoort & Brown found that a word which is not anomalous in its sentence context but which IS anomalous in its larger discourse context yields an N400, a marker of semantic anomaly, within 150 milliseconds of the onset of the anomalous word. This suggests that some aspects of interpretation involve integration of new material into the larger discourse from very early in the interpretive process.

To sum up, the fairly standard assumption that what gets interpreted is an already assigned syntactic representation is supported in part by available evidence. However, given a rich visual context and a task specified in advance of the linguistic input, context can guide both sentence analysis and interpretation. Further, each word of a sentence is not necessarily processed completely (whatever that might mean). Rather interpretation, at least the conscious part of interpretation, is directed largely by focus, which determines the allocation of attentional resources. Prosodic phrases appear to serve as the units of interpretation, with material within the prosodic phrase being more easily related to

other material within the same prosodic phrase than to material outside it, at least for purposes of lexical reanalysis (Schafer 1997) and for Logical Form operations (Hirotani 2004). Integration of word meaning into context, however, appears to involve sentence-external discourse context from very soon after the onset of the word.

### 3. Processing quantifiers

Research on mental models began with Johnson-Laird's pioneering studies of syllogistic reasoning. The idea was that listeners and readers instantiate the relations conveyed by a quantificational sentence using non-linguistic representations of token entities and the relations between them. Errors in syllogistic reasoning result from not instantiating all possibilities in the mental model. Verification times were predicted by the number of different models consistent with the premises, see in particular Johnson-Laird (1977). While these studies are impressive in terms of understanding how people reason with quantifiers, they have several limitations. First, individuals who perform poorly on formal reasoning tasks (e.g., most untrained participants in a Wason task) perform extremely well on the same problem when it is cast in the form of detecting cheaters. This suggests that humans are equipped with reasoning mechanisms that were adaptive in the evolution of the species. Under what circumstances these adaptive reasoning mechanisms come into play rather than formal reasoning mechanisms is largely unknown. Nor is it known how these mechanisms map onto other cognitive processes. Second, the Johnson-Laird type studies of reasoning do not address the issue of how listeners and readers linguistically process quantificational sentences.

Despite their obvious intrinsic interest, no attempt will be made to discuss reasoning studies in this section. Instead, the linguistic processing of quantifiers will take center stage. The following questions will be addressed: How do listeners identify the scope of a quantifier? In cases of ambiguity, do they prefer to interpret a quantifier with scope corresponding to its surface position, or do they prefer to assign it scope with respect to a lower 'reconstructed' position? Are the complexity predictions of Generalized Quantifier Theory confirmed? That is, do quantifiers behave as if they take two arguments? How do comprehenders identify the restrictions on the domain of the quantifier? And, finally, under what circumstances do quantifiers trigger pragmatic implicatures? See article 43 (Keenan) *Quantifiers* for background on quantifiers.

#### 3.1. Scope

Ioup (1975) pioneered the processing of scopally ambiguous sentences. She argued that individual quantifiers have different inherent propensities for acquiring scope, e.g. *each* > *every* > *all*, and she proposed a grammatical function hierarchy specifying, for example, that subjects (and topics) tend to take wide scope. Subsequent research confirms Ioup's basic finding that both the particular quantifier and its position influence preferred scope assignments. Kurtzman & MacDonald (1993) investigated sentences like those in (1) and (2) in a makes-sense judgment task. Participants read the sentences one at a time, and then pressed a button to indicate whether the second sentence was a good continuation of the first sentence. Response times were not informative, but readers did accept the continuation more often when it was consistent with the subject taking wide scope, i.e., (1a) and (2a).

- (1) a. Every kid climbed a tree. The trees were full of apples.  
b. Every kid climbed a tree. The tree was full of apples.
- (2) a. A kid climbed every tree. The kid was full of energy.  
b. A kid climbed every tree. The kids were full of energy.

In a second experiment, testing passives, the preference for surface scope was weaker than with actives, and the acceptability of continuations compatible with the inverse scope reading was higher for passives than for actives. In subsequent experiments, complex noun phrases were tested, and inverse scope was found to be preferred, for reasons that remain unclear. Kurtzman & MacDonald concluded the processor considers various scope interpretations simultaneously and a variety of factors contribute to the ultimate preference for a particular scope-assignment. Tunstall (1998) noted that one problem interpreting the above results is the fact that the second sentence in (1b) is a perfectly good continuation of the discourse even if the universal quantifier takes wide scope. The wide scope universal reading of *Every kid climbed a tree* permits but does not require multiple instantiation of the referent of the object *a tree*.

Tunstall (1998) reported a variety of comprehension and production experiments on quantifier scope, focusing on the difference between *each* and *every*. She argued for a Surface Scope principle: If Q1 c-commands Q2 at surface structure, then perceivers prefer Q1 to scope over Q2. She assumed that *each* and *every* are both distributive and argued that *each* is used when the speaker is interested in the individuals in the set *each* quantifies over. In one study, changing a situation slightly from one where the members of this set were uniform to one where some property distinguished the individual members of the set from each other (e.g., employees all wear identical clothes versus having salient color differences in their uniforms) determined whether speakers described the situation using *each*, for differentiated situations, or *every*, for undifferentiated situations. The Surface Scope principle lies at the heart of Tunstall's account of processing quantifiers. On her view, perceivers assign surface scope but then alter that scope if the conditions associated with the individual quantifiers are not met, though see also Filik, Paterson & Liversedge (2004).

Anderson (2004) conducted an extensive study of processing quantifier scope in sentences like *Every/an expert climbed a/every cliff*. In a large number of written interpretation and self-paced reading studies, surface scope was preferred to inverse scope. Inverse scope sentences also took longer to process than surface scope sentences even when the sentences were unambiguous or presented with a prior disambiguating context. She attributed the cost of inverse scope to its representational complexity, e.g., the extra structure resulting from the application of quantifier raising.

In one set of studies, she investigated the economy of scope hypothesis (Fox 1995) which claims that quantifier raising (that is not forced by type-shifting considerations) may only be performed when it delivers an interpretation that is semantically distinct from the meaning obtained without quantifier raising. Assuming the existence of a constraint requiring scope parallelism, the economy of scope hypothesis predicts that example (3) is unambiguous for grammatical reasons. *Marta* cannot raise because raising would produce no semantic effect, and parallelism thus requires the first sentence in (3) to have only the surface scope interpretation (with *some student* scoping over *every film*).

- (3) Some student loves every Hitchcock film. Marta does too.

Anderson (2004) tested examples like (3) in contexts biased to inverse scope. 67% of the responses indicated participants had assigned the inverse scope interpretation, counter to the predictions of the grammatical economy of scope hypothesis. Anderson concluded that processing factors, the general preference for surface scope, not a grammatical principle such as scope economy, accounts for the preference for the surface scope reading of (3).

It is generally assumed that quantifiers may not take scope outside their immediate clause. But apparent counterexamples to this claim may be found in corpora in so-called ‘telescoping’ environments (*Every candidate approached the stage. He took his diploma and returned to his seat.*). Anderssen (2008) provides an analysis of such examples which involves an implicit generic quantifier, and backs up the analysis with corpus examples and with processing evidence showing that the examples are felicitous primarily in examples with non-accidental properties. (For additional processing evidence on telescoping, see Carminati, Frazier & Rayner 2002.)

### 3.2. Reconstruction

The studies described in section 3.1 investigated sentences where the quantifier phrase occupied an argument position. Very few studies have examined the processing of quantifiers that appear in other positions. Typically such quantifiers may receive scope either in their surface position or in their reconstructed (theta-) position.

Villalta (2003) investigated the processing of *how many*-questions in English and (their counterparts) in French, in contexts supporting both readings. She found that, in contrast to the strong surface scope preference observed for scope ambiguities in studies of quantifiers in argument positions, ‘reconstructed scope’ (scope determined with respect to the base position of a phrase) was preferred for questions like *How many pieces did every student play?*, and this preference was strong, preferred roughly 80% of the time, in both English and French. Villalta attributed the preference for the reconstructed reading to a delay imposed by not knowing which set in the preceding context was the intended referent for the restrictor. (Note that delayed assignment might explain the absence of an immediate surface scope preference, though presumably something more is needed in order for the delay to result in a commitment to ‘reconstructed’ scope.) She offered some data from a self-paced reading study as evidence for the delay account, see Villalta for details.

In written questionnaire studies, Bader & Frazier (submitted) investigated German sentences with expected subject-before-object order and unexpected object-before-subject order. They found that an object moved over a universally quantified subject was likely to reconstruct, unless it was potentially specific (e.g., *ein Buch von Chomsky* ‘a book by Chomsky’ as opposed to *irgendein Buch von Chomsky* ‘some book by Chomsky – I don’t know or care which’). The particular universal quantifier also mattered: *fast jeder* (‘almost every’) received the most wide scope (followed by *jeder* (‘every’), *fast alle* (‘almost all’) and *alle* (‘all’). Finally, more ‘reconstructed’ (low) scope was observed for phrases moved to the beginning of the sentence (Spec, CP) than for phrases moved in front of the subject in the middlefield. These results were explained in terms of a Base position preference principle favoring scope assignments with respect to the base



position of a phrase (presumably due to a desire to interpret a phrase in just one location with respect to all properties, including thematic role, scope and focus). Base position preference may be offset in the case of specific indefinites by a reluctance to reanalyze a phrase if it has already been interpreted as a variable at the highest level of the discourse representation structure (Kamp & Reyle 1993).

To sum up, the data available to date clearly indicate a preference for surface scope in doubly quantified sentences. However, the surface scope preference observed for sentences with quantifiers in argument positions does not hold generally for sentences in which quantifier phrases have been moved out of those positions, in particular when one quantifier phrase has moved over another to Spec,CP.

### 3.3. Complexity

Do quantifiers by definition take two arguments (a restrictor and a nuclear scope) as claimed by Generalized Quantifier Theory and, if so, do these semantically predicted arguments guide sentence processing? The question about semantic prediction, in particular, is extremely difficult to ask properly, because of the overlap between syntactic predictions and semantic predictions. In a study cleverly designed to disentangle syntactic and semantic predictions, Arregui (2003) investigated center-embedded sentences missing their middle verb phrase. There exists an interesting linguistic illusion where listeners' immediate reaction is to accept an ungrammatical sentence like: *The man the woman the dog bit on the cruise ship had a beard*, which omits the middle of three required predicates (Gibson & Thomas 1999). Arregui exploited this illusion by placing a quantifier either in a position where, assuming the quantifier takes two arguments, it would predict the existence of the missing verb phrase or in a position where it would predict the existence of one of the overt verb phrases. As expected, sentences containing a quantifier in a position where it predicted the missing verb phrase resulted in significantly lower acceptability ratings than sentences where the quantifier predicted one of the arguments that actually occurred. This suggests that the quantifier does indeed semantically predict two arguments and these semantic predictions influence processing in an observable manner when the corresponding syntactic predictions have been nullified.

Using quantifiers like *everyone* and *no one*, Warren & Gibson (2002) found that sentences with quantifiers were rated as being less complex than their definite description counterparts (more accurately, sentences containing these quantifiers in the most troublesome or demanding positions were rated as less complex than sentences containing definite descriptions in those positions). In later work, reviewed in Section 3.4 below, Warren showed that it is only quantifiers lacking content noun restrictors, such as *everyone* as opposed to *every reporter*, that are processed quickly and rated as being less complex than their definite description counterparts.

In two studies, Martin Hackl and his students have tested complexity predictions of current linguistic theory. Varvoutis & Hackl (2006) found preliminary evidence that quantifiers in object position do show the complexity effect one would expect if they needed to raise from this position for type reasons, i.e., because the internal argument of a verb should be of the semantic type of an entity/referring expression, not a quantifier. Basically they reasoned that a postverbal phrase that could temporarily be analyzed as either the object of the preceding verb or as the subject of another clause should trigger a direct object reading with definite descriptions due to the preference for minimal

structure. However, with a quantifier phrase the direct object analysis should not be preferred due to the extra complexity resulting from the need to move a quantifier out of object position to avoid a type mismatch. The reading time predictions of this account were confirmed in a self-paced reading study of sentences like *The nun remembered the/ every child (who) was abused and malnourished*.

Hackl & Acland (2006) compared the verification of sentences containing *most* or *more than half*, in a novel self-paced counting study. Participants had to verify sentences containing these quantifiers (*Most dots are black*) by pressing a button that progressively revealed more dots. Despite being semantically equivalent (or nearly equivalent), sentences containing *more than half* took longer to verify than sentences containing *most*. The result is unexpected if only the truth-conditional properties of quantifiers matter. On the other hand, if the denotation of the syntactic constituents of *more than half* are important for determining the interpretation of the expression, then it is not surprising that it is processed in a different manner than *most*.

To date, there have been only a handful of psycholinguistic studies testing the complexity predictions of various theories of quantifiers. The existing studies make it clear that there is great potential for this line of research.

### 3.4. Domain restriction

The issue of how domain restrictions are identified is central to any theory of semantic processing. Warren (2003) found that reading times in a self-paced reading study were longer for quantifier phrases (*every reporter, no reporter*) than for their definite description counterparts (*the reporter*) except when the quantifier lacked a contentful restrictor (*everyone, everybody, no one*, and surprisingly, *many people*). In a follow-up study the target sentences in (6) followed either a context that provided an antecedent set, as in (4), or one without an antecedent set, as in (5). The presence of an antecedent set speeded reading times on the critical (“x reporter”) phrase in the relative clause targets, or after the critical phrase in the complement clause targets, for both the quantifier phrases and the definite descriptions.

- (4) Context with an antecedent set: There was a coffee shop next to the offices of the Boston Globe. On Monday, a group of reporters gathered there for lunch.
- (5) Context without an antecedent set: There was a coffee shop next to the offices of the Boston Globe. On Monday, people who worked nearby gathered there for lunch.
- (6) Targets:  
 A waiter who {no reporter, every reporter, the reporters} liked very much dropped a tray of drinks. (Relative clause)  
 A waiter knew that {no reporter, every reporter, the reporters} liked potato salad so he brought out a big bowl of it. (Complement clause)

It is perhaps of interest that the presence of an antecedent set was equally helpful for the different targets (*no, every, the*). One might have expected that a phrase with a referent would benefit more than a phrase without a referent (*no reporter*). The timing of the



facilitation effect is also noteworthy. In the more difficult relative clause sentence type, the facilitation effect appeared on the quantifier phrase itself, whereas in the easier complement sentence, it showed up on the following region. If the pattern is reliable and general, it would argue against a system which always integrates the interpretation of the current phrase with preceding discourse before moving on to process new material.

### 3.5. Pragmatic implicatures

The issue of how and under what circumstances pragmatic (Gricean) implicatures are drawn has begun to receive attention in the adult processing literature. Some studies have investigated enriched meanings of quantifiers (and other scalar terms such as *or* and cardinal numbers). One approach has focused on whether adults make a distinction between what is said and what is implicated. Gibbs & Moise (1997) presented evidence from paraphrase selection studies, where participants read sentences and selected a paraphrase corresponding to what interpretation best matched what its speaker might have said by its use. Even after participating in a tutorial on what is literally said, participants' judgments of what was said was influenced by pragmatics, with over 75% enriched interpretations for cardinals (interpreting *three* as exactly three), quantifiers (interpreting *everyone* as everyone in some group), 'time-distance' implicatures (interpreting *some time* as a long time), and conjunction (interpreting *and* as and then). The results fit with a neo-Gricean view where certain 'generalized' implicatures are computed automatically. See in particular Levinson (2000), also Bezuidenhout & Cutting (2002) for online evidence.

Not all evidence supports automatic computation of implicatures. Noveck & Posada (2003) investigated underinformative sentences (the French counterpart of *Some elephants have trunks*) along with clearly true sentences (*Some houses have bricks*) and false sentences (*Some crows have radios*). In timed visual verification of sentences, twelve participants said false for nearly all underinformative sentences, consistent with automatic computation of the implicature 'some but not all elephants have trunks', but seven participants said true for nearly all underinformative sentences. Further, in the same study, electrical potentials were measured and they showed a steeper N400 for clearly true or clearly false sentences than for the underinformative sentences even for the group of participants that rejected the underinformative sentences. Since the N400 has been taken to be a marker of semantic unpredictability or anomaly, a possible implication might be that the same linguistic processing occurred for the two groups of participants. What may have differed is their non-linguistic evaluation or classification of the input due to their understanding of the verification task itself. The study highlights the difficulty of targeting precisely the question of interest in experimental studies. This problem is especially acute in the case of interpretation which may encompass strictly linguistic 'semantic' processing, pragmatic processing, conceptual processing, and/or evaluation of an utterance as a description of some state of affairs.

Breheny, Katsos & Williams (2005) argued that implicatures are drawn only when they are relevant to context. They tested Greek sentences containing the counterpart to *some* or *only some* in several self-paced reading experiments. In one experiment (Experiment 3), they tested the Greek counterpart of *some* in Upper-bound (7a) and Lower-bound (7b) contexts, as illustrated in (7).

- (7) a. Mary asked John whether he intended to host all of his relatives in his tiny apartment. John replied that he intended to host some of his relatives. The rest would stay in a nearby hotel.
- b. Mary was surprised to see John cleaning his apartment and she asked the reason why. John replied that he intended to host some of his relatives. The rest would stay in a nearby hotel.

Reading times were longer on the quantifier (*some of his relatives*) in the inference-supporting Upper-bound context than in the Lower-bound context, and reading times were shorter on the target segment (*the rest*) in the Upper-bound context than in the Lower-bound context. The investigators interpreted the data to show that the inference “some but not all” was generated in the context where it was invited, thereby facilitating interpretation of *the rest* (the complement of some of his relatives), but the implicature was not drawn in the Lower-bound context where it was not invited.

Research on implicatures is likely to explode in the next few years. Several directions for this research are already discernible. One uses on-line processing techniques, such as the visual world paradigm, to address issues about the time course of implicature computation. For example, Huang & Snedeker (2009) find a brief stage of purely semantic processing for *some* (though see also Grodner et al. 2008).

Another line of inquiry investigates the pragmatic conditions under which implicatures arise or don't. For example, Grodner & Sedivy (2011) explore the effects of informing participants that the speaker has “an impairment that caused language and social problems.” They argue that conversational implicatures are not generated for utterances that participants are told were produced by an unreliable speaker. In a related vein, Noveck et al. (2007) have argued that autistic individuals do not draw certain implicatures due to deficits involving ‘theory of mind.’

A third line of inquiry investigates the effects of the type of grammatical context in which an implicature trigger appears. The existing studies on processing implicatures examine contexts that are non-Downward Entailing. Based on written interpretation studies and self-paced reading studies, Frazier (2008) argues that fewer implicatures are drawn in Downward Entailing (DE) contexts, which license inferences from sets to subsets, than in non-Downward Entailing contexts. This line of inquiry is also likely to be fruitful, because finding a difference between DE contexts and non-DE contexts might support the view that some pragmatic inferences are computed hand-in-hand with the semantic computation (Chierchia 2004 and article 87 (Chierchia, Fox & Spector) *Grammatical view of scalar implicatures*). The results may also bear on the issue of whether certain kinds of inferences, and contexts based on those kinds of inferences or inference patterns, are distinguished because of the ease of computing the inferences, namely, inferences merely involving substitution of one set, a superset or subset, for another (Geurts & van der Silk 2005).

## 4. Different types of DPs

### 4.1. Anaphoric DPs

There is a vast literature on the processing of anaphoric phrases. Much of it is consistent with centering-theory, e.g., Grosz (1977), Gordon, Grosz & Gilliam (1993), and related proposals claiming that pronouns are used for reference to prominent constituents

(though see among others Wolf, Gibson & Desmet 2004, and especially Kehler et al. 2008, for evidence that discourse coherence structures based on similarity or contrast, or parallel structures, alter preferences). Considerable evidence shows that using a name to refer to a prominent constituent results in long comprehension times, the so-called ‘Repeated Name Penalty,’ Gordon et al. (1999). Further, a sentence containing a pronoun will take longer to comprehend if its antecedent is a non-topic than a topic (Clifton & Ferreira 1987) and if the antecedent is a part of a constituent rather than the whole constituent (e.g., “*Bill’s mother . . . he . . .*” will be read slower than “*Bill’s mother . . . she . . .*”), Gordon et al. 1999). In Italian, it has been shown that null pronominals prefer antecedents that occur in the highest preverbal subject position (Carminati 1992), whereas overt pronouns tend to take less prominent antecedents.

Vonk, Hustinx & Simons (1992) have presented evidence suggesting that overspecification of a referent, using a referring expression that is more than is needed (where  $\text{pro} < \text{pronoun} < \text{name} < \text{definite description}$ ), is an indication of a break in the discourse. The hypothesis is interesting because it suggests that the choice of a referring device conveys information to the listener or reader beyond that needed to identify the referent, namely, subtle information about the structure of the discourse. The hypothesis may also explain the ‘Repeated Name Penalty’ since the short discourses that have been tested typically don’t contain multiple episodes that would warrant overspecification when referring to a prominent entity.

Competition between pronouns and demonstratives has been investigated by Brown-Schmidt, Byron & Tanenhaus (2005). In a visual world study where participants’ eye movements were recorded as they carried out instructions, the investigators showed that a pronoun will preferentially refer to an already available entity whereas a demonstrative will pick up a composite (the cup on the saucer, given (8)).

(8) Put the cup on the saucer. Now put it (cup)/that (composite) on the tray.

Taken together, the above results strongly suggest that anaphoric phrases are specialized in the sense that the anaphoric device chosen by the speaker to refer to some referent implicitly codes information about the discourse structure and the prominence of the discourse referents it contains.

Whether a phrase is taken to be anaphoric or not may depend on its syntactic position. Kaiser & Trueswell (2004) showed that in Finnish using a scrambled OVS word order (e.g. doctor-saw-nurse) may suffice to quickly pick out a discourse-new entity (an unmentioned nurse), as opposed to an already mentioned entity (nurse), as the referent of the post-verbal subject.

## 4.2. Accommodated DPs

The presuppositions of a word often are not satisfied before that word is encountered and they must be added to the model (‘accommodated’) by the listener in response to the presupposition trigger itself. For example, a previously unmentioned entity is often introduced with a definite description even though the familiarity (or uniqueness, or maximality) presupposition of the word *the* is not satisfied. One approach to presupposition accommodation is to invoke the idea of a bridging inference between the current material and prior discourse. Burkhardt tested the German counterpart to the sentences in (9),

where a critical definite (*the conductor*) appeared in a context which either explicitly mentioned the corresponding entity, implied the existence of the entity (a ‘bridging’ context) or did neither. In an Event Related Potential study, Burkhardt (2006) found that already-given DPs elicited a reduced N400 (also found when the descriptive content of a word is highly expected), and that discourse-new DPs elicited a P600 (often found for higher level syntactic and semantic integration processes). Bridged DPs patterned first with given DPs, exhibiting a reduced N400 compared to the new DPs, and then patterned with new DPs, exhibiting a P600.

- (9) a. Tobias visited a conductor in Berlin. Given context  
 b. Tobias talked to Nina. New context  
 c. Tobias visited a concert in Berlin. Bridging context  
 Target:  
 He said that the conductor was very impressive.

She interpreted the results as showing that, if available, referential dependencies to already given entities are formed (indexed by the N400) and that establishing new discourse referents in a mental model involves extra processing and storage, evidenced by the P600.

Chambers et al. (2002) explored referential domains in a visual world study. Participants were instructed to *Put the cube inside the can . . .* When there was only one can big enough to hold the cube, looks to the smaller can were very limited. However, when the display contained two cans big enough to hold the cube, there were significantly more looks to the alternative can. The authors concluded that referential decisions are constantly informed by their relevance for the action described by the unfolding utterance. In the present case, the affordance structure of the cans (their potential to serve as the goal of the action described) determined the domain. The smaller can was apparently eliminated from the domain by its affordance structure. Using a similar methodology, Sussman et al. (2006) found evidence for Carlson’s (2005) analysis of weak definites (*Emily read the newspaper*), which treats them like bare plurals. In contrast to ordinary definites, with weak definites participants did not avoid looking at pictures containing two newspapers when they heard *the newspaper*, nor were their looking times delayed by the presence of an ‘extra’ newspaper.

Evans (2005) put forward the “Small world hypothesis” which claims that “In order for a new single entity to be introduced with the definite article, the scope of its frame of reference must be small enough to single that entity out as more relevant than all others of its type. In this way, an entity designated by the definite article must be locally unique within its frame of reference.” In support of the Small world hypothesis, Evans showed that ‘singling out’ examples where the comprehender can zoom-in on a particularly relevant member of a plural set, as in (10a) and (11a), were rated as significantly more natural than their ‘no singling out’ b-counterparts.

- (10) a. Juan drove up to the busy tollbooths. The tolltaker was rude.  
 b. Juan looked at the busy tollbooths. The tolltaker was rude.
- (11) a. Lyla opened the book. The page was ripped.  
 b. Lyla flipped through the book. The page was ripped.

In a written completion task where participants filled in a determiner, the definite was supplied more often than the indefinite when the context singled out an entity from a larger set even though the entity was not previously mentioned. The Small world hypothesis is important because it suggests that accommodating presuppositions may be viewed not as adding missing propositional knowledge to a model, but rather as instructions about the frame size of the active context or the situation described. The comprehender is implicitly instructed to adjust the size of the contextual frame/situation in such a way that the presupposition is satisfied.

Of course presupposition accommodation must occur for categories other than DPs. Schwarz (2007) presented data from the processing of German *auch* ('too') suggesting that readers do not readily accommodate its presupposition. Instead they will perform a very costly syntactic reanalysis to an object before subject analysis of the sentence if doing so will result in satisfying the presupposition. This fits with theories (Abusch 2005) which claim there is a distinction in kind among different presupposition triggers.

Accommodated DPs are not exceptional. If linguistic input is immediately mapped onto world knowledge (Ferguson & Sanford 2008) using presupposition satisfaction as a means to delimit the active frame, as in Evans' proposal, it may be possible to explain how interpretation may proceed so smoothly without explicitly introduced referents for definite descriptions and in the absence of overtly expressed domain restrictions.

### 4.3. Plurals

The interpretation of plurals is a huge, interesting, and underinvestigated topic. There have been only a few studies of the topic to date. Koh & Clifton (2002) investigated processing plural pronouns lacking syntactically plural antecedents. They showed that group formation was easier with symmetric predicates than with nonsymmetric predicates. Specifically, forming a plural group consisting of the 'subject' and 'object' was easier, as measured by reading times, and more likely, as indicated by fragment completion, when the individual group members were introduced by symmetric verbs (*Tom sang with Jim and Tony. They ...*, where they = 3 people) than when they were introduced with nonsymmetric verbs (*Tom recognized Jim and Tony. They ...*, where they = 3 people).

Turning to the opposite situation, 'DP-splitting' is required when one conjunct of a conjoined phrase is the antecedent of a pronoun. Albrecht & Clifton (1998) and Gordon et al. (1999) showed that there were longer reading times for a sentence containing a pronoun in examples where the antecedent was introduced inside a conjoined phrase like "*Stan and Pam ... He ...*" than in examples where the antecedent was not embedded in a larger phrase, e.g., "*Stan ... He ...*" This suggests that discourse referents are initially postulated for the referent of a plural DP but not for DPs embedded inside it.

There is an ongoing debate about whether the plural marker is semantically plural, or whether it only implies a plurality because the speaker didn't use the singular, Sauerland (2003). Sauerland, Anderssen & Yatsushiro (2005) argued for the latter, implicature-based, approach. In addition to linguistic arguments, they presented a reading study in support of their claim. In the critical condition "*Does a dog have tails?*" (vs. the control "*Does a dog have two tails?*"), participants were less accurate than for the control (they gave a "no" response only 85% of the time vs. over 95% for the control) and the response times were longer than for the control. A semantic account of plurality would presumably have difficulty explaining these results. On the implicature account, the variability

observed in the responses is expected (see the discussion of “underinformative statements” above in section 3.5).

Collective/distributive interpretations have also been investigated. In an eye movement recording study, Frazier, Pacht & Rayner (1999) tested sentences with early or late disambiguation to a collective or distributive interpretation. If an underspecified representation exists which may be further specified to a particular interpretation, then it shouldn't matter whether the disambiguation occurs early or late in the sentence. Assuming an underspecified representation, the processor can simply add the appropriate specification if and when it encounters biasing or disambiguating information. However, if there is an actual ambiguity between two interpretations/readings, then the processor must presumably choose and plausibly it will choose the simpler representation, by hypothesis, the one without a distributive operator. These predictions were tested in an eye movement recording study using sentences like those in (12).

- (12) a. Lynne and Patrick saved \$1000 each to pay for their honeymoon.  
(Distributive, late disambiguation)  
b. Lynne and Patrick saved \$1000 together to pay for their honeymoon.  
(Collective, late disambiguation)  
c. Lynne and Patrick each saved \$1000 each to pay for their honeymoon.  
(Distributive, early disambiguation)  
d. Lynne and Patrick together saved \$1000 each to pay for their honeymoon.  
(Collective, early disambiguation)

The results showed reading times were long for just one of the late disambiguation conditions (12a), as expected according to the hypothesis that collective/distributive distinction is a real ambiguity. This showed up as an interaction of ambiguity (early vs. late disambiguation) and interpretation (collective vs. distributive) in first pass reading times, total times, and the number of regressions to already read material. The fact that it was the late disambiguation distributive interpretation that took longest to read suggests that perceivers adopted the collective (or cumulative) interpretation in the absence of evidence and then revised this decision when they later encountered evidence for the distributive interpretation. See also Kaup, Kelter & Habel (2002) for compatible evidence about the preferred interpretation of the plural pronoun *sie* ('they') in German.

The processing of plurals is not understood at present. A small number of interesting investigations have opened up this avenue of inquiry, but firm conclusions are probably not warranted at this time.

## 5. Beyond DPs

The semantic processing of DPs has been the focus of the discussion in preceding sections. Of course, psycholinguists have also investigated the processing of other types of constituents. A brief pointer to some of this literature follows, starting with verbs, moving on to aspect and tense, and ending with scalar adjectives.

Verbs have been studied from a variety of perspectives. Gennari & Poeppel (2003) compared stative verbs and eventive verbs. They expected eventive verbs to be more complex than stative verbs because they have a causal structure which is lacking in stative



verbs. They report a lexical decision experiment and a self-paced reading experiment supporting this complexity prediction.

Unaccusative verbs have been studied by a number of authors (see Friedmann et al. 2008 and references therein). Friedmann et al. (2008), among others, have tested the unaccusativity hypothesis, which claims that the subject of an unaccusative starts out in direct object position. Using cross-modal semantic priming to determine if the subject of an unaccusative verb behaves as if it is reactivated at some point following the verb, Friedmann et al. found significant reactivation effects for unaccusative verbs but not for unergative verbs. The results thus support the unaccusativity hypothesis.

Gennari et al. (2002) studied motion verbs in Spanish and in English. Their aim was to determine whether claimed cross-language differences in the expression of 'path,' typically expressed in a PP in English but inside the verb in Spanish, translate into perceptual differences when native speakers view scenes which are similar in either their path (dragging a board into a room or out of the room) or their manner (dragging a board or carrying it). They found little support for the hypothesis: speakers of Spanish and speakers of English did not differ much in their behavior and the small differences that were found were only present under circumstances where language could be used as a strategy for classifying similar situations. Papafragou, Hulbert & Trueswell (2008) tested a similar hypothesis concerning cross-language differences in how path is expressed and its effect on perception under circumstances where the participants did or did not have to formulate sentences. In the Papafragou, Hulbert & Trueswell study, differences between English speakers and Greek speakers were observed when sentence production routines were engaged, but not otherwise.

Thematic roles have been investigated by numerous researchers. One central question is whether implicit arguments are introduced lexically as a semantic argument or by a conceptually derived inference. Carlson & Tanenhaus (1988), Maurer & Koenig (1999), Maurer, Tanenhaus & Carlson (1995) present evidence for the lexical approach.

Aspect has been approached primarily in terms of 'semantic coercion' (see Section 2 above, also discussion in Bott 2008 and references therein). Complexity effects are observed when the denotation of a constituent requires 'subtractive' coercion, e.g., a *for*-phrase conflicts with an accomplishment, requiring subtraction of the endpoint of an eventuality to obtain an activity, but not reliably with additive coercion (Bott 2008).

There has been surprisingly little attention paid to the processing of tense. One exception is an investigation by Walsh Dickey (2001). Among other things, he presented evidence that the interpretation of tense is delayed until event type (e.g., telicity) information is available. Gennari (2004) examined temporal relations between distinct clauses and showed that reading times were longer when the two clauses had distant non-overlapping references. Finally, to my knowledge, the processing of modality is essentially unexplored territory (with the exception of Dwivedi et al. 2006).

Scalar adjectives have been investigated in visual world studies. Sedivy et al. (1999) showed that context-specific contrast can be used by the listener to identify a referent even before the head noun has been encountered. If two objects contrast with respect to size, for example a short glass and a tall glass, then an instruction to *Pick up the tall...* may induce listeners to look at the tall object which has a short counterpart rather than at a tall competitor (tall pitcher) which has no short counterpart (a short pitcher).

Rips & Turnbull (1980) contrasted relative (*small*) and absolute (*six-legged*) adjectives in verification studies. They compared *An insect is small/six-legged* and *An insect is a small*

*animal* / *six-legged animal*. They expected relative adjectives to be more context dependent than absolute adjectives, and thus predicted a penalty for having the adjective by itself as the predicate only for the relative adjectives, not the absolute adjectives. The results confirmed the prediction.

Frazier, Clifton & Stolterfoht (2008) studied absolute scalar adjectives, such as *clean* and *dirty* using written interpretation studies and eye movement recording. They found support for the current semantic analysis (Kennedy 1999, Kennedy & McNally 2005, Rotstein & Winter 2004) of absolute scalar adjectives. They also established quantificational variability effects arising in sentences like *The dishes are mostly clean/dirty*, where a proportional reading of the subject *most of the dishes* tends to be reported when *mostly* would otherwise have to modify a minimum standard adjective like *dirty*. They attribute the effect to a clash between the adjective having as a standard any non-zero value and the need of *mostly* to have a determinate value to modify.

The paucity of research in many areas of semantic processing does not seem to be due to in principle problems in pursuing the questions in these areas. Rather these lacunae may have arisen somewhat accidentally due to the lack of collaboration in the past between psycholinguists and semanticists. Psycholinguistic issues and methods and semantic questions have, for the most part, been pursued by distinct researchers in largely non-overlapping communities.

## 6. Conclusions

The study of linguistically guided semantic processing is in its infancy, but the stage is set for a dramatic growth spurt. Indeed, the mere fact that there exists a literature on semantic processing is evidence of great progress in this area. Ten or fifteen years ago, nearly all experimental work on 'semantic' processing investigated 'semantic' processing in the rather loose sense often used in psychology where the term may refer to any aspect of interpretation, be it semantic, pragmatic, conceptual, or whatever.

There are probably several reasons for the recent progress in the psycholinguistic study of meaning. In part, it may be due to the various methodologies now employed, including visual world studies, which permit rich contexts to be studied, ERP studies, which offer a continuous measure of ongoing processing of an input, and various neuro-imaging techniques, which allow questions to be asked about where in the brain certain processes take place (e.g., Pylkkänen & McElree 2007). In part, the recent progress is also due to the better integration of psycholinguistics into linguistics. There are now a few young researchers who are well-trained both in psycholinguistics and in formal semantics. As a result, semantic investigations motivated by linguistic questions are beginning to appear.

*This work was supported by NIH Grant HD-18708 to the University of Massachusetts. I am very grateful to Paul Portner for helpful suggestions, and to the semantics graduate students and faculty at the University of Massachusetts for educating me about semantic issues.*

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Lyn Frazier, Amherst, MA (USA)

## 103. Meaning in first language acquisition

1. Overview of research on the acquisition of semantics
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### Abstract

*Every normal child acquires a language in just a few years. By four or five, children are effectively adults in their abilities to understand novel sentences, to discern entailment relations, and to assess the truth or falsity of endlessly many statements presented to them in conversational contexts. There are two main approaches to explain this remarkable acquisition scenario: one emphasizes the contribution of innate knowledge, and one emphasizes the availability of relevant cues in children's experience. Semantic knowledge is a good testing ground for adjudicating between these alternative approaches, because evidence for principles of interpretation appears to be thin at best. The main focus of this chapter is on children's interpretation of disjunction (e.g., English *or*). In classical logic, disjunction has truth conditions corresponding to inclusive-or. It is evident from cross-linguistic research that human languages assign the inclusive-or interpretation to disjunction, and it is evident from recent experimental research that this is children's initial interpretation, despite the absence of decisive evidence in children's experience. This invites two conclusions: that disjunction has the same basic meaning in classical logic and in human languages, and that children do not learn what disjunction means from experience; rather, this knowledge is innately specified.*

### 1. Overview of research on the acquisition of semantics

The present chapter describes a series of interwoven linguistic phenomena, all dealing with the interpretation of disjunction (English *or*) in human languages. The main focus is on child language because, as we will see, children can be more revealing about the interplay of logic and language than adults are. In discussing the interplay of logic and language, we describe research investigating children's interpretation of disjunction across languages, and in sentences where disjunction appears in combination with other logical expressions: negation, focus expressions, and the universal quantifier. This leaves

insufficient space to pend on other research findings about the nature of meaning in first language acquisition. To make up for this, the following paragraphs briefly introduce a range of other topics, with suggestions for further reading. Children's first words are predominantly open-class or content words (nouns, verbs, adjectives), rather than closed class or function words (determiners, prepositions, pronouns). So, we begin this survey by discussing the emergence of the open class vocabulary, namely nouns and verbs.

## 1.1. Nouns and verbs

Even six-month old English-speaking infants show a preference for listening to open class vocabulary items rather than closed class items (Shi & Werker 2001). In languages like English and Italian, nouns dominate the child's first 200 words, then verbs creep in, followed by closed-class function words (e.g., *and*, *or*) and finally closed-class vocabulary items such as prepositions, determiners and pronouns (Dromi 1987; Nelson 1973). To explain the early emergence of nouns, it has been proposed that nouns are more "cognitively dominant" than verbs or closed-class items, and that closed-class items, in particular, derive their meanings from their linguistic environment and represent opaque grammatical constructs (Gentner 1982; Gentner & Boroditsky 2001). The suggestion that child language is "noun friendly" has been challenged, however, in observational studies of children learning other languages, such as Japanese, Korean and Mandarin Chinese (see, e.g., Tardif, Gelman & Xu 1999, for Mandarin Chinese). In these languages, young children apparently produce verbs in higher proportions than nouns, at least as compared to child English and child Italian.

Another issue is the meanings that children initially assign to nouns. It has been suggested in various studies that children interpret words too broadly (*overextend* their meanings) or too narrowly (*underextend* their meanings) as compared to adults. However, experimental assessments of children's over-extensions and under-extensions indicate that, in fact, mistaken interpretations are quite rare. Children's non-adult behavior is more likely to occur in their productions than in language understanding, and mistakes are likely to be performance errors in on-line language processing, due to less-than-optimal strategies of lexical retrieval in sentence planning, rather than being due to non-adult semantic representations in children's mental dictionaries (e.g., Clark 2003; Huttenlocher & Smiley 1987). A number of cognitive constraints have been proposed to account for children's early associations of labels to objects (see e.g., Markman 1989). One constraint is called *mutual exclusivity*, which guides children to associate a novel linguistic expression with a novel object, rather than associating it with an object that the child can already name. The source of children's one-to-one mapping of labels onto objects is subject to debate. Some researchers attribute it to word learning, whereas others attribute it to pragmatic knowledge (see Bloom 2000).

Turning next to the acquisition of verb meaning, it has been argued that the multiple sentence structures in which a verb appears provide young children with cues to its meaning (see Gleitman 1990). In child directed speech, mothers use most verbs in several sentence structures (e.g., *He broke the vase. The vase broke.*), and it has been shown experimentally that two-year-olds gain insight into the meanings of verbs by attending to the syntactic frames in which they occur (Naigles 1998). This, in turn, is evidence that 2-year-olds are capable of building syntactic representations for sentences (Guasti 2002).



Another topic in the acquisition of verb meaning is telicity. A verb (or verb phrase) that depicts an action or event as complete is said to be **telic**, whereas one that depicts an action or event as incomplete is said to be **atelic** (see article 48 (Filip) *Aspectual class and Aktionsart*). Various studies have investigated children's sensitivity to the telic/atelic distinction. English-speaking and Dutch-speaking children's sensitivity to telicity has been demonstrated in a series of studies by van Hout (1998; 2003; 2004). One study showed 3- to 5-year-old children two versions of an event, such as one picture of an elephant that had consumed only part of a bucket of water, and another picture in which the elephant had consumed the entire contents of a bucket of water. Child preferred the picture that depicted the completed event in response to a description using a verb-particle construction, e.g., *The elephant drank up the water*, as compared to one without a particle, e.g., *The elephant drank the water*). Similarly, Wagner & Carey (2003) claim that children as young as three years old mark telicity in English. In one study, children were shown animations in which periods of activity (separated by breaks) lead to a culminating event (*paint a flower, build a house*). Various types of events were presented (creation, destruction, change of state). The events were described using either atelic or telic predicates. Children were then asked to count the events in the animations. Children's strategy for counting events was influenced by the type of predicate that was used. It has also been found that English-speaking children tend to restrict their use of perfective past tense morphology (*-ed*) to telic verbs, and they tend to restrict the use of imperfective progressive (*-ing*) to atelic verbs for the most part (Bloom, Lifter & Hafitz 1980; Shirai & Andersen 1995). Note that adult English does not adhere to these restrictions; verb forms such as *making* and *bumped* are perfectly natural. Thus the observed pattern in child language is not likely to be learned from adult input.

We move now to topics in the acquisition of the closed class vocabulary, beginning with negation.

## 1.2. Negation

(For background on negation, see article 63 (Herburger) *Negation*.) Early work on child language by Klima & Bellugi (1966) charted the course of development of English-speaking children's negative utterances. They found that children typically go through distinct stages, beginning with a stage during which they produce negative statements with a negative expression followed by a proposition (NEG+PROPOSITION), e.g., *No, the sun shining*, or *No, Mommy do it*. The existence of an early 'primitive' stage of negation was questioned by later researchers, but at least some children appear to pass through a stage of 'external' negation, and such utterances have been analysed in several ways. Many examples have been analysed as anaphoric negation, in which the negative element constitutes a rejection of a previous utterance, so *No, the sun shining* means *The sun is not shining* (Bloom 1970). Other examples have been interpreted as the negation of an implicit verb *want* that resides in a higher clause, so *No Mommy do it* means *I don't want Mommy to do it* (de Villiers & de Villiers 1979). According to these accounts of children's early syntactic development, children's utterances with external negation are structurally different from those of an adult speaker, but they are semantically equivalent to the corresponding adult utterances with sentence-internal negation. A detailed syntactic analysis

relating children's external negation to adult sentence-internal negation is offered by Déprez & Pierce (1993) (but cf. Stromswold & Zimmermann 2000). Taking a different line, Drozd (1995) argues that children's utterances with 'pre-sentential' negation are adult-like utterances expressing 'metalinguistic exclamatory' negation. On this account, the child is objecting to a previous utterance, so *No, the sun shining* means *Don't say the sun is shining*, cf. *The hell the sun is shining*. When negation appears sentence-internally in children's utterances, they continue to produce certain kinds of non-adult utterances, including ones that contain an uninflected verb, such as *Mary no like cheese* and *Mary not like cheese*. An interesting proposal by Harris & Wexler (1996) is that children who produce such utterances are correctly categorizing the negative element (as a head), but children are at a stage during which Tense or Agreement is optionally omitted. This analysis has been called into question, however, by Thornton & Tesan (2007). These researchers elicited negative sentences from children at the same stage of development, and they recorded a robust sample of negated utterances that are not expected on the Harris and Wexler account, such as *Mary not likes cheese*. Based on such non-adult utterances in which Tense and Agreement are present, Thornton & Tesan (2007) argue that children adopt a UG-compatible analysis of negation, one that categorizes negation in a way that is appropriate for embedded clauses in Mainland Scandinavian languages, but neither for main nor embedded clauses in languages such as English. There have been a number of experimental studies on English-speaking children's interpretation of disjunction (English *or*) in the scope of negation and in the scope of negative quantificational expressions such as *not* and *none of the* (Chierchia et al. 2001; Crain et al. 2002; Crain 2008; Crain, Goro & Thornton 2006; Gualmini et al. 2001; Gualmini & Crain 2002, 2004). These studies have revealed that 4- to 5-year-old English-speaking children are aware of the adult interpretation of disjunction when it appears in the scope of these downward-entailing operators. A representative example is an experiment by Crain et al. (2002) using the Truth Value Judgment Task in the prediction mode (see Crain & Thornton 1998). On a typical trial, sentence (1) was uttered by a (wizard) puppet as a prediction about how events would unfold in a story. It subsequently turned out that the girl who stayed up late received a jewel, but not a dime. The 3- to 5-year-old English-speaking subjects correctly rejected sentences like (1) in experimental contexts such as this. Children's stated reason for rejecting (1) was that the girl who stayed up late had received a jewel. It is evidence that, in children's grammars, (1) entails that the girl would receive neither a dime nor a jewel, i.e., she would not receive a dime *and* she would not receive a jewel. This conjunctive entailment follows only if the disjunction operator *or* is assigned an inclusive-*or* interpretation, as in classical logic.

(1) The girl who stayed up late will *not* get a dime *or* a jewel.

(2) The girl who *didn't* go to bed will get a dime *or* a jewel.

The same children consistently accepted sentences like (2) in the same contexts. In (2), the negative element does not have scope (does not c-command) over the disjunction operator. The fact that sentences like (2) do not engender conjunctive entailments for children demonstrates their knowledge of the structural relation that governs semantic interpretation in children's grammars (see section 5).



### 1.3. Focus expressions

As we discuss in section 4.1, focus expressions such as English *only* are typically associated with a particular linguistic expression somewhere else in a sentence. The associated expression is called the focus element. More often than not, the focus element receives phonological stress. In addition, sentences with focus operators are felicitous mainly in contexts in which there is a contrast set. The contrast set consists of individuals in the domain of discourse that are taken by the speaker and hearer to be alternatives to the focus element. These individuals should have been introduced into the conversational context before the sentence was produced; their existence is presupposed. Much of the previous literature on the acquisition of the focus operator, *only*, has centred on children's non-adult interpretation of sentences with a focus operator. For example, it has been observed (Crain, Ni & Conway 1994) that some children associate pre-subject *only* with the VP, such that they interpret *Only John speaks Spanish* as meaning that John only speaks Spanish. There are two main accounts of such non-adult behaviour. On one account, children fail to use phonological stress as a cue in identifying the focus element. For a comprehensive review of the relevant literature on the relation between phonological stress and children's semantic interpretation, see Reinhart (2006). On a second account, it is suggested that young children simply lack the ability to compute contrast sets. Following this second line, Paterson et al. (2003) argue that children fail "to mentally represent contrast information", and often can only compute semantic representations using lexical material that is made explicit, and cannot compute representations that include implied information. (Paterson et al. 2003: 276–277, 286, 289). In the present chapter, by contrast, we report the findings of studies showing that children are just as facile as adults in computing contrast sets with focus operators like *only*, as long as the contrast set is made salient in the experimental workspace. The finding has been replicated in studies of English, Japanese, and Chinese (Crain, Goro & Minai 2007; Jing, Crain & Hsu 2006; Notley et al. 2009; Zhou & Crain 2009, 2010).

### 1.4. Universal quantification

Investigations of sentences with the universal quantifier, e.g., English *every*, have led to qualitatively different conclusions about children's linguistic knowledge. One line of research has uncovered systematic non-adult responses by preschool and even school-age children (Inhelder & Piaget 1964; Philip 1995). For example, 5- and 6-year-old children sometimes reject (3) as an accurate description of a picture in which every boy is riding an elephant, but there is an 'extra' elephant that is not being ridden by a boy.

- (3) Every boy is riding an elephant.

Children non-adult behaviour in response to questions such as (3) has been called the *symmetrical response* since children appear to demand a one-to-one relation between the set of boys and the set of elephants. To explain the symmetrical response, Philip (1995) advanced an analysis in which the universal quantifier takes scope over both the subject N (*boy*) and the object N (elephant) in children's grammars. In the grammars of adults, the universal quantifier *every* quantifies over the set denoted by the subject N (boy), but not over the set denoted by the object N (elephant), so the presence of an 'extra' elephant

does not render sentences like (3) false for adults. Children's symmetrical responses fail to emerge, however, in certain experimental tasks, such as the truth value judgment task (Crain et al. 1996; Crain & Thornton 1998). The observation that different tasks lead to different behaviours has been the subject of considerable debate. According to one account, children's grammars make two readings available for sentences like (3), including one reading that is not attested in human languages, namely the reading on which a pre-subject universal quantifier takes scope over an object N. The crucial point is that this non-adult reading is prompted in certain tasks, including picture verification tasks, which draw children's attention to the set of individuals denoted by the object N; by contrast, the contention is that other tasks, such as the truth value judgment task, draw children's attention to the set denoted by subject N, thereby increasing the proportion of adult-like interpretations (Gordon 1996; Drozd 2006; Geurts 2003). An alternative account maintains that children's grammars are the same as those of adults, with just the reading on which the restriction of a quantifier is the noun it combines with in the syntax. The reason that children produce non-adult responses in certain tasks, on this account, is that these tasks violate ordinary rules of conversation by asking "a question whose answer is already known by both speakers" (Dehaene 1997: 46). As Guasti (2002) points out, the observation that violations of conversational rules evoke 'errors' from children (and adults) has been found in other research domains, such as in number conservation.

## 1.5. Polarity sensitivity

(For background, see article 64 (Giannakidou) *Polarity items*.) There are only a handful of studies bearing on the development of polarity sensitivity in children, but what little is known is consistent with the conclusion that young children produce and avoid negative polarity items in the same linguistic contexts as adults do (O'Leary & Crain 1994; Thornton 1995; van der Wal 1996). An experiment by O'Leary and Crain is representative. These researchers used a Truth Value Judgment task with an elicitation component. In the task, the puppet, Kermit the Frog, often produced false descriptions of the events that had taken place in the story. Whenever Kermit the Frog failed to accurately state what had happened in a story, children were asked to say 'what really happened'. The experimenter who was manipulating Kermit produced sentences like those in (4) and (5).

- (4) Kermit: Every dinosaur found **something** to write with.  
 Child: *No, this one didn't find anything to write with.*
- (5) Kermit: Only one of the reindeer found **anything** to eat.  
 Child: *No, every reindeer found something to eat.*

In the condition illustrated by (4), Kermit's statement had a universal quantifier *every*, which does not tolerate negative polarity items, such as *anything*, in its scope; instead, the (positive polarity) expression *something* was used. Eleven children (mean age 4;10) participated in the study. These children's responses frequently contained the negative polarity item *anything* in linguistic contexts that license it. In another condition, illustrated in (5), Kermit's statement contained the negative polarity item *anything*. However, in correcting Kermit, children consistently used the universal quantifier *every*, so this linguistic context forced children to avoid repeating the negative polarity item *anything*, despite

having just heard it used by Kermit. These findings make it clear that children have mastered some, if not all, of the requisite knowledge of downward entailment, which underlies the appropriate use and avoidance of negative polarity items.

Having surveyed some of the literature on the acquisition of the meanings of open and closed class vocabulary items, we now take a detailed look at the investigation of children's interpretation of disjunction in a variety of linguistic contexts, including sentences with negation, ones with the universal quantifier *every*, and ones with the focus operator *only*.

## 2. Two solutions to Plato's problem

Without special training or carefully sequenced input, every normal child acquires a language in just a few years. By four or five, children have invariably converged on a grammar that is largely equivalent to that of adult speakers in the same linguistic community. Children have effectively become adults in their abilities to understand novel sentences, to discern relations of paraphrase and entailments, and to judge the truth or falsity of endlessly many statements presented in conversational contexts. The alternative approaches to the study of first language acquisition can be traced back to the 'nature versus nurture' debate about how knowledge is acquired in any domain. The debate dates back to Plato's dialogue "The Meno". In this dialogue, the protagonist, Socrates, demonstrates to Meno that a young slave knows more about geometry than he could have learned from experience. By extension, "Plato's Problem" refers to any gap between experience and knowledge.

One solution to Plato's problem views the process of language acquisition on a par with the acquisition of knowledge in all other domains: e.g., social skills, learning to count, learning to read, and so forth. This is a domain-general approach to language development. This 'nurture' approach highlights the availability of relevant cues in the input to children. These cues serve as the basis for the generalizations that children form about language. These generalizations are formed using statistical learning mechanisms including distributional analysis, analogy, cut and paste operations, and the like. The products of these learning algorithms are 'shallow' records which children keep of their linguistic experience. These are piecemeal records of construction types (templates/schemas/constructs) that encode linguistic patterns displayed by the input. Construction types are concatenated sequences of category labels such as *NP*, *V*, *neg*, *INF*, *P*, etc., drawn from an intuitively simple typology, and are learned solely from positive evidence. (see, e.g., Pulum & Scholz 2002). When children's generalizations extend beyond their experience, the supposition is that this is just an instance of a completely general induction problem that arises for all learning that involves projection beyond one's experience (see, e.g., Cowie 1999). On the experience-dependent approach, child language is expected to match that of adults, more or less, with more frequently attested construction types being learned earlier than less frequently attested ones (e.g., Ambridge & Lieven 2011; Tomasello 2000, 2003).

The alternative view is that the gap between the child's linguistic experience and the knowledge they achieve is filled by innate principles of language. This 'nativist' approach highlights the contributions of human nature to the acquisition of linguistic knowledge. It supposes that children are biologically fitted, as part of the human genome, with a theory of 'Universal Grammar' (e.g., Chomsky 1965, 1975, 1986). Universal Grammar contains

the core principles of language, i.e., principles that are manifested in all human languages. In addition, Universal Grammar spells out particular ways in which human languages can vary; these points of variation are called parameters. Taken together, the core principles and parameters of Universal Grammar establish the boundary conditions on what counts as a possible human language. Children navigate within these boundaries in the course of language development. This approach views language learning as the by-product of a task-specific computational mechanism that enables children to rapidly and effortlessly acquire any human language without formal instruction and despite the considerable latitude in experience for different children. Universal linguistic principles are not learned by the computational mechanism, but are implicit in the structure of the mechanism itself. The parameters of Universal Grammar permit children to sometimes “try out” parameter values which generate constructions that are unattested in the local language, but only if such constructions are attested in other human languages (Crain & Pietroski 2001, 2002; Crain & Thornton 1998; Crain 2002).

Both approaches attempt to explain the universal mastery of language by young children. The details of the alternative explanations turn on three factors: (i) the linguistic competence children achieve, (ii) the linguistic input children receive, and (iii) the nonlinguistic capacities of children to form and evaluate generalizations based on their experience. First, let us consider the linguistic competence children achieve.

Children’s linguistic competence encompasses a variety of rich and interrelated linguistic generalizations. To illustrate, we will look at some representative generalizations that govern the interpretation of **disjunction** in human languages (e.g., English *or*, Japanese *ka*, Chinese *huozhe*).

One generalization arises in statements in which disjunction appears with negation, as in (6). First, note that example (6) entails both (6a) and (6b). It follows that (6) entails (7), which is simply the conjunction of (6a) and (6b).

- (6) *Suzi didn’t see Max order sushi or pasta.*
  - a. Suzi didn’t see Max order sushi.
  - b. Suzi didn’t see Max order pasta.

- (7) Suzi didn’t see Max order sushi and Suzi didn’t see Max order pasta.

Let us call (7) the *conjunctive entailment* of disjunction in the scope of negation. So, the English statement (6) generates a conjunctive entailment. Remarkably, when (6) is translated into Japanese or Chinese (or any other language, as far as we know), the corresponding statements also generate conjunctive interpretations. So, what is acquired by any particular child who is learning any particular language is just an instance of a generalization that extends across the globe, to all human languages. It is interesting to note that a similar cross-linguistic generalization does not extend to simple negative sentences with disjunction, such as *Max didn’t eat sushi or pasta*. In statements of this form, some languages (e.g., English, German) license conjunctive entailments, but others (e.g., Japanese, Chinese) do not. This parametric variation, and what children make of it, is discussed in section 3.

Another generalization about the interpretation of disjunction concerns statements with the universal quantifier, e.g., *every* in English. As (8) shows, when disjunction is in subject phrase of a sentence with *every*, the sentence yields the entailments (8a) and (8b).

Therefore, the English statement in (8) makes the conjunctive entailment in (9). And when (8) is translated into Japanese or Chinese (and any other language, as far as we know), the corresponding statements also make conjunctive entailments.

- (8) *Every student who took French or Spanish went to the conference.*  
 a. Every student who took French went to the conference.  
 b. Every student who took Spanish went to the conference.
- (9) Every student who took French went to the conference  
 and every student who took Spanish went to the conference.

Once more, what is acquired by any particular child in any particular language is just an instance of a broader cross-linguistic generalization.

Children also learn where disjunction does *not* license a conjunctive entailment. Interestingly, when disjunction is in the predicate phrase of a sentence with the universal quantifier, *every*, it no longer generates a conjunctive entailment. This is illustrated in (10), which has been formed from (8) by reversing the contents of the subject phrase and the predicate phrase.

- (10) *Every student who went to the conference took French or Spanish.*  
 a. # Every student who went to the conference took French.  
 b. # Every student who went to the conference took Spanish.

In (10), the predicate phrase (*took French or Spanish*) contains disjunction, but a conjunctive entailment is not licensed, because the relevant entailments in (10a) and (10b) are not valid inferences from (10). Later in this chapter we will see why disjunction is interpreted differently in the subject phrase and in the predicate phrase of sentences with the universal quantifier. For now, suffice it to say that this asymmetry extends to languages around the globe and, again, children are aware at an early age that disjunction does *not* to generate a conjunctive entailment in the predicate phrase of sentences with a universal quantifier.

Having provided a sample of the kinds of linguistic generalizations that children achieve, let us now consider the second piece of the acquisition puzzle, the nature of children's abilities to learn. Theories of language learning must be compatible with observations about the cognitive capacities of children to form and evaluate generalizations based on their experience. Children presumably do not (as linguists do) confirm hypothesized principles based on how well principles unify and explain disparate phenomena. Children also do not (as linguists do) confirm hypothesized principles based on both positive and negative evidence, and based on a range of crosslinguistic data.

Nevertheless, perhaps children can extract the relevant generalizations from what adults actually say, in the circumstances in which they say them. Recent research findings have demonstrated children's sensitivity to some statistical and distributional properties of the linguistic input. A study by Read & Schreiber (1982) showed that 7-year-olds are sensitive to structural notions like subject noun phrase, as long as such phrases contain more than one word. Moreover, Saffran, Aslin & Newport (1996) showed that infants can learn to segment speech into "word" boundaries by attending to statistical properties of the input. These researchers demonstrated that 8-month-old children could exploit

statistical learning mechanisms to extract information about transitional probabilities from the input. Infants inferred the existence of word boundaries between three-syllable nonsense “words” using some experience-dependent mechanism. Sequences of syllables that crossed a word boundary were not treated as a “word” during the post-test phase, because there was a lower probability for a sequence of syllables to be repeated if it crossed a word boundary than if that sequence was part of a “word”. These discoveries are of genuine interest. But there is no evidence that the statistical sensitivities children possess are relevantly like the statistical sensitivities they would need to learn the generalizations about the interpretation of disjunction, such as the fact that “or” is assigned different truth conditions in sentences with the universal quantifier, *every*, depending on its position in sentence structure (as illustrated in examples 8 and 10, above). In the absence of a plausible learning account of the acquisition of the kinds of interpretive phenomena that are exhibited by human languages, many linguists have concluded that there are substantive universal principles of human grammar and that, as a result of human biology, children can only acquire languages that conform to these principles. The development of semantic competence is likely to be especially revealing about the kinds of principles that are not learned from experience, since there is no realistic database by which children could come to understand principles of interpretation using the familiar mechanisms of learning.

Still, no one doubts that children use experience-dependent learning mechanisms to master some aspects of language. Children who grow up in an English-speaking community learn to speak English; those who grow up in a Basque-speaking community learn to speak Basque. But is it reasonable, therefore, to infer that the linguistic principles that govern the interpretation of disjunction, illustrated in (6)–(10) above, are acquired by children around the globe using statistical learning mechanisms? To answer this question, it is important to know what experience-dependent mechanisms can and cannot do. One kind of experience-based learning mechanism is a connectionist or parallel distributed processing network. Such networks rely on local regularities—i.e., changes in the “connection between one unit and another on the basis of information that is locally available to the connection” (Rumelhart & McClelland 1986: 214). According to Rumelhart & McClelland (1986: 214), such models “provide very simple mechanisms for extracting information from an ensemble of inputs without the aid of sophisticated generalizations or rule-formulating mechanisms.” In response, Marcus (1998; 1999) and Smith (1996) have shown that while such mechanisms are capable of extracting information about transitional probabilities, they are ill-suited to learning many other properties of languages. We contend that such mechanisms are ill-suited to learn the semantic principles that govern the interpretation of disjunction in human languages.

Not only are experience-dependent learning mechanisms too weak to learn certain properties of human languages, they are also too strong, in the sense that these mechanisms readily make generalizations about human languages which language-users themselves cannot make. Consider again the Read and Schreiber study. In that study, 7-year-old children were found to be sensitive to structure-dependent aspects of language. Read and Schreiber also showed that 7-year-old children cannot learn structure independent rules, like ‘drop the first four words of a sentence’. Similarly, Smith & Tsimpli (1995) showed that adults are unable to learn *structure-independent* rules for question formation. Because experience-dependent learning mechanisms are able to form structure-independent generalizations, these mechanisms are quite unlike human minds.



The third piece of the acquisition puzzle is the linguistic input children receive. A casual (or even intensive) examination of what adults actually say does not reveal the descriptive generalizations we have presented—much less the deeper principles that explain them. For example, we just observed that children come to know about the meanings that speakers' *do not* assign to otherwise well-formed sentences with disjunction. Yet, as far as we know, children are rarely (if ever) informed about the meanings sentences do not have (see Chierchia 2004; Crain 1991; Crain & Pietroski 2001, 2002; Pinker 1990). It is reasonable to suppose that children make use of positive data, sentences in ordinary contexts. However, positive evidence can be misleading. For example, a survey of the input to children (see CHILDES, e.g., the transcripts of Adam or Eve) reveals that the overwhelming majority of adult utterances with disjunction are subject to a scalar implicature of exclusivity or, worse, express mutually exclusive alternatives (e.g., *Was it a big yard or a small yard?*). Moreover, it is highly unlikely, as Chierchia (2004) points out, that English-speaking children are informed that the word for disjunction *or* has a different interpretation when it appears in the subject phrase of a sentence with the universal quantifier, as in (8), than it does when it appears in the predicate phrase, as in (10). And, we will see (section 2.4) that Japanese-speaking children initially interpret negative statements with disjunction (*ka* in Japanese) in the same way as English-speaking children. Japanese-speaking adults, by contrast, assign a different interpretation. This means that Japanese-speaking children cannot be relying on the input as the basis for their initial interpretation of negative statements with disjunction. Despite the sometimes misleading positive data, the lack of negative evidence or information about subtle differences in interpretation, and despite cross-linguistic variation in input to children, all normal children reach the same generalizations about the interpretation of sentences with disjunction, namely that the meaning of disjunction is inclusive-or. We summarize some of the empirical evidence for this conclusion starting in section 2.3.

In this introduction, we have described two main approaches to first language acquisition, one emphasizing the contribution of innate knowledge, and the other emphasizing the availability of experience and children's abilities to extract generalizations from the input. Semantic knowledge is a good test case in adjudicating between these alternative approaches. To illustrate, the chapter will describe, in further detail, some principles governing the interpretation of disjunction in human languages. A second item on the agenda is to assess the contribution of logic to human languages, and to determine what's left over—the specific contingent properties of language that influence logical reasoning, but that do not follow from logic. Although there are some clear differences between classical logic and natural language semantics, there are reasons to suppose that logic and human language share some of the same basic meanings, including the meaning of disjunction, e.g., English *or*. We will examine the interplay of logic and language by studying how children and adults interpret disjunction, across languages.

## 2.1. Disjunction in classical logic

In classical logic, the disjunction operator (' $\vee$ ') has the truth conditions associated with inclusive-*or*. Consider a statement of the form  $(A \vee B)$ . Since the disjunction operator has the truth conditions associated with inclusive-*or*,  $(A \vee B)$  is true in three cases: if A is true but not B ( $A, \neg B$ ), if B is true but not A ( $B, \neg A$ ), and if both A and B are true ( $A, B$ ). A statement of the form  $(A \vee B)$  is false only if both A and B are false ( $\neg A, \neg B$ ). The negation of the original statement is true just in those cases in which the original statement is

false. Therefore,  $\neg(A \vee B)$  is true in just one case, when both A and B are false ( $\neg A, \neg B$ ). It follows that  $\neg(A \vee B)$  logically entails  $(\neg A \wedge \neg B)$ , where ‘ $\wedge$ ’ is logical conjunction. This yields one of De Morgan’s laws:  $\neg(A \vee B) \Rightarrow (\neg A \wedge \neg B)$ . The critical point is that this law assumes that disjunction is inclusive-*or*.

## 2.2. Disjunction in human languages

Turning to human languages, one way to examine the interplay of logic and language is to ask whether or not child and adult speakers of human languages assign the inclusive-*or* interpretation to words that express disjunction in human languages (e.g., English *or*; Japanese *ka*; Chinese *huozhe*). It will be instructive to look at statements that correspond to the logical statements we just discussed:  $(A \vee B)$ , and  $\neg(A \vee B)$ . In both cases, the question is whether or not child and adult speakers judge statements like these, when they are expressed in human languages, to be true in the same circumstances as the corresponding logical statements. If so, then disjunction in human languages is also inclusive-*or*. In particular, we saw that, in the case of classical logic,  $\neg(A \vee B)$  is true only if both A and B are false:  $(\neg A \wedge \neg B)$ . We will call this the ‘conjunctive entailment’ of disjunction under negation. In recent research, we have adopted the research strategy of identifying linguistic constructions in human languages in which (a) disjunction appears under negation (and other expressions), and which language users judge to have truth conditions corresponding to the conjunctive entailment. This research strategy has proven extremely productive in both cross-linguistic research and in research in child language. We will review some of the main discoveries.

We begin with the human language counterparts to statements of the form  $(A \vee B)$ . Suppose you and a friend have just seen Max order some sushi and some pasta. Later you overhear your friend tell someone “Max ordered sushi or pasta.” Would you contradict your friend, saying “No, that’s wrong. Max ordered sushi *and* pasta.”? That’s what adult speakers of English would do, but child speakers would not do this. For young children, “Max ordered sushi or pasta” correctly describes the case where Max ordered both. Since classical logic statements of the form  $A \vee B$  include the possibility of both A and B, child speakers of English appear to be more logical than adult speakers. As children grow up, their decisions change about when “or” is appropriate, because their interpretation of “or” clashes with how adult speakers use the term. But the difference in meaning between disjunction in formal logic and in English emerges late in language development.

Much early research on child and adult language reached a different conclusion about children’s interpretation of disjunction. The findings from several studies were interpreted as showing that children assign the truth conditions associated with exclusive-*or* ( $A \vee B$ , but not both) to disjunction in human languages. For example, Braine & Romain (1983: 291) acknowledge the view that “equates *or* with standard logic,” yet they ultimately reject this view on the grounds that “coherent judgments of the truth of *or*-statements emerge relatively late and are not universal in adults.” The conclusion that children and adults assign the exclusive-*or* interpretation to disjunctive statements is unwarranted, however, because it rests largely on tasks that involve requests to perform actions. For example, in an experiment reported in Braine & Romain (1981), children were instructed to “pick a red balloon or a blue balloon.” The finding was that children generally picked either a red balloon or a blue balloon, but few children picked both—although such ‘conjunctive’ truth-conditions verify statements with disjunction in classical logic. But this



kind of research methodology has limited value in determining the full range of truth conditions that are associated with a linguistic expression. At most, a task in which subjects act out instructions provides evidence that the subjects' grammars allow one interpretation (the one that is acted out), but the findings from such a task cannot be used to infer that other interpretations are not available to them. Children (and adults) may simply favour certain one reading over others in the experimental context. The following section provides ample evidence, from recent research, that children interpret disjunction as inclusive-or, as in classical logic (see Crain 2008; Crain & Khlentzos 2008).

### 2.3. The implicature of exclusivity

(For background, see article 63 (Herburger) *Negation* and article 87 (Chierchia, Fox & Spector) *Grammatical view of scalar implicatures*.) Why do adults understand *or* differently than children do? For adults, simple affirmative sentences of the form *A or B* are subject to an implicature of exclusivity. That is, the use of *or* usually implies 'not both', although it does not entail it. For adults, then, a simple statement of the form *A or B* is pragmatically odd (or infelicitous) as a description of a situation in which both *A* and *B* are true. This is why the use of *or* by adult speakers does not appear to conform to classical logic. But appearances can be deceiving. The implicature of 'exclusivity' stems from the availability of another statement, namely *A and B*, which is more informative. *A and B* is more informative than *A or B*, because *A and B* is true in only one set of circumstances, whereas *A or B* is true in other circumstances as well as in the circumstance in which *A* and *B* are both true, namely circumstances in which either *A* or *B* is true, but not both. Due to this overlap of truth conditions, the expressions *or* and *and* form a scale, based on information strength, with *and* being more informative (i.e., stronger) than *or*. A pragmatic principle *Be Cooperative* (cf. Grice 1975) entreats speakers to be as informative as possible. Upon hearing someone use the less informative (weaker) term on the scale, *or*, listeners assume that the speaker was being cooperative and they infer that the speaker was not in position to use the stronger term *and*. If listeners believe, in addition, that the speaker is informed about the truth or falsity of the stronger term, then the speaker's selection of the weaker term is taken to imply the negation of the stronger term: *not both A and B*. In short, adult use of *or* is governed by a *scalar implicature* of exclusivity. So, adults avoid using *A or B* in situations in which both *A* and *B* are clearly true. Consequently, the vast majority of children's experience is consistent with the conclusion that natural language disjunction is exclusive-or, not inclusive-or (see Crain, Goro & Thornton 2006).

In contrast to adults, children younger than six or seven apparently do not compute scalar implicatures for sentences with *or* (Chierchia et al. 1998; Chierchia et al. 2001; Chierchia et al. 2004; Guasti et al. 2005; Noveck 2001; Papafragou & Musolino 2003). Because of young children's lack of sensitivity to scalar implicatures, considerable evidence has been amassed in favor of the conclusion that young children interpret *or* as the inclusive-or of classical logic, both in contexts where adults enforce an implicature of exclusivity, and in contexts where adults interpret *or* as inclusive-or. This makes it look as though children are more logical than adults. But the real moral to draw is simply that adults compute scalar implicatures in situations where children do not.

So the basic storyline for disjunction in human languages is as follows. Both children and adults assign the truth conditions of inclusive-or to ordinary statements with disjunction.

In many contexts, however, some of the truth conditions associated with inclusive-*or* are eliminated due to a scalar implicature of exclusivity. The implicature is well in place for adults. This means that the input to children is most often consistent with an exclusive-*or* reading. The fact that children do not interpret disjunction as exclusive-*or*, despite the input from adults, suggests that the only available meaning for children is the one associated with inclusive-*or*. Why isn't the interpretation associated with exclusive-*or* available to children? One proposal is that children's knowledge that disjunction is inclusive-*or* comes from universal grammar, taking universal grammar to be a theory of the initial state of language acquisition. Universal grammar contains the linguistic principles that all languages share and all language learners draw upon in the course of language development. On this scenario, children 'project' the interpretation of inclusive-*or* onto human language, regardless of the input, rather than 'inferring' the meaning of disjunction on the basis of experience.

## 2.4. Disjunction in the scope of (non-local) negation

There is further evidence that both children and adults interpret disjunction as inclusive-*or*, as in classical logic. This evidence comes from studies of linguistic constructions in which disjunction appears in negative statements, i.e., the human language counterparts to  $\neg(A \vee B)$  in classical logic. Suppose you and your friend were watching Max order lunch. This time, suppose Max didn't order sushi and he didn't order pasta. Later you overhear your friend tell someone "Max didn't order sushi or pasta." Would you agree with your friend? That's what adult speakers of English would do, and that's what child English-speakers would do. And textbooks of logic would agree. In classical logic  $\neg(A \vee B)$  excludes the possibility of A and the possibility of B. And in English, the statement *Max didn't order sushi or pasta* excludes the possibility that Max ordered sushi and the possibility that Max ordered pasta. So, it looks like English disjunction generates a conjunctive entailment when it appears under local negation, as in one of De Morgan's laws:  $\neg(A \vee B) \Rightarrow (\neg A \wedge \neg B)$ . Since this law assumes that disjunction is inclusive-*or*, this is a reason for concluding that English disjunction is inclusive-*or*.

Why aren't English-speakers' judgments influenced by an implicature of exclusivity in interpreting sentences like (11) *Max didn't order sushi or pasta*? To answer this, compare this to (12) *Max didn't order sushi and pasta*, where *or* has been replaced by *and*.

(11) Max didn't order sushi or pasta.

(12) Max didn't order sushi and pasta. (Just pasta. / Just sushi. / In fact, neither one.)

Adults judge (12) to be true in various different circumstances, as indicated by the possible follow up parenthetical comments. By contrast, (11) is judged to be true in only one set of circumstances, where Max ordered neither sushi nor pasta. In fact, (11) is true in a subset of the circumstances that verify (12). So negation reverses the subset/superset relation of truth conditions that hold for statements with *or* and *and* in positive statements. In the scope of negation, the use of *or* makes a stronger statement than the corresponding statement with *and*. Under negation, therefore, there is no implicature of exclusivity for *or*.

There is another distinction to be drawn. In (11), the negation and disjunction operators, *n't* and *or*, appear in the same clause. In (13), negation and disjunction are in different clauses.

- (13) Utako didn't see Max eat sushi or pasta.  
 a. Utako didn't see Max eat sushi *and* she didn't see him eat pasta  
 b. \*Utako didn't see Max eat sushi *or* she didn't see him eat pasta

In (13), the clause that contains disjunction, ... *Max eat sushi or pasta*, is embedded in the clause with negation. Semantically, the critical observation is that (13) generates a conjunctive entailment, as indicated in (13a); it does not have the 'disjunctive' truth conditions indicated in (13b). When (13) is translated into Japanese, Chinese, Russian, and so forth, its variants in these other languages also carry a conjunctive entailments. Here are further examples from (a) English *or*, (b) Chinese *huozhe*, and (c) Japanese *ka*. In each case, the statement with disjunction generates a conjunctive entailment.

- (14) a. *Mary didn't say*  $s$ [*John speaks French or Spanish*]  
 b. *Mali meiyou shuo-guo*  $s$ [*Yuehan hui shuo fayu huozhe xibanyayu*]  
    *Mary not say-PAST John can speak French or Spanish*  
 c. *Mary-wa*  $s$  [*John-ga French ka Spanish-wo hanas-u*]-to *iwa-nakat-ta*  
    *Mary-TOP John-SUBJ French or Spanish-OBJ speak-COMP say-not-PAST*

As these examples illustrate, in certain linguistic constructions in which negation appears in a higher clause than the clause that contains disjunction, i.e., *not*  $s$ [*A or B*], the corresponding statements are interpreted as excluding the possibility of both A and B. As the examples in (14) indicate, this phenomena appears in typologically different languages.

Notice that in the Japanese example, (14c), the statement takes a different form; [*A or B*] $s$  *not*, rather than *not*  $s$ [*A or B*]. This is because Japanese is verb-final and negation is attached to the verb. Nevertheless, the Japanese example has the same truth conditions as the examples from English and Chinese. It makes no difference that the disjunction operator, *ka*, precedes negation in Japanese, whereas *or* and *huozhe* follow negation in the English and Chinese examples. This shows that the interpretation of disjunction does not depend on linear order; what matters is constituent structure. In any event, we may now derive a candidate for consideration as a linguistic universal:

- I. When disjunction appears in a lower clause than negation, it licenses a conjunctive entailment

This principle needs further refinement to exclude so-called intervention effects. For example, if a universal quantifier intervenes between negation and disjunction, it may interfere with the interpretive relationship that would otherwise hold. Nevertheless, in constructions without such interveners, such as (14), speakers of typologically distinct languages interpret disjunction as licensing a conjunctive entailment. And this reinforces the conclusion that disjunction has the truth conditions associated with inclusive-*or* in (perhaps all) human languages.

### 3. Disjunction in human languages: A parameter

You may be wondering why we didn't derive the universal principle using simple negative sentences such as *Max didn't eat sushi or pasta*, with negation and disjunction in the same clause. After all, this sentence also licenses a conjunctive entailment that Max didn't eat

sushi and Max didn't eat pasta. The problem is that, if we translate the English into Japanese, Russian, or Chinese, the corresponding sentences do not generate a conjunctive entailment. Example (15) illustrates, in Japanese. Adult speakers of Japanese typically interpret (15) to mean that the pig didn't eat the carrot or didn't eat the pepper. Despite the appearance of the disjunction operator *ka* under local negation in the surface syntax, *ka* is interpreted as if it has scope over negation.

- (15) *Butasan-wa ninjin ka pi'iman-wo tabe-nakat-ta*  
 pig-TOP pepper or carrot-ACC eat-NEG-PAST  
 Literally: 'The pig didn't eat the pepper or the carrot'  
 Meaning: 'The pig didn't eat the pepper *or* the pig didn't eat the carrot'

Pursuing a suggestion by Szabolcsi (2002), Goro (2004) proposed that languages are partitioned into classes by a 'parameter.' According to this parameter, the disjunction operator is a *positive polarity item* (like English *some*) in one class of languages (including Japanese and Russian, among others), but disjunction is not a positive polarity item in another class of languages (including English and German, among others). By definition, a positive polarity item must be interpreted as if it were positioned outside the scope of negation (OR > NEG), rather than in the scope of negation (NEG > OR). The Japanese/Russian setting of the parameter is (OR > NEG), so a paraphrase of (15) would be: *it is a carrot or a pepper that the pig didn't eat*. On this parameter setting, negation does not influence the interpretation of disjunction, so *or* makes a weaker statement than the corresponding statement with *and*. Since *or* and *and* form a scale, with *or* being the weaker term on the scale, the implicature of exclusivity induces Japanese speakers to assume the denial of the stronger term on the scale, resulting in the "not both" reading of *ka* in (15). So Japanese speaking adults interpret (15) to imply that the pig ate either a carrot or a pepper, but not both. On the English/German setting of the parameter (NEG > OR), disjunction is interpreted under negation, so (15) would be paraphrased in English as *the pig didn't eat a carrot or a pepper*. In this case, negation reverses the scale, making *or* stronger than *and*, such that a conjunctive entailment is generated, and no implicature is raised.

Based on considerations of language learnability, Goro (2004) made an intriguing prediction—that young Japanese-speaking children would initially generate a conjunctive entailment in simple negative disjunctive sentences, in contrast to adult speakers of Japanese. The prediction was based on the observation that the two settings of the parameter are in a subset/superset relation. Setting aside the implicature of exclusivity, on the Japanese/Russian setting of the parameter, (15) is (logically) true in three different sets of circumstances: when the pig didn't eat a carrot, but did eat a pepper, when it didn't eat a pepper, but did eat a carrot, and when it didn't eat either one. These are the circumstances associated with the inclusive-*or* interpretation of disjunction when disjunction takes scope over negation (OR > NEG). On the English/German setting of the parameter, negation takes scope over disjunction (NEG > OR). On this setting, (15) is true in just one of set of circumstances, namely ones in which the pig didn't eat either a carrot or a pepper. This parameter setting also invokes the inclusive-*or* interpretation of disjunction. This means that disjunction has the inclusive-*or* interpretation on both settings of the parameter. What changes, according to the setting of the parameter, is the scope relations between disjunction and negation.

Notice that one setting of the parameter (NEG > OR; English/German) makes the statement of (15) true in a subset of the circumstances corresponding to the other setting

(OR > NEG; Japanese/Russian). The *semantic subset principle* dictates that, whenever parameter values are in a subset/superset relation, the *language acquisition device* compels children to initially select the subset value (Crain, Ni & Conway 1994). The semantic subset principle anticipates that the subset reading (NEG > OR; English/German) will be children's initial setting (i.e., the default). Based on this line of reasoning, Goro (2004) predicted that children learning Japanese would initially interpret (15) in the same way as English-speaking children and adults. The prediction was confirmed in an experimental investigation of 4- and 5-year-old Japanese-speaking children by Goro & Akiba (2004). They found that young Japanese-speaking children consistently licensed a conjunctive entailment in response to statements like (15). This finding reinforces the conclusion that human languages invoke the inclusive-*or* meaning of disjunction, as in classical logic (Crain, Goro & Thornton 2006).

## 4. Disjunction and downward entailing expressions

### 4.1. Disjunction and the universal quantifier

The universal quantifier *every*, and its variants in other languages, are just one of dozens of linguistic expressions that license a conjunctive entailment when disjunction appears in their scope. The group of expressions are known as *downward entailing* operators (again, see article 63 (Herburger) *Negation* and article 87 (Chierchia, Fox & Spector) *Grammatical view of scalar implicatures* for background.) An operator is downward entailing if it guarantees the validity of an inference from general statements to more specific statements. The examples in (16) illustrate three expressions that have this defining property of downward entailment, since it is valid to substitute claims about sets (speaking a Romance language) with claims about subsets of the original set (speaking French, speaking Spanish, speaking Italian ...). Example (16a) shows that the subject phrase of the universal quantifier *every* is downward entailing. Similarly, the antecedent of a conditional statement may be downward entailing, as shown in (16b), and so is the preposition *before*, as illustrated in (16c).

- (16) a. Every student who speaks a Romance language likes to travel.  
       ⇒ *every student who speaks French likes to travel*  
       b. If a student speaks a Romance language, she likes to travel  
       ⇒ *if a student speaks French, she likes to travel*  
       c. John went to Europe before learning a Romance language.  
       ⇒ *John went to Europe before learning French.*

Another diagnostic of downward entailment is the licensing of certain negative polarity items, such as *ever*, *any* and *at all*. The examples in (17a)–(19a) illustrate that *any* is welcome in the subject phrase (Restrictor) of the universal quantifier *every*, in the antecedent of a conditional statement, and following the preposition *before*. Examples (17b)–(19b) show, however, that *any* is not licensed in the predicate phrase (Nuclear Scope) of the universal quantifier *every*, or in the consequent clause of conditional statements, or following the preposition *after*. Such asymmetries are potentially problematic for language learners.

- (17) a. Every linguist who agreed with **any** philosopher is in this room.  
       b. \* Every linguist who is in this room agreed with **any** philosopher.

- (18) a. If **any** linguist enters the gym, then Geoff leaves.  
 b. \* If Geoff leaves, then **any** linguist enters the gym.
- (19) a. Geoff went to the gym before **any** linguist.  
 b. \* Geoff went to the gym after **any** linguist.

We have already witnessed another property of downward entailing operators, one that pertains to the interpretation of disjunction. In the scope of a downward entailing operator, disjunction licenses a conjunctive entailment (Boster & Crain 1994; Chierchia 2004; Crain, Gualmini & Pietroski 2005; Crain & Khlentzos 2008). Example (20) shows that *or* generates a conjunctive entailment in the subject phrase (Restrictor) of the universal quantifier *every*; (21) shows that the antecedent of a conditional yields a conjunctive entailment; and (22) shows that a conjunctive entailment is generated by the preposition *before*.

- (20) a. Every student who speaks French or Spanish passed the exam.  
 b.  $\Rightarrow$  every student who speaks French passed the exam **and**  
 every student who speaks Spanish passed the exam
- (21) a. If Ted **or** Kyle enters the gym, then Geoff leaves.  
 b.  $\Rightarrow$  if Ted enters the gym, then Geoff leaves **and**  
 if Kyle enters the gym, then Geoff leaves
- (22) a. Geoff went to the gym before Ted **or** Kyle.  
 b.  $\Rightarrow$  Geoff went to the gym before Ted **and**  
 Geoff went to the gym before Kyle

It is likely that all human languages exhibit the same linguistic behaviour. Example (23) is an example in which the Chinese disjunction operator *huozhe* licenses a conjunctive entailment when it appears in the subject phrase of the universal quantifier *meige*; (24) is the Japanese counterpart to (23).

- (23) Meige [hui shuo fayu huozhe xibanyayu de] xuesheng dou tongguo-le kaoshi  
 every canspeak French or Spanish DEstudent DOU pass-Perf exam  
 'Every student who speaks French or Spanish passed the exam'
- (24) [French *ka* Spanish-wo hanasu] dono gakusei-mo gougakushi-ta  
 French or Spanish-ACC speak every student pass-exam-past  
 'Every student who speaks French or Spanish passed the exam'

Based on crosslinguistic research, a second linguistic universal can be put forward:

## II. Disjunction licenses conjunctive entailments in the scope of downward entailing expressions

By contrast, conjunctive entailments are **not** generated for disjunction when it appears in positions where *any* is not tolerated. To take just one example, a conjunctive entailment is

not generated when disjunction is in the predicate phrase of the universal quantifier *every*, as in (25). To see this, notice that (25a) and (25b) are not contradictory, as would be the case if (25a) made a conjunctive entailment. Similarly, there is no conjunctive entailment of *or* when it is in the consequent clause of conditionals, or when it follows the preposition *after*. In all of these linguistic contexts, the disjunction operator *or* carries an implicature of exclusivity.

- (25) a. Every student who passed the exam speaks French **or** Spanish.  
 b. every student who passed the exam speaks French or Spanish, but no one speaks both languages  
 c. \*  $\Rightarrow$  every student who passed the exam speaks French **and** every student who passed the exam speaks Spanish

We now turn to the literature on child language. Several studies have investigated the truth conditions children associate with disjunction in the subject phrase and in the predicate phrase of the universal quantifier (e.g., Boster & Crain 1994; Gualmini, Meroni & Crain 2003). Using the Truth Value Judgment task, children were asked to evaluate sentences like those in (26) and (27), produced by a puppet, Kermit the Frog.

(26) Every woman bought eggs or bananas.

(27) Every woman who bought eggs or bananas got a basket.

In one condition, sentences like (26) were presented to children in a context in which some of the women bought eggs, but none of them bought bananas. The child subjects consistently accepted test sentences like (27) in this condition, showing that they assigned a 'disjunctive' interpretation to *or* in the subject phrase of the universal quantifier, *every*. In a second condition, children were presented with sentences like (27) in a context in which women who bought eggs received a basket, but not women who bought bananas. The child subjects consistently rejected the test sentences in this condition. This finding is taken as evidence that children generated a conjunctive entailment for disjunction in the subject phrase of *every*. This asymmetry in children's responses in the two conditions demonstrates their knowledge of the asymmetry in the two grammatical structures associated with the universal quantifier—the subject phrase and the predicate phrase. Taken together, the findings are compelling evidence that children know that the subject phrase of *every* is downward entailing, but not its predicate phrase. In addition, the findings are consistent with the analysis of disjunction according to which (a) disjunction has a basic meaning of inclusive-or, and receives a 'derived' meaning due to a scalar implicature of exclusivity. The findings represent a challenge to the experience-dependent approach to language acquisition. It is conceivable that children could master the facts about the distribution of negative polarity items, such as *any*, based on statistical properties of the input. Even so, children would need to be exceedingly careful record keepers to demarcate the linguistic environments that license such items, to avoid producing them in illicit environments.

A greater challenge is posed by the asymmetry in the interpretation of disjunction *or* in the subject phrase (Restrictor) versus the predicate phrase (Nuclear Scope) of the universal quantifier, since the distinction is one of interpretation, not the distribution, of lexical items (see Chierchia 2004). The problem of record keeping is further escalated in



more complex sentences, such as negated universals. Under negation, the interpretations of disjunction in the two arguments of the universal quantifier are reversed, such that *or* yields a conjunctive interpretation in the predicate phrase of *every*, but not in subject phrase. This is a straightforward consequence of the meanings of the relevant logical expressions in first order logic. Again, these facts about the interpretation of sentences with such combinations of logical words (negation, the universal quantifier, and disjunction) are manifested in typologically different languages, such as English, Japanese, and Chinese. To illustrate, examples (20), (23) and (24) were used as evidence that disjunction licences a conjunctive entailment, across languages, when it appears in the subject phrase of a universal quantifier, as for example, in (20) *Every student who speaks French or Spanish passed the exam*. However, when (20) is negated, the conjunctive entailment is no longer licensed, so *Not every student who speaks French or Spanish passed the exam* does not entail that (a) not every student who speaks French passed the exam *and* (b) not every student who speaks Spanish passed the exam. We also saw that disjunction fails to licence a conjunctive entailment when it appears in the predicate phrase of a universal quantifier, as in example (25) *Every student who passed the exam speaks French or Spanish*. Under negation, however, disjunction does generate a conjunctive entailment, so *Not every student who passed the exam speaks French or Spanish* means that some student passed the exam but does not speak either French or Spanish (i.e., the student does not speak French *and* does not speak Spanish). These reversals of entailments follow straightforwardly from first order logic (see Crain & Khlentzos 2008; Crain, Thornton & Khlentzos 2009). They also make the point that the semantic contribution of logical words depends on the linguistic environment; they did not exhibit stable discourse or communicative functions. Unless human children are innately endowed with knowledge about the meanings of logical words, they would have to be excellent record-keepers indeed to master such complex linguistic facts. The next section illustrates another linguistic phenomenon in which the meaning of disjunction is not readily apparent in the input children experience.

## 4.2. Disjunction in the scope of “only”

Further confirmation that natural language disjunction is inclusive-*or* comes from studies of how speakers of English, Japanese, and Chinese interpret disjunction in sentences with certain focus operators: English *only*, Japanese *dake*; Chinese *zhiyou*. The semantic contribution of such focus operators is quite complex. Consider the statement: *Only Bunny Rabbit ate a carrot or a pepper*. This statement expresses two propositions. Following common parlance, one proposition is called the *presupposition* and the other is called the *assertion* (e.g., Horn 1969; 1996). The presupposition is derived simply by deleting the focus expression from the original sentence; this yields *Bunny Rabbit ate a carrot or a pepper*. For many speakers, there is an implicature of exclusivity (‘not both’) in the presupposition. The second proposition is the assertion. The assertion concerns individuals that are not mentioned in the sentence. To derive the assertion, the sentence can be further partitioned into (a) a *focus element* and (b) a *contrast set*. Focus expressions such as *only* are typically associated with a particular linguistic expression somewhere in the sentence. This is the focus element. More often than not, the focus element receives phonological stress. In the sentence *Only Bunny Rabbit ate a carrot or a pepper*, the focus element is *Bunny Rabbit*.



The assertion is about a contrast set. The members of the set are individuals in the domain of discourse that are taken by the speaker and hearer to be alternatives to the focus element. These individuals should be available in the conversational context before the sentence was produced; their existence is presupposed. In the present example, the contrast set consists of individuals being contrasted with *Bunny Rabbit*. The sentence would not be felicitous in the absence of this contrast set. The assertion states that the members of the contrast set *lack* the property being attributed to the focus element. In *Only Bunny Rabbit ate a carrot or a pepper*, the assertion is the following claim: *everyone else (being contrasted with Bunny Rabbit) did not eat a carrot or a pepper*. The critical point is that the assertion contains disjunction in the scope of (local) a downward entailing operator, e.g., negation or its semantic equivalent. Because disjunction appears under a downward entailing operator in the assertion, a conjunctive entailment is licensed: *everyone else (being contrasted with Bunny Rabbit) didn't eat a carrot and they didn't eat a pepper*. Japanese sentences with the focus expression *dake* are analysed in the same way, as in (28).

- (28) Only Bunny Rabbit ate a carrot or a pepper.  
 Usagichan-dake-ga ninjin ka piiman-wo taberu-yo.  
 rabbit-only-NOM carrot or green pepper-ACC eat-dec  
 a. *Presupposition*: Bunny Rabbit ate a carrot or a pepper  
 b. *Assertion*: Everyone else (being contrasted with Bunny Rabbit) did not eat a carrot or a pepper

The interpretation of *or* by English- and Japanese-speaking children was used to assess their knowledge of the semantics of *only* in a series of experiments by Goro, Minai & Crain (2005, 2006). In one experiment, twenty-one English-speaking children (mean age = 5;0) and twenty Japanese-speaking children (mean age = 5;4) participated. To see if children assign ‘disjunctive’ truth conditions to *or* in the presupposition of sentences with *only/dake*, the test sentences were presented in a situation in which Bunny Rabbit ate a carrot but not a pepper. The other characters in the story, Winnie the Pooh and Cookie Monster, did not eat a carrot or a pepper. The truth conditions are summarized in (29).

(29) *Condition I*

|                 | Carrot | Pepper |
|-----------------|--------|--------|
| Winnie the Pooh | *      | *      |
| Bunny Rabbit    | √      | *      |
| Cookie Monster  | *      | *      |

To see if children generate a conjunctive entailment in the assertion of sentences with *only/dake*, the test sentences were presented (to different children) in the situation represented in (30). As in Condition I, Bunny Rabbit ate a carrot but not a pepper. But in Condition II, Cookie Monster ate a pepper. Because “only” is downward entailing in the assertion, the sentence in (28) is expected to generate a conjunctive entailment—that

everyone else (being contrasted with Bunny Rabbit) did not eat a carrot *and* did not eat a pepper. Therefore, children were expected to reject the test sentences Condition II, on the grounds that Cookie Monster ate a pepper.

(30) *Condition II*

|                 | Carrot | Green pepper |
|-----------------|--------|--------------|
| Winnie the Pooh | *      | *            |
| Bunny Rabbit    | √      | *            |
| Cookie Monster  | *      | √            |

Children responded exactly as predicted. In Condition I, both English-speaking children and Japanese-speaking children accepted the test sentences over 90% of the time. The high acceptance rate in Condition I suggests that children assigned disjunctive (*not both*) truth conditions to *or* in the presupposition. In contrast, the same children rejected the test sentences in Condition II over 90% of the time. (Adult controls accepted Condition I sentences 100% of the time and rejected Condition II sentences 100% of the time in both languages.) The high rejection rate by children in Condition II suggests that they know that the disjunction operator *or* creates conjunctive entailments in the assertion of sentences with *only/dake*. The findings invite the inference that children have adult-like knowledge about the semantics of *only/dake*, and are able to compute its complex semantic interaction with disjunction. Similar experiments have been conducted with Chinese-speaking children, with the same pattern of results (Jing, Crain & Hsu 2006).

It is likely that sentences with disjunction in the scope of certain focus expressions generate conjunctive entailments in all natural languages, so we can advance a third linguistic universal:

III. Disjunction generates a conjunctive entailment in the assertion of certain focus expressions

Here is an example from Chinese, where the focus expressions is *zhijyou* and the disjunction operator is *huozhe*. Example (31) entails that everyone else (being contrasted with John) does not speak French and does not speak Spanish.

- (31) *zhijyou Yuanhan hui shuo fayu huozhe xibanyayu*  
only John can speak French or Spanish

Recall that in Japanese and Chinese the translation of a simple negative statement with disjunction (e.g., *Max didn't order sushi or pasta*) does not generate a conjunctive interpretation (see section 2.4). Rather, adult speakers of these languages judge the corresponding sentences to mean that Ted didn't order sushi *or* Ted didn't order pasta. The same is true for the sentences that constitute the assertion in (28). Example (28) is *Only Bunny Rabbit ate a carrot or a green pepper*. The corresponding assertion is *Everyone else*

*did not eat a carrot or a green pepper*. However, if adult speakers of Chinese or Japanese overtly produce sentences corresponding to the English sentence *Everyone else did not eat a carrot or a green pepper*, these sentences do not have the same meaning as the English sentence. In contrast to the English sentence, the corresponding Japanese sentence (32) and the Chinese sentence (33) do not generate a conjunctive interpretation, because these are simple negative statements, with disjunction and negation in the same clause (see section 3). The sentences (32)–(33) mean that everyone else didn't eat a carrot *or* didn't eat a green pepper.

(32) Japanese:

*Usagichan igai-no zen'in-ga ninjin ka piiman-wo tabe-nakat-ta.*

Rabbit except-GEN everyone-NOM carrot or pepper-ACC eat-NEG-PAST

'Everyone except Bunny Rabbit didn't eat a carrot OR didn't eat a green pepper'

(33) Chinese:

*Chule tuzi zhiwai de suoyou dongwu dou meiyou chi huluobo huozhe qingjiao.*

Except rabbit DE every animal all not eat carrot or pepper

'Everyone except Bunny Rabbit didn't eat a carrot OR didn't eat a green pepper'

The 'disjunctive' interpretation of (32)–(33) may seem paradoxical because, as we saw, the assertion associated with (28) generates a conjunctive interpretation in Japanese and Chinese, just as it does in English. In all three languages, the assertion is the proposition that everybody else did not eat a carrot *and* everybody else did not eat a green pepper. But, making the assertion overt changes its meaning in Chinese and Japanese, cancelling the conjunctive interpretation of disjunction. Consequently, adult speakers of Chinese and Japanese are hard-pressed to overtly instruct children about the meaning of the assertion component of sentences with focus expressions. It also follows from this that evidence for the interpretation of disjunction as inclusive-*or* is even harder to come by for Chinese-speaking children and Japanese-speaking children, as compared to English-speaking children. For English-speaking children, the fact that disjunction generates a conjunctive interpretation under local negation could be used as evidence that disjunction is inclusive-*or*, although negative statements with disjunction are rare in adult speech to children (Crain & Khlentzos 2008). It is striking, therefore, that Japanese-speaking children (and adults) generate a conjunctive interpretation for disjunction in the assertion of sentences with *dake*, and Chinese-speaking children (and adults) generate a conjunctive interpretation for disjunction in the assertion of sentences with *zhiyou*. The findings from studies of Japanese-speaking children further reinforce the conclusion that disjunction is innately specified as inclusive-*or*. In fact, there is no evidence of an effect of input on the acquisition of disjunction in any language, at any age. Experience-dependent accounts of language acquisition (e.g., Ambridge & Lieven 2011; Goldberg 2003, 2006; Tomasello 2000, 2003) owe us an explanation of this uniformity across languages. Such accounts also owe us an explanation of how the dual interpretations of disjunction arise in sentences with the focus operators like *only/dake/zhiyou*.

## 5. Loose ends and conclusions

There are two loose ends to tie up. In describing the relation between negation and disjunction, the term "scope" has been used rather loosely. Scope is a structural property that

cuts across all of the phenomena we have been discussing. In human languages, scope is defined as c-command. (An expression A c-commands an expression B in a phrase structure diagram if there is a path that extends above A to the first branching node, and then proceeds down to B.) In order for disjunctive statements to license conjunctive entailments, disjunction must appear in the scope (c-command domain) of a ‘nearby’ downward entailing operator. And in order to license negative polarity items, the downward entailing expression must c-command the position where the negative polarity item is introduced. The general idea can be seen by comparing examples like (34) and (35). Disjunction resides in the scope of the negative expression *not* in (34) but in (35) *not* is embedded in a relative clause (... *who did not go to bed*) so negation fails to have scope over disjunction. This difference in structure results in a difference in interpretation. Example (34) generates a conjunctive entailment, but (35) does not.

(34) The girl who stayed up late did *not* get a dime *or* a jewel.

(35) The girl who did *not* go to bed got a dime *or* a jewel.

A study by Gualmini & Crain (2005) investigated 5-year-old English-speaking children’s knowledge that c-command is a structural prerequisite for a conjunctive entailment. On one trial in the study, either sentence (34) or (35) was produced by a (wizard) puppet as a description of a story about two girls who had each lost a tooth. One girl went to sleep, but one girl stayed up to see the tooth fairy. The girl who was asleep received both a dime and a jewel from the tooth fairy, but the girl who had stayed awake was only given a jewel. At the end of the story, some children were presented with sentences (34) and others with (35) as descriptions of what had happened in the story. Children accepted sentences like (34) 87% of the time. By contrast, children rejected sentences like (34) 92% of the time, in the same context, on the grounds that the girl who stayed up late had only received a jewel. It is evident that, in the grammars of these children, (34) licenses a conjunctive entailment—the girl who stayed up did not receive a dime *and* did not receive a jewel. Again, this entailment hinges on disjunction being interpreted as inclusive-*or*.

There is one loose end remaining. The findings reported in this chapter invite the conclusion that children know that natural language disjunction is inclusive-*or*, as in classical logic. This may give the impression that human languages and classical logic go hand in hand in universal grammar. While a similar case can be made for conjunction, there are clearly cases, such as material implication, where the correspondence between classical logic and human languages breaks down. And this is just one reason for resisting the conclusion that what is innately specified in the mind/brains of language learners is limited to the conceptual apparatus used in logical reasoning. In fact, there are many specific contingent properties of natural language that are likely candidates for innate specification, but which do not correspond to notions from classical logic. Some of these specific contingent properties of human language are used in the linguistic universals we have proposed. According to these universal principles, disjunctive statements license conjunctive entailments in three linguistic contexts: (a) in the scope of non-local negation, (b) in the assertion of certain focus expressions, and (c) in the scope of downward entailing operators. The first of these contexts invokes a distinction between structures in which disjunction and negation appear in the same clause, and ones in which negation appears in a higher clause than disjunction. If it turns out that aspects of sentence structure (including labelled brackets) are needed to explain when implicatures become engaged or

disengaged, as Chierchia has recently proposed, then this would introduce machinery from language that has no counterpart in classical logic. And, as we saw, one class of natural languages exhibits an inverse scope interpretation (rather than the surface scope relations) in structures in which disjunction (a positive polarity item) and negation appear in the same clause. There is nothing like such inverse scope relations in classical logic. The second principle contrasts the interpretation of disjunction in the presupposition and in the assertion of a focus expression. These contrasting meaning components have no counterparts in logic, although one part of the meaning clearly invokes notions from classical logic. Finally, the third principle maintains that the conjunctive entailment of disjunction is licensed by a host of linguistic expressions, namely ones that are downward entailing, and does not arise simply with negation, as in De Morgan's laws. There are no counterparts in logic to many of these downward entailing expressions. There is more to human languages than logic, though logic plays a major role, as we have tried to demonstrate.

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Stephen Crain, Sydney (Australia)

## 104. Meaning in second language acquisition

1. Introduction
2. Important recent theories of L2A
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4. Two learning situations in the L2A of semantics
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### Abstract

*The article identifies the critical period issue as the fundamental research-generating question in second language acquisition (L2A) theory: namely, is there a critical period after which acquisition of a second language becomes impossible. Recent theoretical answers to this question are presented. A modular view of language architecture suggests that there may be different critical periods for different modules of the grammar and L2A of meaning involves acquiring interpretive mismatches at the L1-L2 syntax-semantics interfaces. In acquiring meaning, learners face two types of learning situations. One situation where the sentence syntax presents less difficulty but different pieces of functional morphology subsume different primitives of meaning is dubbed Simple Syntax—Complex Semantics. Another type of learning situation is exemplified in less frequent, dispreferred or syntactically complex sentences where the sentential semantics offers no mismatch; these are labeled Complex Syntax—Simple Semantics. Two studies representative of these learning situations are reviewed. A third study attests to the unimportance of explicit instruction with respect to some interpretive properties. Implications of these findings for the critical period issue are discussed. The three representative studies reviewed here and numerous other studies on the L2A of meaning point to no visible barrier to ultimate success in the acquisition of phrasal semantics.*

### 1. Introduction

The outcome of first language acquisition (L1A) is a uniform success: at about five or six years of age, normally developed children fully acquire the grammar of the language that surrounds them (see article 103 (Crain) *Meaning in first language acquisition*). Adult second language acquisition (L2A), on the other hand, results in varying degrees of success. Failure to acquire the target language grammar is not atypical. This well known contrast has been amply documented (e.g., Johnson & Newport 1989; Sorace 1993, among many others). Striving to explain this difference in ultimate attainment has been rightfully promoted to the forefront of L2A research and has engendered much debate.

The contrast in ultimate attainment has mostly been associated with age. The Critical Period Hypothesis (CPH) (Penfield & Roberts 1959; Lenneberg 1967) gives a reasonable explanation for the facts of L1 and L2 acquisition. In its most succinct formulation, it states that there is a limited developmental period during which it is possible to learn new languages to normal, native-like levels. Once this window of opportunity has closed, however, the ability to acquire language declines (for recent surveys, see Hyltenstam & Abrahamsson 2003; DeKeyser & Larsen-Hall 2005; Birdsong 2005).

It is also relatively well established that failure to engage the “language acquisition device” in children through exposure to meaningful input (due to deprivation or isolation) results in severe linguistic deficits that cannot be overcome by subsequent exposure to language. Cumulatively, these data point to the conclusion that the human brain is particularly adapted for language acquisition during an early period of life and, if this window was not utilized, slight to severe divergence from native norm ensues.

However, as Lenneberg (1967: 176) himself acknowledges, it is not entirely obvious how the CPH relates to L2A, since L2 acquirers already have a native language and the language centers in the brain have been activated in the opportune window. Thus in L2A, it is probably more appropriate to consider age-related effects rather than a critical cut-off point, past which it is impossible to achieve native-like proficiency (see Birdsong 2005 for many explicit arguments in favor of this idea).

The age variable examined in L2A studies is usually the age of first exposure to the L2 (or age of acquisition, AoA). In studies of immigrant populations, this is typically indexed by the learner’s age of arrival in the host country. Nowadays, researchers of the CP within L2A fall roughly into two camps: those arguing for the “robustness” of CP effects (DeKeyser 2000; Johnson & Newport 1989; McDonald 2000; Newport 1990) and those who claim that there is no real cut-off point for language acquisition abilities but there are age effects that persist throughout life (Birdsong 2005; Birdsong & Molis 2001; Flege 1999; Hakuta, Bialystok & Wiley 2003).

Another important idea has gained a lot of support recently: there is not just one but multiple critical periods for language acquisition. More specifically, there are differential age-related effects for different parts of grammatical competence. For example, Eubank & Gregg (1999) proposes that critical or sensitive periods affect various areas of linguistic knowledge differently (i.e., phonology, syntax, lexicon, etc.) and even subcomponents of these modules (e.g., lexical items, inflections, syntactic effects of abstract features). Lee & Schachter (1997) suggests that principles of UG (e.g., binding, subadjacency) and parameters have different age-related cut-off points for successful triggering and acquisition. Proposals of this type can be unified under the label Multiple CPH.

In recent years, L2 researchers’ efforts have turned to isolating precisely which linguistic modules, submodules, features, or interface areas are affected, how, and why (see more on this in section 2). This chapter addresses the Multiple CPH by promoting the positive side of the argument (in terms of possibility of acquisition). It will demonstrate not what parts of the grammar *are* subject to age-related effects but what is *not* subject to such effects. It is a very common assumption, articulated in, for example, Paradis (2004: 119) that among the language modules are phonology, morphosyntax, and semantics. Semantics should be viewed as comprising two types of linguistic operations on two levels: lexical semantics and phrasal semantics (Jackendoff 2002, among others). The focus here is on acquisition of phrasal semantics, which, similar to the acquisition of the more subtle syntactic properties that purportedly come from UG, does not present insurmountable difficulty to the L2 learner. Behavioral studies of learners of all levels of proficiency support this view. Based on learners’ success in acquiring interpretive properties, I argue that there is no critical period for acquisition of phrasal semantics. In order to present a comprehensive picture of L2A, acquisition of semantic properties are compared and contrasted to acquisition of morpho-syntactic properties. The Bottleneck Hypothesis brings these findings together and argues that in certain areas of the grammar, namely, functional morphology, learners can expect to encounter enhanced difficulty, in comparison to other

areas such as syntax and phrasal semantics, where they can expect to sail (relatively) free. Lexical entries in the functional lexicon are shown to be *the* bottleneck of L2A, and once their properties are acquired, comprehension of meaning obtains without setbacks.

## 2. Important recent theories of L2A

An important division in recent accounts of L2A derives from the nature of linguistic properties being acquired, which cuts across modules. Researchers distinguish between acquisition of UG *principles*, purportedly active in all languages, and acquisition of *parameters*, points of variation between languages with highly-restricted, theoretically described values. Since research on acquisition of syntax has been central to the field, that's where the main issues have been debated most extensively. Most theoretical questions in the field have been formulated from a syntactocentric point of view. However, in the last ten or twelve years, there has been a surge of new research involving acquisition of interpretation. Most linguistic properties whose acquisition is discussed in this article are located at the syntax-semantics interface.

Subadjacency (a locality constraint on movement) is a linguistic principle tested often in the debate on the CPH. For example, Johnson & Newport (1991) used maturational effects on knowledge of subadjacency to support the possibility that adult L2 grammars may be outside the purview of UG, because they allow violations of a language universal and therefore constitute "wild" or unnatural grammars. However, many alternative linguistic explanations for their subjects' grammars can be advanced, making the claim of adult learners' wild grammars difficult to maintain. Later research on principles, notably that of Kanno (1996, 1998) has successfully established that linguistic principles like the Empty Category Principle are active in the grammar of L2 learners, even if their native language does not exhibit the exact same property that the ECP regulates in the L2.

Nevertheless, successful acquisition of universal linguistic principles cannot strongly support the view that L2 learners have continued access to UG in adulthood. It is impossible to know whether their knowledge comes directly from UG or through their native language. For this reason, most of the research addressing the access to UG issue has focused on the acquisition of parameterized properties and in particular, on learning situations where the L1 and the L2 are assumed to have different parametric values.

Several positions on whether or not adult L2 learners "have access to UG" have been articulated recently. The access to UG metaphor has been accepted to mean that interlanguage grammars are within the hypothesis space of UG, that is, in addition to being regulated by universal principles, they also reveal knowledge of the L2 functional categories, including the L2 values of all formal features. One general position is the Global Impairment view, to borrow a label from White (2003), on which parameter resetting in L2A is fundamentally different from parameter setting in L1A. Proponents of this approach have sought to demonstrate that whenever a cluster of superficially unrelated constructions are ostensibly dependent on a single parameter value, all these constructions appear together in the grammar of children, but not in the grammar of adult L2 learners. That is to say, L2A proceeds construction by construction and is not dependent on underlying parametric choices. Clahsen & Hong (1995) as well as Neeleman & Weerman (1997) make the case for such construction-specific, non-UG-regulated acquisition.

The most recent reincarnation of this view is the Shallow Structure Hypothesis (Clahsen & Felser 2006). The main idea is that in adult native language processing, a lot

of the time, language users employ simpler sentence representations that do not utilize the whole spectrum of grammatical mechanisms like movement of NPs, leaving traces at the original and each intermediate position where they land. Instead, language users rely more on lexical, semantic, and pragmatic information to get a fast parse that saves time but also psycholinguistic resources. It has been argued that these “shallower” representations for comprehension are less-detailed than might be necessary, but they are “good enough” most of the time. Townsend & Bever (2001) call such representations “pseudo-syntax”, a “quick-and-dirty parse”, and argue that high frequency templates with the canonical thematic pattern NVN = actor-action-patient play a major role in forming them, as well as the fast recognition of function words. Coming back to L2A, then, Clahsen & Felser (2006) propose that contrary to what happens in native speakers, the shallow processing available to the human processing system is the only type of processing that L2 learners can engage in. However, this is not a claim about processing only, it is a claim about linguistic representations. The supporting evidence comes from studies on the L2A of filler-gap dependencies. One such study is Marinis et al. (2005), who carried out a self-paced reading task on sentences containing long-distance *wh*-dependencies as in (1):

- (1) The nurse *who* the doctor argued \_\_\_\_\_ that the rude patient had angered \_\_\_\_\_ is refusing to work late.

The native speakers in the Marinis et al. (2005) experiment showed a significant interaction between extraction and phrase type on the crucial segment, indicating that the presence of the intermediate trace (the gap in front of *that* in the example) facilitated the *wh*-phrase integration into the sentence structure. Advanced learners of English with Greek, German, Chinese, or Japanese as native languages did not show such an interaction, thus indicating that they are not sensitive to the intermediate trace. Clahsen & Felser (2006) conclude that advanced L2 learners do not have the same mental representations of long-distance *wh*-questions compared to native speakers, which would constitute a globally impaired grammar.

Another position on the fundamental nature of L2 grammars is the Local Impairment view. In this view, the L2 learners are capable of resetting parameters but under restricted circumstances. The specific claim is that the acquisition of formal features is restricted in some way for L2 learners either because features are permanently “impaired” (Beck 1998), or because L2 learners can only make use of features instantiated in their L1 (Hawkins & Chan 1997; Tsimpli & Roussou 1991). Hawkins & Chan’s (1997) Failed Functional Features Hypotheses states that access to new parametric options as instantiated in functional categories and their associated features are no longer available in L2 acquisition after a critical period, but principles of UG still are. L2 learners may be able to map features from functional categories in their L1 to new L2 morpho-phonological material but will not have access to the functional features of the L2. Hence, L2 learners may use the morphology of the target language but with the feature specifications of their L1. Hawkins & Chan show that advanced Chinese learners of English are able to learn Complementizer Phrase (CP) morphology but are unable to reject subjacency violations because their mental representation does not involve *wh*-operator movement triggered by the features [ $\pm$  *wh*]. In contrast, intermediate Chinese learners were more sensitive to subjacency violations because they were using another operation allowed by their L1. The most recent reincarnation of this view is the Interpretability Hypothesis (Hawkins & Hattori 2006; Tsimpli & Dimitrakopoulou 2007) which makes the claim even more precise: uninterpretable features

that are not transferred from the native language cannot be acquired (unlike interpretable features). The evidence in these studies again comes from comprehension of long-distance *wh*-dependencies and knowledge of resumptive pronouns.

Sorace (2003) advances a third hypothesis: Aspects of grammar that require the integration of syntactic knowledge with other types of information (e.g., pragmatic, semantic, prosodic) are more problematic for L2 learners than properties that require only syntactic knowledge. These former properties may present residual difficulties even at the near-native level. In other words, the vulnerability resides at the syntax-semantics or the syntax-pragmatics interface. This proposal implies terminal inability for near-native speakers to retreat from optionality in production or indeterminacy in their comprehension judgments for properties located at the interfaces. Sorace dubs this The Interface Hypothesis. More recently, however, Sorace & Filiaci (2006) offer an interesting specification of these claims. In testing the syntactic and pragmatic knowledge of English-speaking near-native learners of Italian with respect to pronoun-antecedent ambiguity resolution, Sorace & Filiaci find that the syntactic constraints on pronoun antecedents are indeed observed by their participants. What is non-native-like in their performance is processing strategies, more specifically, a processing principle called Position of Antecedent Strategy. Thus under the evidence of more data, Sorace's earlier representational-deficit account has evolved into a processing-load account.

Finally, the most popular view of adult interlanguage grammars is that learners are indeed capable of engaging new functional categories and of acquiring new interpretable and uninterpretable features (Schwartz & Sprouse 1996; Epstein, Flynn & Martohardjono 1996; Lardiere 1998; Prévost & White 2000, see White 2003, particularly chapter 4 for a review). The most cogent argument of this approach is the demonstration that, while L2 learners may omit functional morphology (e.g., past tense *-ed* in English), they acquire the syntactic reflexes (nominative subject, no verb raising, etc) of the respective functional category (in this case, Tense). For these researchers, the correlation between production of morphology and underlying syntactic structure does not necessarily hold. The challenge to this view is explaining the optional suppliance of functional morphology, the use of default forms, as well as the sometimes indeterminate judgments of even advanced L2 learners. Recent attempts to explain this variability, mostly in L2 production, are the Missing Surface Inflection Hypothesis (Prévost & White 2000), the Prosodic Transfer Hypothesis (Goad & White 2004) and the Feature Re-assembly Hypothesis (Lardiere 2008).

### 3. Assumptions about language architecture and predictions based on them

It is important to review current proposals for the language architecture, with special attention to the syntax-semantics interface, in order to clarify our assumptions on modularity and learning tasks in L2A. The key ideas here are compositionality, a matching procedure between syntactic structure and interpretation, and type-driven interpretive processes. While the content of meaning is the same, different linguistic forms map different natural groupings of meanings. This is particularly clear when we compare grammatical meanings in different languages and how they are assembled in functional morphology. What hosts all the language variation in meaning, then, is the syntax-semantics interface. Thus, linguistic semantics is the study of the interface between conceptual form and linguistic form.

Let us look more closely at the syntax-semantics interface, assuming, for example, the language architecture articulated in Jackendoff (2002). Fairly uncontroversially, syntactic



structure needs to be correlated with semantic structure, however, this correlation is not always trivial. The syntactic processor works with objects like syntactic trees, their constituents and relations: DP, VP, uninterpretable features, etc. The semantic processor operates with events and states, agents and patients, individuals and propositions. The operations at the interface are limited precisely to those structures that need to be correlated and they “do not see” other structures and operations (like case-marking) that would have no relevance to the other module.

Semanticists frequently envisage more work being done at the syntax-semantics interface than syntacticians would allow. This is a view that relieves the syntax of much of its complexity. For example, Jackendoff proposes that *wh*-movement, traditionally treated as a syntactic phenomenon, can be dealt with at the interface. The crucial difference, then, between a syntactocentric view like Minimalism and Jackendoff's Parallel Architecture (among other semantic theories) is that, for the latter, there is no operation of sending syntactic structure to the semantic processor like “sending a signal down a wire, or a liquid down a pipe” (Jackendoff 2002: 223). Going from syntactic structure to semantic structure is a computation in its own right, a non-trivial process, and qualitatively different from semantic and syntactic integrative processes.

When more than one language comes into play, this computation gets even more complicated. That is why it is crucial to identify the locus of language variation. The central question for L2 researchers then is: How much of semantic/conceptual structure is part of UG and how much of it may be parameterized? Jackendoff (2002: 417) argues that the basic architecture and contents of conceptual structure are universal and innate, while languages differ in their syntactic strategies for expressing phrasal semantics (see also article 30 (Jackendoff) *Conceptual Semantics*). Different linguistic forms assemble and map different natural groupings of meanings. There are numerous instances of mismatches at the syntax-semantics interface. For example, while the English past progressive tense signifies an ongoing event in the past, Spanish Imperfect can have both an ongoing and a habitual interpretation. The English simple past tense, on the other hand, has a one-time finished event interpretation and a habitual interpretation while the Spanish Preterite has only the former. Thus, the same semantic primitives (ongoing, habitual, and one-time finished event), arguably part of universal conceptual structure, are distributed over different pieces of functional morphology. (A L2A study of this mismatch, Montrul & Slabakova (2002), is described in section 4.1.) What hosts most of the language variation in meaning, then, is the syntax-semantics interface.

What is involved in learning new meanings as well as new morphosyntactic forms? Within the Minimalist paradigm (Chomsky 1995), meanings and forms are reflected in functional categories with sets of formal features: Complementizer, Tense, Determiner, Aspect are functional categories hosting sets of formal features (e.g., *wh*, case, number, gender, definiteness, ongoing event) and related morpho-phonological forms (*that*, *-ed*, *-s*, *the*, *-ing*). Features vary as to their strength: strong features often correlate with overt morphology and are checked overtly prior to spell-out, whereas weak features tend to correlate with lack of morphology and are checked after spell-out at the interface (but see Sprouse 1998 for arguments against this claim). Parameter values make up part of lexical entries of functional categories and are encoded in the strengths of associated features (Borer 1984; Chomsky 1995). For language acquisition to take place, children select from a universal inventory of categories and features those relevant to their language and learn to associate these sets of features with morphemes and certain meanings. Thus, the acquisition of a functional category comprises at least three different types of knowledge:

- 1) morphological reflexes: target-like usage of inflectional morphology (if any);
- 2) syntactic reflexes: knowledge of feature strength, which would result in movement prior to or after spell-out, case-marking, etc.; and
- 3) semantic reflexes: knowledge of the semantic properties of the functional category, or what meanings are computed when the particular functional category is checked.

In the L2 acquisition situation, the task of the L2 learner is to acquire new functional categories, or new features of native functional categories together with their strength, morphological realization, and semantics; or to learn that features already instantiated in her L1 have different strength or meaning in the L2. If building L1 and L2 linguistic representations involves the acquisition of three distinct types of knowledge, then, in principle, these processes can be dissociated in time and/or success of acquisition. What is more, any one of the three types of knowledge (morphological, syntactic, semantic) can constitute evidence for the engagement of a functional category. This is the type of logic employed by studies using acquisition of semantics to address the “access to UG” debate.

To recapitulate our assumptions, linguistic meaning has its own combinatorial structure and is not simply “read off the syntax”. The operations at the interface are non-trivial computations. When learning a second language, a speaker may be confronted with different mappings between units of meaning on the conceptual level and units of syntactic structure.

#### 4. Two learning situations in the L2A of semantics

Recent studies on the L2A of interpretive properties have mainly looked at two types of learning tasks. In one type, the syntactic structure presents less difficulty to the learners. Quite often, these studies deal with properties related to truth-conditional meanings of common morphological forms, like the Preterite and Imperfect tenses in Spanish-English interlanguage (Montrul & Slabakova 2002), progressive tenses in Japanese-English interlanguage (Gabriele 2005), bare verb meaning in Bulgarian-English interlanguage (Slabakova 2003). Not surprisingly, native speakers in these experiments show the regular range of accuracy found in studies of L2A (80–90%). The learning challenges lie, however, at the syntax-semantics interface. Learners have to figure out what morphological forms are mapped onto what meanings in the target language, since there is no one-to-one correspondence at the syntax-semantics interface. Somewhat simplistically, I shall dub this learning situation *Simple Syntax—Complex Semantics*. Results at all levels of proficiency from beginner to near-native point to the conclusion that knowledge of this type of semantic mismatch emerges gradually but surely.

In another learning situation, the properties under discussion demonstrate quite complex syntax, in the sense that sentences involve less frequent constructions (double genitives in Dekydtspotter, Sprouse & Anderson 1997; discontinuous constituents in Dekydtspotter & Sprouse, 2001; quantifiers at a distance in Dekydtspotter, Sprouse & Thyre, 1999/2000; scrambling in Unsworth 2005, etc.). The native speakers in these experiments very often show far lower acceptance rates than we are used to seeing in the L2A literature. In a lot of cases, alternative ways of articulating the same message exist, making the tested constructions dispreferred. (This in itself may explain the fact that learners sometimes have higher rates of acceptance than native speakers.) In most cases, the properties under scrutiny present poverty of the stimulus situations to the learner, in the sense that no positive evidence exists for them in the linguistic input. However, at the syntax-semantics interface, these



same properties do not present much difficulty, as there are no mismatches. This situation can be dubbed *Complex Syntax—Simple Semantics*. If learners have acquired the relevant functional lexicon item and have constructed the right sentence representation, the presence or absence of semantic interpretation follows straightforwardly without any more stipulations. In most cases, learners demonstrate that a contrast exists in their grammar between the allowed and the disallowed interpretations. In the next sections we discuss studies representative of the two learning situations.

4.1. Simple Syntax—Complex Semantics: Acquisition of grammatical aspect (Montrul & Slabakova 2002)

In a series of studies (Montrul & Slabakova 2002, 2003; Slabakova & Montrul 2002, 2003) Montrul and Slabakova investigated acquisition of interpretive properties related to the aspectual functional projection AspP in English-Spanish interlanguage (for background, see article 48 (Filip) *Aspectual class and Aktionsart*, article 49 (Portner) *Perfect and progressive*, article 97 (Smith) *Tense and aspect*). Montrul & Slabakova’s (2002) study was specifically designed to probe the connection between acquisition of inflectional morphology and interpretations related to the aspectual tenses Preterite and Imperfect. As already discussed above, Spanish and English aspectual tenses encode different meanings. While the English past progressive tense signifies an ongoing event in the past, Spanish Imperfect can have both an ongoing and a habitual interpretation. The English simple past tense, on the other hand has a one-time finished event interpretation and a habitual interpretation while The Spanish Preterite has only the former. The examples below illustrate this:

- (2) a. Guillermo robaba en la calle. (habitual)  
Guillermo rob-IMP in the street  
‘Guillermo habitually robbed (people) in the street.’  
b. Guillermo robó en la calle. (one-time event)  
Guillermo rob-PRET in the street  
‘Guillermo robbed (someone) in the street.’
- (3) a. Felix robbed (people) in the street. (habitual)  
b. Felix robbed a person in the street. (one-time event)

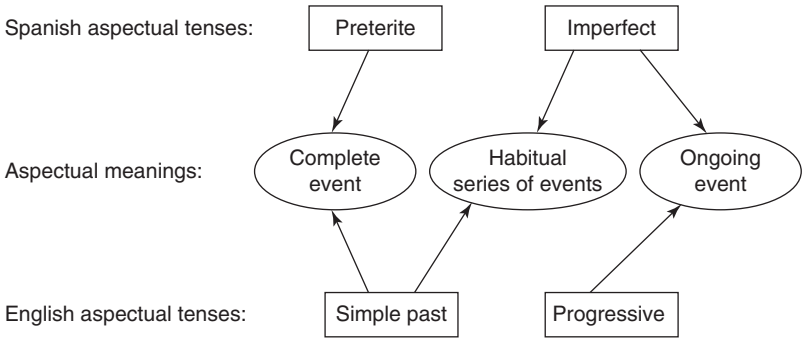


Fig. 104.1: Aspectual tense meanings in English and Spanish

In the diagram in Fig. 104.1, arrows point to meanings that are encoded by the same piece of inflectional morphology. In restructuring her grammar, the learner has to acquire the fact that it is the Imperfect morphology that encodes habituality in Spanish, and not the perfective Preterite morphology. Another acquisition task is noticing that the Imperfective ending is ambiguous between two interpretations, habitual and ongoing, while the Preterite ending only encodes the perfective meaning of a one-time complete event. In this sense, the habitual meaning is now paired with another Imperfective meaning (the ongoing one) and crucially does not depend on the lexical class of the predicate. This situation of course, presents a significant mismatch between syntactic structure and conceptual structure. The pieces of inflectional morphology come from the functional lexicon. The functional projections (e.g., AspP) where features are checked are part of sentence syntax. The aspectual meanings (ongoing event, habitual event, one-time complete event) reside in conceptual structure. But different languages have different form-to-meaning mappings, which are calculated at the syntax-semantics interface.

Montrul & Slabakova (2002) tested 71 adult learners of Spanish. Based on a proficiency task, they were divided into advanced and intermediate learners. Based on a test of inflectional morphology of aspectual tenses, the intermediate learners were further divided into those that demonstrated knowledge of the inflectional morphology and those who did not (a Yes-morphology group and a No-morphology group). The main test instrument was a sentence conjunction judgment task which specifically tested the semantic implications of the Preterite and Imperfect tenses. In this task, subjects were presented with a list of sentences consisting of two coordinated clauses. Some of the combinations were logical while others were contradictory. Subjects had to judge on a scale ranging from -2 (contradiction) to 2 (no contradiction) whether the two clauses made sense together. Following is an example with an accomplishment verb:

- (4) Joaquín corría (imperf) la carrera de fórmula 1 pero no participó.  
 ‘Joaquín was going to participate in the Formula One race but he didn’t take part in it.’

-2    -1    0    1    ②

- (5) Pedro corrió (pret) la maratón de Barcelona pero no participó.  
 ‘Pedro ran the Barcelona marathon but he didn’t take part in it.’

⊖②    -1    0    1    2

In addition to the described form-to meaning mismatches in the aspectual tense morphology, lexical aspectual classes of verbs are another factor in the acquisition picture. Stative verbs are infelicitous with the progressive in English (*\*The room was being white*) but are fine with the Imperfect in Spanish. Achievements in the Imperfect and in the progressive force aspectual coercion on the predicates, a pragmatic process which provides a context to avoid a clash of semantic features. Coercion shifts the emphasis to the process immediately preceding the change of state, so they can be negated without contradiction: *The Smiths were selling their house but in the end they did not sell it* (see article 25 (de Swart) *Mismatches and coercion* and de Swart 1998). That is why the authors look at aspectual classes of verbs separately in Tab. 104.1. Group results show that advanced and

Tab. 104.1: Mean rates for acceptable/unacceptable combination of clauses with the different lexical classes (range +2/–2)

| <i>Groups</i>                  | <i>Accomplishments</i> | <i>States</i> | <i>Achievements</i> |
|--------------------------------|------------------------|---------------|---------------------|
| Native speakers                | 1.34 / –.98*           | 1.56 / –1.5*  | 1.39 / –1.69*       |
| Advanced                       | 1.23 / –1.1*           | .92 / –.9*    | .25 / –1.79*        |
| Intermediate<br>yes-morphology | .42 / –.2*             | .53 / –.32*   | .03 / –.86*         |
| Intermediate<br>no-morphology  | .24 / –.24*            | .12 / –.25    | –.57 / .75 *        |

Notes: \* The contrast between these two means is significant by t-test.

intermediate learners who scored above 80% accuracy with the morphology test (the yes- morphology group) appear to have acquired the semantic implications associated with Preterite and Imperfect tenses in Spanish. By contrast, those intermediate learners who have not controlled knowledge of the Preterite/Imperfect morpho-phonology (the no-morphology group) are not yet sensitive to the semantic contrast between these tenses, especially with achievement and state predicates. The no-morphology group of intermediate learners even displayed the opposite pattern: they rejected achievements with Imperfect and accepted those with Preterite.

In addition, individual results were calculated with scalar responses converted into absolute values (acquired, has not acquired). Contingency tables based on these values reveal that there is a significant correlation between knowledge of morphology and knowledge of semantics, and that knowledge of morphology necessarily precedes knowledge of semantics in this aspectual domain. The acquisition of the semantic contrast appears to be a gradual development, which eventually reaches complete native-like knowledge in advanced proficiency learners.

A possible criticism that may be addressed to this study is that it looks at learners' recognizing the form and basic meanings of grammatical aspect morphemes (the aspectual tenses). Not only the forms but their aspectual meanings are widely taught and drilled in language classrooms. Thus it is difficult to rule out instruction effects. The study we discuss in section 4.3 was designed to control for such a possibility.

#### 4.2. Complex Syntax—Simple Semantics: *Wh*-quantifiers and tense distinctions (Dekydtspotter & Sprouse 2001)

In this section, we look at a study representative of the second learning situation. Dekydtspotter & Sprouse's (2001) experiment investigates tense-dependent interpretations of discontinuous quantifiers. The semantic knowledge to be acquired involves the speech-time vs. past time construal of adjectival restrictions of quantifiers. Consider the data in (6).

- (6) Qui de célèbre fumait au bistro dans les année 60?  
 Who of famous smoked at-the bar in the 60ies?  
 'Which famous person smoked in bars in the 60ies?'

A possible answer to this question may involve a present and a past celebrity. On the other hand, it is impossible to answer the discontinuous interrogative constituent as in (7) with a present celebrity. Only someone who was a celebrity in the past is the appropriate answer.

- (7) Qui fumait de célèbre au bistro dans les année 60?  
 Who smoked of famous at-the bar in the 60ies?  
 ‘Which famous person smoked in bars in the 60ies?’

The linguistic facts that bring these interpretations forward can be explained by combining language-specific movement for checking of a *wh*-feature, the possibility of left-branch extraction (again, language-specific) and a universal semantic-computational mechanism. When a *wh*-phrase (*qui*) moves to Spec, CP to check a *wh*-feature (pied-piping the rest of the phrase with it, or checking a strong feature) it can optionally take its adjectival restrictions (*de célèbre*) along for the ride, resulting in the structures in (8) and (9).

- (8) [<sub>CP</sub> Qui de célèbre [<sub>C</sub> [<sub>TP</sub> *t*<sub>qui de célèbre</sub> fumait [<sub>VP</sub> *t*<sub>qui de célèbre</sub> [<sub>V'</sub> *t*<sub>fumait</sub>] au bistro]]]]?  
 who of famous smoked at-the bar
- (9) [<sub>CP</sub> Qui [<sub>C</sub> [<sub>IP</sub> *t*<sub>qui</sub> [<sub>I'</sub> fumait [<sub>VP</sub> [*t*<sub>qui</sub> de célèbre] [<sub>V'</sub> *t*<sub>fumait</sub>] au bistro]]]]]?  
 who smoked of famous at-the bar

The authors argue that the relevant aspects of the expression *qui de célèbre* can be interpreted at any of the various steps in the derivation (see also article 66 (Krifka) *Questions*). More specifically, the analysis in (8) allows *de célèbre* to be interpreted in CP, in TP, or in VP (assuming local movement). The past tense operator P is located in TP. Thus the continuous interrogative constituent can be interpreted to pertain to either people who are famous at the time of the utterance (without tense restrictions), or to people who were famous at the time when the smoking in bars, the verbal predicate, was taking place. On the other hand, the discontinuous constituent in (9) has the adjectival restriction in VP, under the scope of the past operator, hence one of the two interpretations is missing. The habitual smoking state and the state of being famous have to coincide temporally.

What kind of knowledge must an L2 learner have in order to be aware of both interpretations in the case of continuous *wh*-constituents but only one interpretation in the case of discontinuous ones? First, knowledge of overt *wh*-movement is required. It relies on properties of *wh*-words encoded in the functional lexicon but such knowledge can be transferred from the native language in English-French interlanguage, since both English and French exhibit *wh*-movement to Spec, CP. Secondly, knowledge that discontinuous interrogatives are allowed in French is necessary. This property is not taught in French classrooms (Dekydtspotter & Sprouse 2001: 7) but is given to the participants in the experiment in the form of the test sentences (assuming they believe that the researchers did not trick them into judging ungrammatical sentences). Thirdly, the (not taught) language-specific knowledge that French allows the *wh*-word *qui* ‘who’ to have an adjectival restriction at all is necessary, while English *who famous* and *who of famous* are not legitimate strings. Most

importantly, however, what Dekydtspotter & Sprouse label “the universal deductive procedure” is indispensable for reaching the interpretive knowledge. The authors make a convincing case for the interpretations’ not being learnable on the basis of input alone (pairing of linguistic sign with meaningful extralinguistic context) and not transferable from English (Dekydtspotter & Sprouse 2001: 7–10).

The researchers tested 47 intermediate English-native learners of French, who were enrolled in third and fifth semester French classes at a US university and a group of 11 advanced speakers who had spent more than a year at a French-speaking country. Although no independent proficiency measure was administered to those latter learners, it is possible that some of them were at or close to near-native proficiency. There were two control groups tested as well. One control group was made up of 30 native French speakers. The second control group was composed of 47 English-speaking individuals with no exposure to French, who were given literal translations of the test sentences in English (see the glosses of examples 8 and 9). The purpose was to see how the interlanguage group would have performed on the experimental task if they had judged the test sentences based solely on their English intuitions.

The task of the participants was to read a paragraph-length context in English matched with a test sentence in French. After the test sentence, the participants had to answer whether that was the correct answer to the question. Test sentences in the form of question and answer sequences were organized in quadruples, as exemplified below:

(10) Sample stimuli: Context for all 4 items in the quadruple:

Attitudes toward smoking have changed drastically since the 1960s. In the 60s many people would go to bars and smoke every night. For example, Herman the Hermit was a famous rock star in those days and was often seen at bars smoking with Linda Tripp, who was then totally unknown. How times have changed! Now it is Linda Tripp who is famous, and neither of them smokes any more!

Continuous interrogative with past time answer:

Mme Goyette: Qui de célèbre fumait—dans le bistro—pendant les  
année 60?

Élève: Herman the Hermit

Continuous interrogative with speech time answer:

Mme Goyette: Qui de célèbre fumait—dans le bistro—pendant les  
année 60?

Élève: Linda Tripp

Discontinuous interrogative with past time answer:

Mme Goyette: Qui fumait de célèbre—dans le bistro—pendant les  
année 60?

Élève: Herman the Hermit

Discontinuous interrogative with speech time answer:

Mme Goyette: Qui fumait de célèbre—dans le bistro—pendant les  
année 60?

Élève: Linda Tripp

Question for respondents on all items: Is this a correct answer to the question?

The results are summarized in Tab. 104.2 (based on Dekydtspotter & Sprouse 2001).

Tab. 104.2: Percentage of acceptance of past time and speech time construals with continuous or discontinuous interrogatives

|                  | <i>Intermediate</i><br>( <i>n</i> =47) |                 | <i>Advanced</i><br>( <i>n</i> =11) |                 | <i>Native French</i><br>( <i>n</i> =30) |                 |
|------------------|----------------------------------------|-----------------|------------------------------------|-----------------|-----------------------------------------|-----------------|
| <i>construal</i> | <i>past</i>                            | <i>speech</i>   | <i>past</i>                        | <i>speech</i>   | <i>past</i>                             | <i>speech</i>   |
| continuous       | 90.7                                   | <b>41.2</b> (✓) | 79.6                               | <b>46.6</b> (✓) | 88.8                                    | <b>12.5</b> (✓) |
| interrogatives   |                                        |                 |                                    |                 |                                         |                 |
| discontinuous    | 90.7                                   | <b>25</b> (#)   | 90.9                               | <b>15.9</b> (#) | 96.3                                    | <b>5</b> (#)    |
| interrogative    |                                        |                 |                                    |                 |                                         |                 |

As Tab. 104.2 indicates, past time construals are preferred across the board by natives and learners alike. Speech time construals are in bold with a checkmark after the available one and a hachure after the unavailable one. It is knowledge of the missing interpretation, the speech-time construal with discontinuous constituents, that is crucial in answering the research question of this study. Both learner groups show a statistically significant difference between the available and the unavailable interpretations. In other words, they reliably treat the two constructions differently. The argument would have been even more convincing if the native speakers had exhibited more categorical knowledge of the property. As it is, French natives do not like speech time construals, and do not reliably distinguish between the two constructions ( $t(29) = 1.61, p = .119$ , with a large SD of 27.46 on the discontinuous constituent meanings and a much smaller SD of 7.76 on the continuous constituent meanings). However, what is important is the behavior of the learners. They are successfully combining the properties related to the French functional lexicon: the availability of *wh*-movement and discontinuous interrogatives, with the universal meaning-calculating algorithm. Note that even not very proficient L2 learners, in this case learners with as little as three semesters of exposure to French, are capable of manifesting knowledge depending on this universal algorithm. In addition, the results of the English control group demonstrate that a pure glossing strategy (mapping word for word the English and French questions) would not lead the French learners to the expected contrast in their L2 knowledge. In judging ungrammatical but interpretable questions such as *\*Who of famous smoked in bars in the 60ies?*, the English native speakers allowed speech-time construals equally with continuous and discontinuous interrogatives.

One final observation pertaining to this experimental study is in order. I have argued here, together with the researchers themselves, that the interpretive knowledge comes for free, and thus precedes the morphosyntactic knowledge involved in the relevant properties. Why don't we see reliably high percentages of acceptance then? To appreciate the findings, we need to keep in mind that the study examines dispreferred grammatical options. The past-time construal was widely preferred to the speech-time construal by all participants, including the English control group. It is no small achievement, then, on the part of the learners, that even with dispreferred strings or interpretations and under severe poverty of the stimulus, they manage to exhibit the contrasts we expect based on the respective syntactic structures and the universal meaning computation procedure.

### 4.3. Ruling Out the Effect of Instruction: viewpoint aspect-related interpretations (Slabakova 2003)

The linguistic properties investigated by Slabakova (2003) have to do with viewpoint (grammatical) aspect again. In this sense, they fall into The Simple Syntax—Complex Semantics type of learning situation. It is well known that English differs from German, Romance, and Slavic with respect to the semantics of the present simple tense in that it cannot denote ongoing events.

- (11) a. \*She eats an apple right now.      #Ongoing event  
       b. She is eating an apple right now.    Ongoing event  
       c. She eats an apple (every day).      Habitual series of complete events

Furthermore, the English bare infinitive denotes not only the processual part of an event but includes the completion of that event. English accomplishment and achievement predicates in the infinitive (without any aspectual morphology) have only complete events in their denotations. Sentence (12a) cannot be uttered in a situation where a truck comes along while Mary is crossing the street and it hits her before she can reach the other sidewalk, while (12b) can.

- (12) a. I saw Mary cross the street.      completion entailed  
       b. I saw Mary crossing the street.    no completion entailed

In trying to explain the relationship between the facts illustrated in (11) and (12), many researchers have noticed that English verbal morphology is impoverished (Bennett & Partee 1972/1978; Landman 1992). The experimental study adopts Giorgi & Pianesi's (1997) proposal. English verbs, they argue, are "naked" forms that can express several verbal values, such as the bare infinitive, the first and second person singular, and the first, second and third person, plural. Many English words are even categorially ambiguous in that they can either identify an "object" or an "action," such as *cry*, *play*, *drive*, and many others. Giorgi & Pianesi (1997) propose that verbs are disambiguated in English by being marked in the lexicon with the aspectual feature [+perf] (perfective). English eventive verbs acquire categorial features by being associated with the aspectual marker [+perf]. In other words, English (eventive) verbs are inherently perfective and include both the process part of the event and its endpoint. Thus, children acquiring English notice the morphological poverty of English verbs and attach the [+perf] feature to verbal forms, thus distinguishing them from nominals, whose feature specification bundle excludes it. This feature has to be checked in a functional category, say AspP, in the sentential structure. We shall not go into the rest of the analysis here of how the other grammatical aspectual meanings obtain (but see the original study for details).

In Romance, Slavic, and other Germanic languages, on the other hand, all verbal forms have to be inflected for person, number, and tense. Thus, nouns and verbs cannot have the same forms, unlike English, in which zero-derivation abounds. The Bulgarian verb, for example, is associated with typical verbal features as [+V, person, number] and it is recognizable and learnable as a verb because of these features. Nominal inflections are distinguishable from verbal ones. Bulgarian verbs are therefore not associated with a [+perf]

feature. Unlike English, Bulgarian has no present progressive tense and the present simple tense is ambiguous between a habitual and an ongoing event or state. This is true of eventive verbs as in (13) below, as well as of stative verbs. Thus, Bulgarian and English exhibit a contrast of viewpoint aspect in present tense forms (see article 48 (Filip) *Aspectual class and Aktionsart*).

- (13) a. Maria sega jade jabalka. simultaneous event  
 Maria now eat-PRES apple  
 'Mary is eating an apple right now.'
- b. Maria jade jabalka vsemi den. habitual series of events  
 Maria eat-PRES apple every day  
 'Mary eats an apple every day.'

Because Bulgarian verbs are not marked [+perf] in the lexicon, Bulgarian equivalents to bare infinitives do not entail completion of the event.

- (14) Ivan vidja Maria da presiča ulicata. no completion entailed  
 Ivan saw Maria to cross street-DET  
 'John saw Mary crossing the street.'

In the acquisition of English by Bulgarian native speakers, then, the learning task is to notice the trigger of this property: the fact that English inflectional morphology is highly impoverished, lacking many person-number-tense verb endings. The property itself, if Giorgi & Pianesi are correct, is the [+perf] feature that is attached to English eventive verbs in the lexicon. Knowledge of this property will entail knowledge of four different interpretive facts: 1) bare verb forms denote a completed event; 2) present tense has only habitual interpretation; 3) progressive affix needed for ongoing interpretation of eventive verbs; 4) states in the progressive denote temporary states. Even if the four facts above are not related, or not due to the presence or absence of a specific formal feature, the language contrasts remain as syntax-semantics mismatches, and they have to be acquired. Crucially for this study, of the four semantic properties under investigation enumerated above, the second, third, and fourth are introduced, discussed, and drilled in language classrooms. The first one, however, is not explicitly taught.

A hundred and twelve Bulgarian learners of English took part in the experiment, as well as 24 native speaker controls. The learners were typical classroom instructed learners. All participants took a Truth Value Judgment Task with a story in their native language and a test sentence in English. The same story appeared with another test sentence (see below) elsewhere in the test. Here is an example of a test quadruple:

- (15) Quadruple testing completed interpretation of English bare forms (the construction is known as "perceptual reports")

Matt had an enormous appetite. He was one of those people who could eat a whole cake at one sitting. But these days he is much more careful what he eats. For example, yesterday he bought a chocolate and vanilla ice cream cake, but ate only half of it after dinner. I know, because I was there with him.



|    |                                |      |       |
|----|--------------------------------|------|-------|
| or | I observed Matt eat a cake.    | True | False |
|    | I observed Matt eating a cake. | True | False |

Alicia is a thin person, but she has an astounding capacity for eating big quantities of food. Once when I was at her house, she took a whole ice cream cake out of the freezer and ate it all. I almost got sick, just watching her.

|    |                                 |      |       |
|----|---------------------------------|------|-------|
| or | I watched Alicia eat a cake.    | True | False |
|    | I watched Alicia eating a cake. | True | False |

Results on the acquisition of all four semantic properties pattern the same way. We focus on the instructed properties first. The less proficient learners are quite accurate in mapping the present simple tense to habitual context (roughly around 80 %), while they are slightly less accurate at recognizing the progressive form semantics (around 65%). This contrast may be due to the fact that the habitual meaning *can* be expressed by the present tense form in their L1, even though it has to be supported by adverbials and/or context. The progressive meaning, on the other hand, is associated with a *different* piece of morphology in the L2, making the process of form-function mapping more problematic. The advanced learners are highly accurate on all three properties taught in classrooms. Thus initial L1 transfer and subsequent morphological acquisition are clearly attested in the data.

Fig. 104.2 presents accuracy on the untaught property: in the perceptual report construction, the bare verb has a completed interpretation. As the figure shows, advanced learners are even more accurate than native speakers in their knowledge that an English bare verb denotes a complete event, and consequently is incompatible with an incomplete event story (see first group of columns). Even more importantly, all learner groups are quite accurate in attributing a complete interpretation to the bare verb, a property

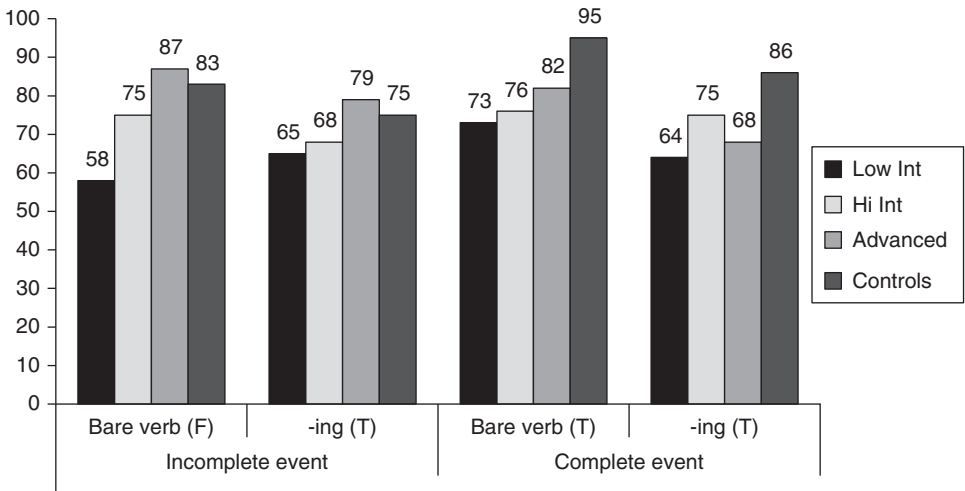


Fig. 104.2: Mean accuracy on bare verbs versus -ing forms in perceptual reports (in percentage)

After establishing that it is *possible* to acquire semantic properties in the second language that are not manifested in the native language, let us now turn to the impact of the instruction variable. Slabakova (2003) reports that extensive scrutiny of the instruction materials and discussions with the instructors ascertained that the present simple and progressive tense meanings are explicitly taught and drilled from the beginning of classroom instruction. On the other hand, the telic interpretation of bare verb forms is not taught, and the Bulgarian teachers are not consciously aware of it. Is it the case that instruction is a significant variable and learners were more accurate on the taught than on untaught properties? The short answer is no. Analysis of variance was performed on the data for each group, with condition as the sole factor. The Low Intermediate Group performed equally accurately on all conditions ( $F(2, 93) = 1.71, p = .185$ ), and so did the High Intermediate Group ( $F(2, 120) = 2.67, p = .07$ ). The Advanced Group showed a marginally significant difference for condition ( $F(2, 114) = 3.11, p = .05$ ), but it is due to the only lower accuracy score (68%) on the *-ing* verb form combined with a telic story. (As mentioned above, this combination is not ungrammatical, it is simply dispreferred.) In general, there seems to be no effect of instruction in Bulgarian learners' acquisition of the semantic properties of English present tenses. The theoretical implication of this finding is that all semantic effects of learning the trigger (English verbs are morphologically impoverished) and the related property ([+perf] feature attached to verbs in the lexicon) appear to be engaged at the same time.

The three studies discussed in this article are representative of at least 20 other studies, in a rapidly growing field of inquiry within generative L2A research. Their findings are not at all unique or atypical in that field of research (Dekydtspotter & Sprouse 1997; Dekydtspotter, Sprouse & Thyre 1999/2000; Dekydtspotter, Sprouse & Swanson 2001; Marsden 2004; Unsworth 2005; Gabriele 2005; Ionin, Ko & Wexler 2004; Borgonovo, Bruhn de Garavito & Prévost 2006; for an overview of more studies, see Slabakova 2006, 2008). We will now turn to the implications of the findings we have observed. In section 2 we summarized briefly several influential proposals on whether adult L2A proceeds much like child language acquisition. Within the Global Impairment View, the Shallow Structure Hypothesis argues that adult L2A is fundamentally different from L1A because adult L2 language users do not process long-distance dependencies as native speakers do. One type of evidence that addresses the question of whether or not L2 speakers utilize detailed and complete syntactic representations in their parsing comes from comprehension experiments of the type we have discussed above. Let us take, for example, the correct interpretations of sentences as in (8) and (9) tested in Dekydtspotter & Sprouse (2001).

- (8) [CP Qui de célèbre [C [TP *t* qui de célèbre fumait [VP *t* qui de célèbre [V, *t* fumait] au bistro]]]]?  
 who of famous smoked at-the bar
- (9) [CP Qui [C [IP *t* qui [I' fumait [VP [*t* qui de célèbre] [V, *t* fumait] au bistro]]]]?  
 who smoked of famous at-the bar

Recall that (8) allows for a past and present celebrity construal while (9) only allows for a past celebrity construal. In order to recognize these meanings, speakers need to interpret the *wh*-phrase with or without its associate *de célèbre* at each of the intermediate sites. That is, correct interpretation crucially depends on positing and processing intermediate traces. Intermediate as well as advanced learners of French with English as their native language show statistically significant sensitivity to this contrast, correctly choosing speech time construals more often with continuous interrogatives than with discontinuous interrogatives. This result cannot be explained by the Shallow Structure Hypothesis. The proposal assumes that intermediate traces are not needed on the shallow parse, and not processed by L2 speakers, who rely on argument structure assignment and pragmatics in processing. In examples (8) and (9) above, the verbs are the same, therefore learners should have come up with a similar shallow analysis for them. Since the results of Dekydtspotter & Sprouse (2001) are hardly isolated or atypical, I conclude that the Shallow Structure Hypothesis is an eminently testable and sensible proposal, but there is a lot of experimental evidence militating against it.

The second view we introduced, the Local Impairment position, included Hawkins & Chan's (1997) proposal that the acquisition of formal features is subject to some sort of critical period effect and is unavailable to L2 learners, if the features are not transferable from the native grammar. The more recent version of this position claims that only uninterpretable, but not interpretable features, are uniformly unavailable in L2A. For example, Hawkins & Hattori (2006) and Hawkins et al. (2008) look at semantic effects of uninterpretable features regulating *wh*-movement and verb movement, respectively, and find support for their claim. However, White (2003: 127–141) provides many examples of studies demonstrating successful acquisition of new features, new feature strength values, and new functional categories. As it stands, the Local Impairment position makes a further prediction: that the L2A of a new interpretable feature (e.g., tense on T in English for Chinese native speakers) should be possible, while acquiring a new uninterpretable feature (e.g., a strong [wh] feature in English for Chinese native speakers) should be impossible. To my knowledge, such a direct comparison has not been investigated yet.

The third influential proposal explaining L2A we discussed was Sorace's Interface Hypothesis. It is important to point out that a simpler position, namely, "adult and even advanced learners cannot fully acquire properties at linguistic interfaces" is plainly wrong. All of the studies we have enumerated so far directly contradict this simplistic claim. Sorace (2003) rather claims that linguistic properties requiring *integration* of syntactic knowledge with discourse-pragmatic, semantic, or prosodic information, present insurmountable difficulties even to advanced learners. Unfortunately, at this time linguistic theory has not proposed concrete theoretical analyses of how exactly prosodic and pragmatic (discourse-related) information interact with and change syntactic information (but see article 94 (Potts) *Conventional implicature*). Thus, it may be the case that these particular types of information, prosodic and discourse information, are difficult for learners to take into account while calculating appropriate usage. What I have shown in this chapter is that learners do not have trouble calculating meaning at the syntax-semantics interface, even in the case of L1-L2 mismatches at this interface. More empirical investigations targeting prosodic and discourse integration into the syntax are needed before the Interface Hypothesis is substantiated. Its theoretical underpinnings also need to be better defined.

Another highly promising area of inquiry that would also pertain to acquisition at the interfaces is the L2A of scalar implicatures (see article 87 (Chierchia, Fox & Spector) *Grammatical view of scalar implicatures* and article 92 (Simons) *Implicature*). The learning situation in the case of scalar implicatures is the following. Since they are supposed to be universal, once the learners know the lexical items for the scales, they should have no problem computing them. Even though pragmatic competence takes time to develop in children, L2 adults should be better than children since they have already developed that competence in their L1. Native language transfer and lexical learning should bring forward native-like pragmatic competence. The first L2 studies probing these questions (Dekydtspotter & Hathorn 2005; Dekydtspotter, Sprouse & Meyer 2005; Slabakova 2010) indicate that this is indeed the case. Both very complex as well as simple interpretive effects are discovered in learners' grammars, observed in a native-like fashion, therefore supporting the claim that L2A is constrained by a universal meaning computation processor. In sum, we have no reason to expect acquisition at the syntax-pragmatics and semantics-pragmatics interfaces to be any less successful than that at the syntax-semantics interface.

Returning to the syntax-semantics interface then, let us reiterate that most current studies on L2A of semantics fall into two major groups: those investigating Simple Syntax—Complex Semantics and those investigating Complex Syntax—Simple Semantics. As exemplified in the Montrul & Slabakova (2002) and Slabakova (2003) studies, in the first learning situation, characterized with an L1-L2 mismatch at the syntax-semantics interface, both initial transfer from the native language and subsequent incremental development reaching native levels are attested. In the second learning situation, illustrated by Dekydtspotter & Sprouse (2001), learners' answers are characterized with lower acceptance rates altogether, but both proficient and less proficient learners demonstrate that they have established the semantic contrast in their interlanguage grammars. Once learners are capable of understanding the test sentences by being able to parse their complex syntax, they have no trouble with the available interpretations, since there is no syntax-semantics mismatch and they have recourse to the universal semantic calculation procedures.

Taken together, these findings point to the conclusion that inflectional morphology encoded in the functional lexicon presents the most formidable challenge to L2 learners. The morphology has to be learned on an item-by-item basis, a process that takes time and is subject to individual differences. The inflectional morphology is either mapped onto new meanings (the first learning situation) or implicated in the calculation of complex syntactic structures (the second learning situation). The different patterns of acquisition in the two situations are explained by the Bottleneck Hypothesis, which claims that morphology is the bottleneck of L2 acquisition. Incremental morphology learning reaching high accuracy levels happens in the first case. Lower morphology accuracy, but with the semantic contrast in place from the beginning, is attested in the second case.

The claims of the Bottleneck Hypothesis (Slabakova 2006, 2008) are partially based on these observed patterns of acquisition. This hypothesis postulates that indeed the functional morphology is the "tight spot" in the acquisition process flow. Morphology is processed by declarative memory, has to be learned by rote, and its forms (or phonological features) present difficulty for L2 learners not only at beginning stages of acquisition but at later stages, too (Lardiere 2008). It is a stumbling block in linguistic production, but it is also crucial in comprehension. Past the figurative bottleneck, application of

universal semantic principles continues to flow freely, and target interpretations are achieved.

Looking at the big picture, then, the Critical Period Hypothesis that we discussed in the introduction is not precise enough to predict differential effects for different areas of the grammar. The Multiple Critical Period Hypothesis, postulating such differential effects, is obviously closer to the mark. Within the latter, data from numerous experimental studies investigating two learning situations confirmed that there is no critical period for the acquisition of phrasal semantics.

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Roumyana Slabakova, Iowa City, IA (USA)

## 105. Meaning in neurolinguistics

The article that was to appear in this section had to be omitted.

## 106. Conceptual knowledge, categorization, and meaning

1. Introduction
2. Conceptual knowledge
3. Theoretical approaches
4. Issues of debate
5. Conceptual combination
6. Relationship between conceptual knowledge and word meanings
7. Concluding remarks
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### Abstract

*Since Eleanor Rosch's groundbreaking work in the 1970s, conceptual knowledge has become a subject of extensive research in cognitive psychology. This chapter provides an overview of the current state of the art. Research has focused on conceptual knowledge about concrete physical things. The main research questions concern the structure and content of conceptual knowledge and its functions, in particular categorization. Most research is based on the view that conceptual knowledge comprises a set of relatively fixed packets of information, or concepts, which are assumed to correspond to lexical meanings. This view of the relationship between conceptual and lexical-semantic knowledge is discussed towards the end of the chapter.*



## 1. Introduction

The human mind does not have direct access to the world. What is taken as a real situation in the world is the content of a mental representation constructed from sensory data and knowledge stored in long-term memory. Conceptual knowledge plays a pivotal role here, imposing a particular structure on the representation and promoting a conceptualization in terms of entities of particular kinds, possessing certain properties and being related to each other in particular ways. For example, a given dynamic visual input may, by virtue of conceptual knowledge, give rise to the perception of a structured motion event such as a rabbit jumping into the room. In a similar way, conceptual knowledge also shapes the structure and contents of mental representations in thinking and action planning. It is important to distinguish between conceptual knowledge itself and mental representations constructed at certain points in time that are shaped by conceptual knowledge. The distinction may best be framed in terms of the distinction between long-term memory, which is a permanent store of information, and working memory, where temporary representations are created and manipulated. In working memory, information retrieved from long-term memory is integrated with information from the sensory-motor and emotional systems, and the resulting representations are also heavily influenced by motivational factors and attentional processes. Thus, the mental representation of a situation, event, or individual entity currently perceived or thought of is a representation in working memory. It is shaped by conceptual knowledge but is not part of conceptual knowledge. Conceptual knowledge itself is a component of long-term memory.

Language is a means by which a person can convey information residing in working memory to another person. In doing so, the person needs to carve up the working memory representation and package the intended information in a way which conforms to the linguistic structures of his or her language. For example, to communicate the above mentioned motion event of a rabbit jumping into the room, the various pieces of information, including the entities and the manner and path of motion, must be organized in a particular way. Obviously, the difficulty of the task largely depends on how similar the required structure is to the structure of the given working memory representation, as induced by conceptual knowledge. Many cognitive psychologists assume that conceptual knowledge comprises distinct concepts, each of which corresponds to the meaning of a particular lexical item. If so, carving up working memory representations for the purpose of coding their contents linguistically would be a relatively straightforward process. However, matters are far from settled. As yet few studies have addressed the conceptualization of complex situations or actions and their mapping onto linguistic structures, except in research on the linguistic relativity hypothesis (see Sec. 6) and language development (see, e.g., Snedeker & Gleitman 2004; see also article 107 (Landau) *Space in semantics and cognition*). By far the most studies of conceptual knowledge are concerned with concepts of everyday physical things (for research on other noun concepts, see, e.g., Wisniewski 2009 and Papafragou 2005 on substance concepts, and Goldwater, Markman & Stilwell 2011 on relational concepts). Moreover, even for concepts of everyday physical things, the claim that they correspond to lexical meanings is difficult to evaluate. The reason is that research on conceptual knowledge in general simply presupposes that concepts are word meanings, rather than investigating this issue experimentally. Due to this presupposition, it is common practice in empirical studies to employ verbal stimuli to investigate concepts and when using nonverbal tasks, rarely is any effort made to control for internal linguistic

processes such as covert naming or priming from preceding or expected linguistic tasks. Thus, for many of the studies on conceptual knowledge it is strictly speaking impossible to decide whether the results do in fact reveal something about conceptual knowledge or rather about lexical semantic knowledge. However, notwithstanding this unfortunate ambiguity, the findings are in any case of interest to semantics.

This chapter provides an overview of research on conceptual knowledge in cognitive psychology. Its focus is on behavioral research (cf. Martin & Caramazza 2003 for neuroscientific research). In Sections 2 to 5 we report empirical findings on the content and structure of conceptual knowledge and outline the different theoretical approaches as well as their major points of contention. In these sections, we adopt the view of concepts as lexical meanings, but in Section 6, we explicitly address the question of how conceptual and lexical-semantic knowledge are related.

The literature on conceptual knowledge is enormous and there are many different foci of research. Our chapter concentrates on research with human adults. Readers interested in conceptual development or concepts in animals are referred to the reviews by Smith & Colunga (2012) and Lazareva & Wasserman (2008), respectively. For reasons of space, we must also ignore research on the impact of conceptual knowledge on inductive reasoning (for a review, see Hayes, Heit & Swendsen 2010) and formal models of categorization (see Pothos & Wills 2011).

## 2. Conceptual knowledge

### 2.1. Functions of conceptual knowledge

The most obvious function of conceptual knowledge is to allow for the categorization of things. In fact, this function has traditionally been in the focus of theoretical and empirical research on conceptual knowledge. It is commonly assumed that conceptual knowledge comprises distinct concepts, each of which provides information about a particular category of entities in the world (or more precisely, of entities that people deem as being in the external world). For example, the concept HAMMER may include information about what members of the category {hammers} look like, how they are used, and so on. (We indicate concepts by small caps and sets of entities in the world by curly brackets). A given thing is categorized by examining how well its properties match the information contained in a particular concept, possibly compared with alternative concepts. Theories differ in their assumptions as to the information contained in concepts and categorization decision rules (see Sec. 3 and 4).

A deeper understanding of what conceptual knowledge is good for is gained by considering its influence on representations of things in working memory (cf. Sec. 1). What happens when some part of a scene is recognized as a particular kind of entity, say, as a car? In what way does this use of conceptual knowledge shape the interpretation of the sensory input or, in other words, the mental representation of this part of the scene? Concept theories are not always explicit with respect to this issue but a widespread assumption seems to be that if something is conceptualized as a member of a particular category (e.g., {cars}), then its representation in working memory is essentially a replica of the content of the respective concept. This implies that whenever a person identifies things as a car, the working memory representations of those things are identical in content. Some more recent accounts ascribe greater flexibility to working memory

representations. For example, simulation theory (Barsalou 2009) emphasizes that their contents are also influenced by the situational context. On this view, a car may be represented rather differently in working memory depending on whether it is being driven, filled with gas, washed, or bought. In any case, the accounts agree that conceptual knowledge affects representations in working memory in two complementary ways. On the one hand, some pieces of information are suppressed or deleted from the representation, specifically ones that are conceptually irrelevant. This may be considered the *abstraction* function of conceptual knowledge. Instead of representing the given thing in all its details, the representation mainly contains information that characterizes it as a particular kind of entity (in a particular situation). Abstraction is advantageous if not necessary to protect subsequent processing (e.g., thinking, problem solving, action planning) from being influenced by irrelevant information. On the other hand, the representation is supplemented with some pieces of information which stem from conceptual knowledge rather than being given by the stimulus itself. We refer to this as *prediction*. Prediction is a less obvious function of conceptual knowledge than abstraction. Let us therefore consider it in some more detail.

Conceptual knowledge is constantly used for predictions in daily life. When we grasp a hammer, we anticipate its approximate weight, even if we've never seen it before. When we cut an apple we expect it to be white inside. When we see a snowman in a backyard, we assume it to have been built by children. Notice that the predictions considered here are not predictions in the ordinary sense. They may not only concern the future but also the present (e.g., the snowman is made out of snow) and the past (e.g., the snowman was built by children). Furthermore, they may be made unconsciously, and they derive from stored information about past situations rather than from explicitly learned rules. What is the basis for such predictions? Let us assume that in the current situation, there is something possessing the feature A. We further assume that according to the information represented in conceptual knowledge, previous situations with feature A also involved feature C, say, in 70% of the cases. Unless feature C's presence in the current situation is obvious anyhow, this knowledge can be used to estimate that the likelihood of feature C in the current situation is .70. Clearly, using feature A for estimating the likelihood of feature C is pointless if according to prior knowledge, C was present in 70% of *all* past situations (i.e., if according to prior knowledge, the base rate of C is .70). In this case, one could have estimated the likelihood of C to be .70 without considering feature A. However, taking into account feature A *is* advantageous if according to prior knowledge, feature C was more often, or alternatively, less often present in situations containing A than in other situations. More generally speaking, taking into account a given feature A improves the prediction of a yet unobserved feature C, if there is a statistical **association** between the features A and C. Of course, usually more than a single feature A is used to estimate the likelihood of an unobserved feature C, and other features or feature combinations, say B, may modify the association between the features A and C. For example, the likelihood of feature C <breaks when dropped> is high for an object with feature A <cup-shaped> if feature B <made of porcelain> is present but low if feature B' <made of plastic> is present instead.

It should be noted that in the literature on concepts and categorization, one frequently finds the term *correlation* instead of *association*. However, as features are usually considered qualitative properties (i.e., being either present or absent), it is most often the

contingency between two features that is at issue. We therefore use the umbrella term *association* to cover both correlation and contingency.

In sum, feature prediction uses information about associations among features in past situations. This information is provided by conceptual knowledge. As we have seen, conceptual knowledge need not be organized into distinct concepts to allow for feature prediction. However, as mentioned, many accounts postulate such an organization. These accounts generally consider categorization a necessary first step for feature prediction. Specifically, a given thing is first assigned to a particular category and then the information contained in the respective concept becomes available (see Murphy & Ross 2010 and Hayes, Heit & Swendsen 2010: 286–287, for a discussion of this issue).

## 2.2. The content of conceptual knowledge

Our characterization of conceptual knowledge as knowledge about feature associations converges with a view that has been widespread since Rosch's seminal articles (e.g., Rosch 1978; Rosch et al. 1976). On this view, conceptual knowledge has its basis in the correlational structure of the world. Each concept represents a particular bundle of strongly associated features (cf. Sec. 3 for other views). Of course, the features are not features of the world as such but arise from our sensory-motor and emotional systems (e.g., <red>, <sticky>, <ugly>) and higher cognitive processes integrating information from various sources (e.g., <dangerous>, <breakable>, <expensive>).

The relationship between features and concepts is an intricate matter. First, at least many high-level features arise so as to facilitate the discrimination of categories (see Schyns, Goldstone & Thibaut 1998). Thus, rather than being independent building blocks of concepts, features themselves may to some extent depend on required conceptual distinctions. Second, high-level features are probably often configurations of simpler features. From a structural point of view, such features are therefore difficult to distinguish from concepts. Moreover, features may even involve concepts (e.g., <has a pit>, <eats meat>). This entails a significant broadening of the notion of features, and in addition, it introduces a new aspect of conceptual structure, namely that of thematic relations. Let us briefly explain this issue.

In Section 2.2 we deliberately spoke of features *in situations*. People usually do not experience isolated things. Rather they experience things in the context of particular situations and as objects of their own actions. It is likely that associations between the features of a given thing (e.g., a cherry) and features of things frequently encountered in its context (e.g., tree), as well as features of actions frequently performed with the thing (e.g., picking, eating) are encoded. Thus, conceptual knowledge also contains information about so-called thematic relations (e.g., cherry – tree; cherry – eating; hammer – nail; for empirical evidence, see, e.g., Estes, Golonka & Jones 2011). Having a particular thematic relation to other entities can be considered a feature of an entity. Such features are sometimes called *extrinsic* features as opposed to *intrinsic* features, which are true of an entity in isolation (see Barr & Caplan 1987). Thus, for example, the concept CHERRY may include not only the intrinsic features <red> and <round> but also the extrinsic features <grows on trees>, <can be bought on the market>, <can be eaten>. Indeed, many studies have shown that commonalities with respect to extrinsic features increase perceived similarity and affect categorization (for a review, see Estes, Golonka & Jones 2011).

We have emphasized the correlational structure of the world as the basis of conceptual knowledge. However, subjective factors play an important role as well. It is reasonable to assume that the feature associations that get encoded are mainly those that are sufficiently salient and relevant to a person's life. Thus, cultural background, job, and interests may have a significant impact on people's conceptual structure (see, e.g., Medin et al. 2006, and Tanaka & Taylor 1991). It may even be the case that only feature associations construed as causal relations are encoded (see Sec. 4.3 for a discussion). Another important issue is that not all feature associations encoded in conceptual knowledge stem from direct experience; many of them may derive from communication with other people.

### 2.3. Conceptual hierarchies

Things can often be categorized in various ways. For example, something may be conceptualized as a flute, a component of an orchestra, a gift for a child, a thing to take on a vacation, a recorder, or a musical instrument. Particularly the possibility of identifying things at various levels of specificity (e.g., musical instrument, flute, recorder) has received much attention in research on concepts and categorization. Which level is preferred and why? Before addressing this question, let us consider the conditions for differentiating a concept into more specific concepts.

Establishing concepts at a more specific level of abstraction is not done arbitrarily, but according to certain constraints. For example, most people lack concepts for different types of mountains or ideas. Furthermore, while `RED_WINE` and `WHITE_WINE` are well-established concepts, `RED_DRESS` and `WHITE_DRESS` are not. Why not? If we take into account that a main function of concepts is feature prediction, the answer is straightforward. A concept such as `RED_DRESS` would not allow for any predictions other than those inferable from the concept `DRESS` plus the information that the dress is red. In contrast, the concept `RED_WINE` allows additional predictions with respect to the taste of the wine, its optimal temperature, and the meals that it goes well with. Such predictions are possible because in the category {wines}, certain colors are associated with certain tastes, optimal temperatures, and appropriate meals. In other words, our conjecture is that a more specific concept is established only if there are feature associations *within* the category specified by the parent concept. The more specific concept then renders it possible to predict new features that cannot be predicted on the basis of the parent concept. It may be interesting to note that according to this view, it is unlikely that the concept `BACHELOR` only comprises the features listed in the concept `MAN` (<human>, <male>, <adult>) plus the feature <unmarried>. If conceptually a bachelor were no more than an unmarried man, then the concept would not exist. Rather, the concept captures the association between <unmarried> and certain other features occurring in the category {men}, as for instance, <has to take care of the laundry himself>, <is not responsible for a family>, <is always ready to go to a party>, and so on.

Based on these considerations, it may be supposed that people prefer using concepts at the lowest level, since that allows the most predictions. In their renowned study, Rosch et al. (1976), however, demonstrated that the level that people prefer in conceptual tasks (dubbed the *basic level*) is most often a certain middle level in a taxonomy. For example, people prefer categorizing things as members of {chairs}, {tables}, or {beds} rather than as members of {kitchen chairs} or {pieces of furniture}, and similarly, they prefer using the categories {flutes}, {drums}, {pianos} rather than the subordinate categories (e.g.,

{recorders}) or the superordinate category {musical instruments}. Many subsequent studies replicated this finding, and in addition provided evidence that basic level superiority is not simply due to the fact that the labels of basic level categories are relatively frequent and short words and are acquired relatively early in childhood (for reviews, see Mervis & Rosch 1981 and Murphy & Lassaline 1997). It should be noted, however, that the basic level is not always privileged. For experts in a domain (e.g., dog experts, bird watchers), the subordinate level is as useful as the basic level in their domain of expertise (e.g., BEAGLE or COLLIE vs. DOG; see Johnson & Mervis 1997; Tanaka & Taylor 1991), and in semantic dementia, the superordinate level appears to be better preserved than the basic level (see Rogers & Patterson 2007).

Why is the basic level usually privileged in conceptual tasks? Important hints come from studies in which participants were asked to list as many features as possible that are shared by the members of a given superordinate, basic, or subordinate category, respectively (e.g., Johnson & Mervis 1997; Rosch et al. 1976; Tanaka & Taylor 1991). Not surprisingly, participants listed more features for categories lower in the hierarchy (e.g., the number of listed features increases from {pieces of furniture} to {chairs} to {kitchen chairs}). Yet, the increase was not constant for each downward move but largest when moving from the superordinate level (e.g., {pieces of furniture}) to the basic level (e.g., {chairs}). The move from the basic to the subordinate level (e.g., {kitchen chairs}) yielded relatively few additional features. This suggests that basic-level categories are much more homogenous than superordinate categories, which is clearly advantageous with regard to category-based feature prediction. In addition, Rosch et al. (1976) found that the members of a basic category (e.g., {chairs}) share relatively few features with the members of other categories at the same level, (e.g., {tables}, {beds}, {cupboards}). In other words, alternative categories at the basic level are particularly clearly differentiated from each other, compared with alternative categories at other levels (e.g., at the subordinate level: {kitchen chairs} vs. {office chairs} vs. {easy chairs}).

On the basis of these findings, Mervis & Rosch (1981) characterized the basic level as the level at which the set of entities of a domain is partitioned in such a way that the categories maximize within-category similarity relative to between-category similarity. Other researchers have also been concerned with the *structural* properties of the partitions at different levels in natural and artificial taxonomies and with possible measures of the utility of partitions (for an overview and a recent proposal, see Gosselin & Schyns 2001).

Another possible explanation of the privileged status of basic-level categories emerges from the consideration that outside of the laboratory, the different kinds of features typically play different roles in conceptual processing. For example, what is typically “given” when perceiving things are salient visual features (e.g., shape, part structure, color, movement), whereas the features that we want to predict are the features that arise over time (e.g., the melting of a snowman), the appropriate motor programs for interacting with the thing, and the features that emerge from this interaction (e.g., the weight of a hammer; the behavior of a rabbit when one approaches it), as well as more abstract features. Thus, concepts should capture the associations between visual features and these latter kinds of features. Superordinate concepts may be largely useless in this regard. Rosch et al. (1976) (see also Jolicoeur, Gluck & Kosslyn 1984; Tanaka & Taylor 1991) found that different superordinate categories (e.g., {vehicles}, {buildings}) can hardly be distinguished on the



basis of visual properties; they mainly differ in function (e.g., <used for transport of persons>). In contrast, basic-level categories (e.g., {cars}, {trucks}, {airplanes}) were found to typically differ in salient visual features (shape, part structure) as well as with respect to motor movements for interacting with the things. Thus, identifying a thing as an instance of a particular basic-level concept is probably relatively straightforward and allows predictions as to appropriate interactions. The subordinate level may again be less useful. At this level, the information about the visual features is refined but with respect to action affordances and appropriate motor programs there are no significant differences between the different subordinate categories of the same basic category (e.g., {Rolls Royces} vs. {Mini Coopers}). In other words, categorization at the subordinate level costs more perceptual effort (see, e.g., Collin & McMullen 2005) without providing more information as to how the given thing can be interacted with (clearly, there may be a profit with respect to the prediction of some other features, e.g., <expensive>). Taken together, it is plausible that when perceiving things, the natural “entry point” into conceptual knowledge is at the basic level (Jolicoeur, Gluck & Kosslyn 1984). Let us add, however, that this probably does not apply to all conceptual tasks. For example, in action planning, when pondering about possible means of achieving a particular goal, functional features may come to mind first. Someone who is hungry may think of buying something that can be eaten, and someone planning to go to a dangerous place may think of taking along something for self-defense. Thus, in action planning, the entry point into a taxonomy may often be at the superordinate level.

We end this section with a cautionary remark on the notion of hierarchical relations. The organizational principle of a truly hierarchical classification scheme is that of set inclusion. However, it is questionable whether this principle generally applies to concept-based taxonomies. First, concepts, as we have characterized them, do not provide defining features of the members of a category but features are more or less biased to the assignment of a given entity to a particular category (cf. Sec. 3 and 4). Hence, intransitive categorical decisions may arise. For example, a car seat may be judged to belong to the category {chairs} but not to the category {pieces of furniture} (Hampton 1982; see also Sloman 1998). Second, many of the concepts that are commonly considered superordinate concepts (e.g., CLOTHING, FOOD, JEWELRY) may actually refer to groups or collections of heterogeneous entities, united by spatio-temporal contiguity and function (see Wisniewski, Imai & Casey 1996). If so, then a single item, for example a shirt, can not more be considered an instance of CLOTHING, than a single singer an instance of CHOIR or a single ship an instance of FLEET.

### 3. Theoretical approaches

Although in the previous section we tried to avoid committing ourselves to a particular concept theory, our presentation was certainly not theory-neutral. This section gives an overview of the theoretical approaches to conceptual knowledge and categorization.

According to the **definitional approach** (or classical approach), a concept defines a category by specifying the features that are singly necessary and jointly sufficient for membership in the category. Few if any cognitive psychologists consider this view adequate for everyday concepts and categories. This is not to deny that in certain kinds of artificial or technical category learning tasks, people may expect the categories to be well-defined and aim at finding a simple rule for discriminating between them (*rule-based*

categorization; see Close et al. 2010). However, there are a number of strong theoretical and empirical arguments against the definitional view of everyday concepts (see, e.g., Murphy 2002, chap. 2). Many of them were pointed out by Rosch and her colleagues in a series of seminal articles in the 1970s (for an overview, see Mervis & Rosch 1981). These researchers also proposed an alternative to the definitional view which quickly found many adherents, namely the prototype view (e.g., Rosch & Mervis 1975).

According to the **prototype view**, the different members of a category, rather than all sharing a certain set of features, each match (or resemble) other members in different respects. In other words, they bear a “family resemblance” (Rosch & Mervis 1975). Category membership is a matter of degree; it is a function of an item’s similarity to the *prototype* of the category, which is what is represented in the corresponding concept. There are two rather different conceptions of a prototype. According to the first one, it is an assemblage of all possible features, each weighted by its frequency of occurrence in the category (e.g., Rosch & Mervis 1975) or by another measure of its importance for the category (e.g., Hampton 1993). For example, in the prototype for TOMATO, <red> has a greater weight than <green>. According to the second conception, a prototype is a sort of central-tendency instantiation of the category, possessing the features that correspond to the mean or modal value of the category members on each attribute dimension (e.g., Minda & Smith 2011). Notice that neither conception envisages that a prototype captures within-category relations between attribute dimensions or the relative frequency of co-occurrence of certain features in the category (e.g., <red> & <ripe>). Rather, the various attribute dimensions are considered independently of each other. Hence, prototype theories belong to the class of *independent cue theories* (Medin & Schaffer 1978).

The previously mentioned theoretical approaches regard concepts as knowledge structures that – albeit possibly being used as building blocks in other types of knowledge – are in principle independent of other types of knowledge. By contrast, the **theory-based approach** (sometimes referred to as explanation-based or knowledge-based approach) assumes that concepts are embedded in naïve domain-specific theories (e.g., Murphy & Medin 1985). Concepts are “mini-theories” (Rips 1995), specifying categories in terms of causal relationships among features. Category membership is determined by estimating how well the features of a given thing can be explained by the causal mechanisms specified in the concept (e.g., Rehder 2010). One version of the theory-based approach is **psychological essentialism** (e.g., Gelman 2004; Medin & Ortony 1989), according to which people believe that the members of a category share an unchanging property, an essence, that causes category members to have the features they do. The essence of a category may be unknown, in which case the concept contains an “essence placeholder”. Notice that psychological essentialism, like the definitional approach, assumes that categories have clear-cut boundaries – every entity either is or is not in a particular category. This does not imply clear-cut categorization judgments. Often a person may be uncertain about the essence of a given thing and needs to rely on features considered diagnostic of essences.

Almost all theories posit that a concept is a sort of summary representation of a category, characterizing the set of category members as a whole. The only exception is the **exemplar approach**, which assumes that a concept represents the individual exemplars of the category that have been encountered in the past (e.g., Medin & Schaffer 1978; Nosofsky 1986; Storms 2004). The “glue” holding together the different exemplars of a category is their common label. A thing with an unknown label is categorized by comparing it with



the individual exemplars of the relevant alternative categories and choosing the category for which the observed similarities are largest overall. Exemplar theories imply that people possess implicit knowledge about the co-occurrence of features within categories and that categorization is sensitive to the particular combination of features being true of the given thing.

According to **connectionist models**, conceptual knowledge is encoded in a large network of representational units with weighted connections between them. In distributed models (e.g., McRae 2004; Moss, Tyler & Taylor 2007) the units represent conceptual microfeatures and the weights of the connections reflect the strengths of their associations. When a group of microfeatures becomes activated (e.g., by sensory input), activation is propagated through the network via the connections until eventually a stable pattern of activated units is reached. This pattern is a working memory representation that is shaped by conceptual knowledge. However, the process does not necessarily imply categorization in the usual sense, as distributed connectionist models do not generally assume the conceptual network to be organized into distinct concepts.

A related theory is the **simulation view** of conceptual processing (e.g., Barsalou 2009), which assumes that concepts are bindings of memory traces distributed over modality-specific mental subsystems. Importantly, concepts include information about the situations in which the category's members were encountered. Upon perceiving an entity, its features and the context entail a re-enactment of various memory traces that were formed when similar things were previously encountered in similar situations. The result is a highly situation-specific construal of the given thing as a member of the category.

The various theoretical views are not mutually exclusive. For instance, a prototype model may make the additional assumption that concepts contain information about causal and other relations between features (see Hampton 2006). Furthermore, summary representations and sets-of-exemplars representations are frequently taken as end points of a continuum. Example models include Anderson's (1991) rational model, SUSTAIN (Love, Medin & Gureckis 2004), and the varying abstraction model (Vanpaemel & Storms 2008). Other models assume that people draw on different kinds of knowledge when categorizing items, for instance, on prototypes plus remembered exemplars (e.g., Smith & Minda 2000). Similarly, some researchers emphasize that multiple, neurobiologically distinct memory systems contribute to category learning and categorizing (e.g., Ashby & Maddox 2011).

## 4. Issues of debate

Many controversies in research on concepts and categorization originate from criticisms of the prototype view. In this section, we address three important issues of debate. In each of them certain implications of the prototype view are compared against those of one or two other theoretical views mentioned in the previous section.

### 4.1. Is category membership a matter of degree?

Prototype theories assume that category membership is graded. The more similar a given thing is to the prototype the more clearly it is a member of this category. In addition, according to prototype theories, the typicality of an item reflects its degree of category membership. Both these assumptions are questioned by other researchers, in particular

by proponents of the definitional and essentialist view. They posit that category membership is all-or-none – a thing is either a full member of a category or it is not a member of the category – and typicality has nothing to do with category membership. Let us first consider the variable of typicality and then turn to the more general question of whether category membership is all-or-none or a matter of degree. Before reviewing the empirical findings, it is important to re-emphasize that in empirical research on conceptual knowledge, the categories and the items to be categorized are often specified linguistically, and this is especially true in this research area. Most of the findings we report in this section are therefore actually findings about knowledge and use of lexical meanings. However, we present them in accordance with the way they are normally interpreted.

It is well-established that members of a category vary in the degree to which they are considered representative or good examples of the category. One particular cat may appear “cattier” than another one. Similarly, a trout or a herring is considered more representative of the category {fish} than a shark or a flounder, for instance. The most common measure of representativeness is typicality. Typicality is operationally defined, namely by responses to questions of the form *How typical is item x of category y?* or *How good an example is item x of category y?* Notice that typicality is a matter of the *relation* between an item and a category. This becomes evident when we consider different levels of a taxonomy. For example, a robin is rated more typical than a chicken if the target category is {birds}, but the opposite is true if the target category is {animals} (see Roth & Mervis 1983).

It should be mentioned that ratings of typicality are not always based on considerations concerning representativeness. Specifically, in domains in which a person has expert knowledge, and with goal-derived categories (e.g., {foods to eat on a diet}), the ratings are mainly determined by how close an item is to the ideal of the category (see, e.g., Barsalou 1985; Lynch, Coley & Medin 2000; for a unified account, see Davis & Love 2010). However, we ignore this “atypical” variant of typicality in the following.

Empirical research has revealed that typicality plays a role in a wide variety of conceptual tasks (for reviews, see Mervis & Rosch 1981 and Smith & Medin 1981, chap. 3), as well as in lexical processing and the pragmatics of certain expressions (see, e.g., Onishi, Murphy & Bock 2008; Rosch, 1978). Most importantly in our context, typicality has been found to be highly correlated with category-membership judgments as well as with measures of feature overlap and other measures of similarity to the prototype (e.g., Hampton 1998; Rosch & Mervis 1975). Proponents of the prototype view consider these findings as evidence that typicality is based on the same underlying variable that category membership is based on, namely similarity to the prototype (see Hampton 2007 for an explication of this assumption). This conclusion is challenged by other researchers (e.g., Armstrong, Gleitman & Gleitman 1983; Kamp & Partee 1995; Osherson & Smith 1997), who argue that for theoretical reasons and in view of certain empirical findings, typicality and category membership need to be distinguished. For example, Armstrong, Gleitman & Gleitman (1983) point out that graded typicality judgments are obtained even for well-defined categories such as {even numbers}. A summary of the main arguments in this debate is given in Hampton’s (2007) rejoinder.

Considering the controversial status of typicality ratings, it is reasonable to ask participants directly for judgments of category membership to find out whether category membership is absolute or a matter of degree. The simplest and most frequently used method of obtaining category-membership judgments are Yes-No categorization tasks.

Participants are presented with a category name and various items (pictures of objects or verbal labels) and are asked to decide for each item whether or not it is a member of the category. Typically, a gradient of judged category membership is found – some items are categorized as members of the target category by more participants than are others. For example, in a study by McCloskey & Glucksberg (1978), the item *airplane* was categorized as a member of the category *vehicles* by nearly all participants whereas *roller skate* and *parachute* turned out to be “borderline” items, judged as members of the category *vehicles* by barely more than 50% of the participants. Of course, this finding may simply reflect individual differences in the placement of the category boundaries. However, McCloskey & Glucksberg (1978) also found that participants, when presented with the task a second time, sometimes changed their categorization decision, in particular for borderline items. This variability may be attributed to an instability of the criteria for judging category membership or to fluctuations in the content of the representations established in working memory. In any case, the finding suggests that judged category membership is more “fragile” for some items than for others. This however does not yet prove that people believe that category membership is a matter of degree.

To clarify this issue, other experimental paradigms were developed. For example, participants were asked to judge the category membership of items on a scale from “definitely not a member” to “definitely a member”, offering the opportunity for expressing degrees of category membership (e.g., *How clearly is an escalator a member of the category ‘vehicles’?*) (see, e.g., Barr & Caplan 1987; Diesendruck & Gelman 1999). Furthermore, various meta-cognitive tasks were used. For example, Kalish (1995) presented pairs of statements such as *John says this animal is an elephant* and *Jane says this animal is not an elephant* and asked participants to decide whether this disagreement would in principle be resolvable as only one statement can be true, or whether it would in principle be irresolvable as one can always argue for both sides. Together, the results from these studies (see Estes 2004 and the literature cited therein) suggest that people consider category membership a matter of degree for artifacts (e.g., vehicles, tools), while they are somewhat more inclined to assume absolute membership for many categories of natural kinds (e.g., birds, fruit). It should be added that differences between concepts of artifacts and natural kinds have been revealed in other areas of research as well, but there is as yet no widely accepted answer as to what precisely distinguishes the concepts in these domains (see Margolis & Laurence 2007).

#### 4.2. Summary representations or representations of sets of individual exemplars?

Much research has been devoted to the question of whether concepts provide information about entire categories (“summary representation”) or represent individual exemplars of categories. Although the former view is taken by many different theories, the debate is centered between those versions of prototype theory that consider prototypes as central-tendency representations (see Sec. 3) and exemplar theories. The debate led to a flood of categorization studies, mostly using artificial categories (e.g., sets of dot patterns; sets of geometric forms varying in shape, size, and color) that participants first learn in the experiment. Using artificial stimuli has the advantage that the categories can be tailored to the question at hand. To illustrate, let us consider a simple categorization task in which participants assign stimuli to one of two categories, {a} and {b}. According to

prototype theory, all that matters is the similarity of the given stimulus *S* to the prototype of each of the categories (see Minda & Smith 2011). The more similar *S* is to one of the prototypes, the more likely it will be categorized as a member of this category. Specifically, if *S* exactly matches one of the prototypes, say that of category {*a*}, then the likelihood that it is categorized as a member of category {*a*} rather than {*b*} is maximal, even if it is quite similar to some exemplars in the alternative category. According to exemplar accounts, however, what matters is the similarity of *S* to the individual exemplars of the two categories (see Nosofsky 1986). Even if *S* is identical to the prototype of one of the categories, it may be categorized as a member of the contrast category, provided it is extremely similar to one or more of the exemplars of this category. By creating artificial categories, variables such as these can be manipulated, while keeping other ones constant. Importantly, whereas in many natural categories the prototype is an abstract entity, which doesn't actually exist, artificial categories can be designed such that the prototype exists in the set of stimuli.

To test the validity of the theories, many studies have investigated the categorization of the prototypes of categories. In a typical experiment, the stimulus material comprises two stimuli constituting the prototypes of two categories (e.g., two different patterns of five dots each) and a number of different "distortions" of the prototypes (e.g., patterns of five dots that slightly differ from the respective prototype with respect to the spatial relations among the dots). In a training phase, participants are presented with a selection of the distortions and are told which category each pattern belongs to. The prototypes themselves are not presented in this phase. In a later transfer phase, participants categorize old distortions (i.e., patterns that were presented during training), new distortions (i.e., patterns that were not presented before), as well as the prototypes of the categories. According to prototype theory, the prototype of a category should be particularly easy to categorize (*prototype-enhancement effect*). Early studies using this prototype-distortion paradigm (e.g., Posner & Keele 1968) confirmed this prediction. However, in those studies, the similarity between the prototype of a given category and the old distortions belonging to the same category was on average higher than the similarity between the new distortions and the old distortions in the same category. For such a situation even exemplar models predict a prototype-enhancement effect (see, e.g., Shin & Nosofsky 1992). More recent studies that tease apart the relevant variables (i.e., similarity to the prototype vs. similarity to other exemplars of the categories) support the predictions of the exemplar view (cf. Nosofsky 2000, but see Minda & Smith 2002).

A possible drawback of artificial categories is that researchers inadvertently create conditions that favor one or the other account. For example, if the experiment involves only a few categories, with a small number of exemplars per category and little "within-category structure", then it isn't surprising that participants tend to encode and remember the individual exemplars. In contrast, if multiple, large and highly structured categories are to be learnt then creating summary representations may be advantageous. Indeed, the results mentioned above that favored exemplar models mostly stemmed from studies that employed only two small categories with little within-category structure. When conditions were less favorable for memorizing individual exemplars, results were more in line with prototype theories than with exemplar models (for an overview, see Minda & Smith 2011). To account for these findings, in recent years various hybrid categorization models have been proposed (see Sec. 3). In addition, increasingly more attention has been devoted to whether the findings generalize to natural language categories (see,

e.g., Storms 2004) and to a wider range of category uses (see, e.g., Markman & Ross 2003).

### 4.3. Relations between features within a category

Rosch (1978) emphasized that conceptual knowledge captures the correlational structure of the world. Surprisingly, however, according to Rosch's and other prototype theories, feature associations *within* categories are not encoded in conceptual knowledge. To illustrate, let us consider the category {spoons} (see Medin & Shoben 1988): Spoons differ from one another with respect to the material they are made of and their size, among other things. For the category {spoons}, these two attribute dimensions are associated: Wooden spoons tend to be relatively large, whereas metal spoons are more often small or medium-sized. Notice that this is a *within-category* relation, which possibly only holds for {spoons}. Across the board, material and size may be unrelated, and in certain other categories there may even be an association in the opposite direction (e.g., in the category {ships}). In any case, according to prototype theories, associations such as these are not captured in a concept. However, other theories do assume that concepts contain information about within-category featural associations. According to exemplar theories, the information about the statistical co-occurrence of features within a category is implicitly coded in the knowledge of the category's exemplars. Connectionist and theory-based accounts both posit explicit representations of feature associations but their assumptions differ in an important respect: Connectionist accounts imply that statistical co-occurrences are encoded; the more often two features are encountered together, the greater the weight of the connection between the respective units (see, e.g., McRae 2004). By contrast, theory-based accounts assume that mainly those feature relations are encoded for which the person has a causal explanation (e.g., Ahn et al. 2002; Murphy & Medin 1985). We will refer to these two kinds of associations as *statistically-based* and *theory-based* associations, respectively.

It is now well-established that, contrary to what prototype theories imply, conceptual knowledge does encode within-category feature associations. Much evidence comes from studies conducted in the theory-based framework. For example, it was found that the status of a feature in the structure of causal relations (supposed to be represented in a concept) affects how much importance is attached to this feature in categorization decisions (*causal status effect*). Furthermore, objects are classified by evaluating whether their features are likely to have been generated by the structure of causal relations that make up the concept (for an overview, see Rehder 2010).

However, these studies have been exclusively concerned with theory-based associations. It remains open whether purely statistically based feature associations are encoded in conceptual knowledge as well, as connectionist and exemplar accounts imply. A study by Ahn et al. (2002) suggests that the associations people are aware of are mostly ones they conceive of as causal relations. However, this conclusion was challenged by McNorgan et al. (2007). Moreover, it must be borne in mind that not all information encoded in conceptual knowledge is necessarily conscious. Indeed, various studies demonstrate that people possess and use knowledge of feature associations that they have probably never consciously thought of and that they may not be able to provide an explanation for (e.g., McNorgan et al. 2007; McRae 2004; Murphy & Ross 2010).

## 5. Conceptual combination

Conceptual combination is the process by which a complex representation is constructed from two or more concepts. Using almost exclusively linguistic stimuli, research on conceptual combination is effectively concerned with the interpretation of complex linguistic expressions, mainly nominal expressions such as *brown apple*, *sports which are games*, or *mountain bird*. The result of conceptual combination is frequently called a *complex concept*. However, it is important to keep in mind that it is actually a representation in working memory, not a novel long-term memory structure (see Sec. 1). We refer to the result of conceptual combination as a *composite working memory representation* or simply *composite representation*.

After an initial debate about the viability of an extensional analysis of conceptual combination in the early 1980s (e.g., Osherson & Smith 1981), research has focused on intensions, that is, on the properties represented in concepts and in composite representations constructed from them. Consequently, in empirical studies, participants are typically asked to generate or verify properties of the members of a named category or to describe their interpretation of a given stimulus expression in detail.

### 5.1. Empirical findings and theoretical approaches

An early model of conceptual combination is the Selective Modification Model (Smith et al. 1988), which is concerned with **adjective-noun combinations** (e.g., *brown apple*). Noun concepts (e.g., APPLE) are assumed to have a prototype structure comprising a list of relevant attribute dimensions (e.g., color, shape, taste), with a set of weighted values for each dimension (e.g., <red>, <green>, <brown> for the color dimension in the concept APPLE). To create a composite representation for an adjective-noun phrase such as *brown apple*, the relevant attribute dimension (color) is selected and the weight of the value <brown> is enhanced whereas the weights of the other values are set to zero. With a few additional assumptions, this model accounts for typicality-judgment phenomena observed with adjective-noun phrases. However, the model is limited to adjectives that unambiguously refer to one of the attribute dimensions listed in the noun concept. It cannot deal with multiattribute adjectives (e.g., *shriveled apple* – shape and texture), nor with subsecutive adjectives (e.g., *good apple* vs. *good coffee*), nor with privative adjectives (e.g., *fake apple*). Several researchers (e.g., Medin & Shoben 1988; Murphy 1988, 1990) take this failure to reflect a more fundamental problem of prototype theories, which, according to their view, severely underestimate the richness of information used in conceptual combination (for another objection, see Connolly et al. 2007). For example, Murphy (1988, 1990) emphasizes that world knowledge plays a pivotal role in conceptual combination, and Medin & Shoben (1988) call attention to the context dependence of adjectives. We shall come back to these arguments in Section 5.2. Since this debate, only few articles addressing adjective-noun combination have been published (e.g., Franks 1995).

Much more research has been devoted to **noun phrases containing a restrictive relative clause** (e.g., *sports which are games*), which are thought to require the conjunction of noun concepts for their interpretation. Research in this field is strongly influenced by Hampton's (1987) Composite Prototype Model, which posits prototype concepts representing property lists, where the properties are weighted according to their importance for the respective concept. A composite representation is formed by merging the



properties of the two constituent concepts, assigning new weights to the properties according to certain rules, and performing a consistency checking procedure to ensure that the composite representation does not inherit incompatible properties. This model accounts for a wide range of empirical findings, including concept dominance, non-commutativity, and overextension (see Hampton 1997). There is a phenomenon, however, that must be attributed to processes not captured by the model – the occurrence of *emergent properties*. We discuss this phenomenon in Section 5.2.

The current focus of conceptual-combination research is on (novel and familiar) **noun-noun compounds** (e.g., *mountain book*). There are two different theoretical approaches, the *schema-based* and the *relation-linking* approach. Schema-based theories (e.g., Costello & Keane 2001; Murphy 1988; Wisniewski 1997) posit rich concepts similar to those proposed by the theory-based view (see Sec. 3). Concepts are schema representations with complex internal structure, containing information about possible properties and their interconnections as well as typical functional roles in scenarios (e.g., SPOON: instrument for eating, instrument for stirring), and other thematic relations to other concepts (see Sec. 2.2). According to these theories, a noun-noun compound is interpreted by integrating information from the modifier concept with the head concept. Wisniewski's (1997) Dual-Process Theory may serve as an example. Wisniewski distinguishes between different kinds of interpretations, the two most common ones being *relational interpretations* and *property interpretations*. These interpretations result from different processes. Relational interpretations occur if the modifier and head concept are found to fit different functional roles in a particular scenario. For example, *paint spoon* could be interpreted as a spoon used to stir paint because SPOON can be bound to the instrument role and PAINT to the object role in a stirring scenario. In contrast, property interpretations involve a mapping of one or more properties from the modifier concept onto the head concept. For example, *box clock* may be interpreted as a square clock and *zebra clam* as a striped clam. According to the Dual-Process Theory, property interpretations are the outcome of a process involving a comparison and alignment of the modifier and the head concept. However, recent findings suggest that the salience and diagnosticity of the modifier's properties play a crucial role (see, e.g., Costello & Keane 2001; Estes & Glucksberg 2000).

The relation-linking approach is inspired by traditional linguistic theories of compounding (see article 80 (Olsen) *Semantics of compounds*, Sec. 2) and was introduced into the research on conceptual combination by Gagné & Shoben (1997), see also Gagné & Spalding (2009). According to their theory CARIN (Competition Among Relations in Nominals), a compound noun is interpreted by linking the two constituent concepts via a thematic relation selected from a limited set including 'located', 'made\_of', 'about', 'during', and some others. For example, *mountain bird* may be interpreted by selecting the relation 'located' (a bird in the mountains) and *mountain magazine* by selecting the relation 'about' (a magazine about mountains). To find a suitable interpretation, people exploit knowledge about statistical regularities in language use. More specifically, upon encountering a noun in modifier position, knowledge about its past use as a modifier becomes activated and the respective relations then compete for selection. CARIN predicts that, all else being equal, compounds instantiating a relation that has been used frequently with the given modifier are easier to interpret than compounds instantiating a relation less often used with this modifier. Thus, for example, as corpus analyses show that the modifier *mountain* is most often associated with the 'located' relation, *mountain bird* and

*mountain tent* should be easier to interpret than *mountain magazine*. Empirical findings correspond to this prediction (e.g., Gagné & Shoben 1997; for left-headed compounds, see Storms & Wisniewski 2005).

It has often been questioned whether the great variety of relationships between nouns in compounds can indeed be reduced to a limited number of categories. However, let us accept this assumption and instead draw attention to CARIN's proposal concerning statistical knowledge. Considering the ample experimental evidence for the exploitation of statistical regularities in language comprehension (see Jurafsky 2003), the claim that people use statistical knowledge in processing compound nouns is no doubt plausible. However, does this knowledge actually concern individual lexical items, as Gagné & Shoben (1997) propose? Maguire, Wisniewski & Storms (2010) have reported that semantically similar words exhibit similar combination patterns in compounds. With the benefit of hindsight, this finding is not surprising. Semantically similar words share many meaning components, and the way words are used in compounds certainly depends to a great deal on certain critical components. For example, the fact that *mountain*, when used as a modifier, is frequently associated with the relation 'located' but not with, say, the relation 'during' is most likely due to the fact that this noun denotes objects conceived as spatially extensive and permanent. Words that likewise denote objects conceived as spatially extensive and permanent (e.g., *valley*, *sea*, *city*, *garden*) can be expected to show the same preference for 'located' over 'during'. More generally speaking, one may assume that certain critical meaning components (or combinations of them) are each associated with a characteristic relation frequency distribution. Thus, the statistical knowledge people use in processing compound nouns may actually concern relation frequencies associated with certain meaning components rather than lexical entries. Unlike Gagné & Shoben's proposal, this revised proposal accounts for the finding that even rare words, which have probably never been encountered in compounds, display clear preferences for certain relations, when used as modifiers (Maguire & Cater 2005).

Certainly, the use of knowledge of statistical regularities can only be a *part* of the interpretation process. It only provides likely candidate relations. The respective interpretations must be worked out and their plausibility must be evaluated in order to eventually settle on one interpretation. CARIN says nothing about these processes. As several researchers (e.g., Storms & Wisniewski 2005) have pointed out, a fully-fledged theory should probably integrate assumptions from CARIN with those from schema-based theories. The processing of a compound noun may involve a statistic-based activation process (similar to the one assumed by CARIN or the revised proposal) as well as construction and evaluation processes (as proposed by schema-based theories).

As we have seen, research on conceptual combination has been dominated by the prototype view and the theory- or schema-based view. Connectionist theories and simulation theory are only recently becoming involved in the discussion (see, e.g., Levy & Gayler 2004; Wu & Barsalou 2009). The exemplar view, however, faces a particular problem. Its central assumption that a concept is a set of stored exemplars renders it difficult to account for the productivity of conceptual combination. Let us take the concepts STRIPED and APPLE as an example (see Osherson & Smith 1981). How can people form a composite representation out of these concepts if they have never encountered an exemplar of the category {striped apples}? Some authors (e.g., Storms et al. 1993; see also Storms 2004) propose to take representations of subcategories as the stored exemplars of a concept



(e.g., PIGEON, CHICKEN, RAVEN are three exemplars of BIRD). However, it is as yet unclear whether this conception of exemplars solves the above-mentioned fundamental problem of the exemplar approach.

## 5.2. Conceptual compositionality

Psychological research on conceptual combination, in which theories primarily seek to make correct predictions concerning people's interpretations of complex expressions, has devoted relatively little attention to the issue of compositionality (for compositionality in semantics, see article 6 (Pagin & Westerståhl) *Compositionality*). Definitions of conceptual compositionality are most often left implicit, but many researchers would probably agree that the composite representations created by means of conceptual combination are compositional to the extent that they are the result of processes that operate on the constituent concepts, guided by syntactic information. According to this definition, any use of information beyond that contained in the constituent concepts counts as non-compositional – even if this information is used in a rule-governed, predictable way. Hence, a non-compositional account of a given phenomenon is not necessarily inferior to a compositional account as far as predictive power is concerned. It should also be borne in mind that composite representations are representations in working memory, constructed in particular situations. Every reasonable theory must therefore acknowledge that at some point in time during the construction of a composite representation, information external to the constituent concepts is used. Of course, whether or not a theory provides a compositional account of a finding is still an important question. Two sets of findings have received particular attention in the discussion, context-dependent property instantiation and emergent properties.

Several researchers have pointed out that properties (even ones named by intersective adjectives) are instantiated differently in composite representations depending on the entities they are applied to (e.g., Medin & Shoben 1988; Murphy 1988; Wisniewski 1997). For example, when *zebra clam* is interpreted as a black-and-white striped clam, the stripes on the clam are probably represented as smaller and thinner than those of a zebra (Wisniewski 1997; see also Wilkenfeld & Ward 2001). Context dependence is often taken as evidence that the properties in a concept are not independent of one another, so that a new property must be accommodated to the particular selection of properties in the head concept (but see Rips 1995 for a more differentiated view). If this is true, then theory-based or schema-based theories are, in principle, able to provide a compositional account, while prototype theories are not, as a prototype concept contains no information about the interrelations among properties (see Sec. 3 and 4.3).

As we mentioned above, conceptual combination sometimes yields emergent properties (or *phrase features*): People consider certain properties true or typical of the composite but not of either of its constituents. For example, Hampton's (1987) participants often listed the property <live in cages> for *pets which are birds* but did not judge this property true of pets nor of birds. Emergent properties have also been observed with other kinds of combinations (e.g., *large spoon* → <wooden>; *beach bicycle* → <equipped with wide tires>) (see, e.g., Hampton 1997; Medin & Shoben 1988; Murphy 1988; Wilkenfeld & Ward 2001). It is widely agreed that there are at least two possible sources of emergent properties. First, they may arise from *extensional feedback*. That is, if the complex expression denotes a category of familiar things (e.g., *large spoons*; *pets that are also birds*), then

people may retrieve familiar instances of this category from long-term memory and “look up” their properties. Notice that according to prototype and theory- or schema-based theories, extensional feedback can only take place *after* the combination of the concepts – the combination process cannot peek at instances of the composite (*no-peeking principle*, Rips 1995). Hence, these theories cannot provide a compositional account of emergent properties arising from extensional feedback. In line with the notion of extensional feedback, empirical studies (e.g., Swinney et al. 2007) have shown that emergent properties become available at a later point in time during the processing of a complex nominal expression than do “inherited” properties. For example, when presented with *peeled apple*, people need more time to access the emergent property <white> than the inherited property <round>.

Second, emergent properties may result from reasoning processes and domain theories. An example is when *helicopter blanket*, interpreted as a cover for a helicopter, is ascribed the emergent property <waterproof> (Wilkenfeld & Ward 2001). Obviously, prototype theories must attribute these properties to reasoning processes taking place after concept combination. In contrast, theory-based approaches may be well-suited to provide a compositional account, by explaining how these properties emerge from reasoning processes that use the mini-theories contained in the concepts. However, as yet there are no systematic studies on this issue.

## 6. Relationship between conceptual knowledge and word meanings

As we mentioned in the previous sections, many authors assume that conceptual knowledge is organized into distinct packages of information, that is, into concepts, and take concepts to be equivalent to lexical meanings. In the present section, we consider the implications of this equivalence view, and describe possible alternatives. The issue has much in common with the dictionary/encyclopedia debate in linguistics (for an overview, see Peeters 2000; see also article 30 (Jackendoff) *Conceptual Semantics*, and article 31 (Lang & Maienborn) *Two-level Semantics*). However, instead of repeating arguments from this debate, we look at the issue from a different perspective, examining whether the equivalence view is compatible with theoretical considerations and empirical findings from research on conceptual knowledge. Accordingly, the focus is on the relationship between concepts and meanings of count nouns. We disregard morphological issues and up until the end we also ignore homonymy, polysemy, and synonymy. Thus, we simply speak of *word meanings* and assume that each of them is associated with exactly one *word form*, and vice versa.

### 6.1. Equivalence view

The view that concepts are equivalent to the meanings of words comes in two variants (see Fig. 106.1). On the first variant, which seems to be the prevalent one in research on concepts in cognitive psychology, concepts *are* word meanings. On the second variant, concepts and word meanings are stored in different mental subsystems but for each concept there is exactly one word meaning that shares the same informational content and vice versa. This variant is more in line with the traditional notion of a mental lexicon as a mental subsystem clearly separated from non-linguistic long-term memory.

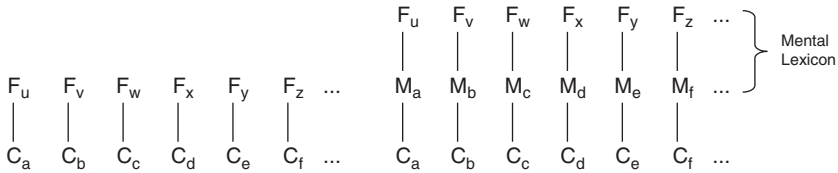


Fig. 106.1: Two variants of the equivalence view. Left: Concepts are word meanings. Right: Concepts and word meanings are distinct but informationally equivalent knowledge structures.  $C_i$  = concept,  $M_i$  = word meaning,  $F_i$  = word form.

One problem with the equivalence view is that it implies that all concepts have a label. Each concept is connected with one particular form, either directly (Variant 1) or indirectly via the corresponding meaning (Variant 2). This entails a very narrow perspective on conceptual knowledge, which disregards concepts in pre-verbal infants and animals (for reviews, see Rakison & Yermolayeva 2010 and Lazareva & Wasserman 2008, respectively) and also a good deal of conceptual knowledge of human adults. Concepts can no doubt be acquired incidentally and without learning labels for them. This has been shown experimentally by studies of unsupervised category learning (e.g., Billman & Knutson 1996) and is also evident in our everyday experience. For example, people often discriminate between several subcategories of things (e.g., different subcategories of trees) without having names for them (see Malt & Sloman 2007: 102), and they possess concepts for which there is no label in their language (e.g., `EXTENDING_ONE'S_ELBOWS_TO_THE_SIDE_TO_FEND_OFF_A_SHOVING_NEIGHBOR`; see Murphy 2002: 389).

A second important implication of the equivalence view concerns the issue of the universality of the structure of conceptual knowledge. Different languages carve up the world in different ways, and, according to the equivalence view, conceptual distinctions match lexically coded distinctions. Speakers of different languages must therefore be assumed to differ in the structure of their conceptual knowledge. In recent years, there has been a revival of interest in the Sapir-Whorf or linguistic relativity hypothesis, which states that language influences thought (for an overview of current research, see Gleitman & Papafragou 2012). Clearly, this hypothesis goes beyond the equivalence view, which is mute on the factors that give rise to the asserted correspondence between conceptual structures and lexicalization patterns. However, some empirical findings from this research are directly relevant to the issue at hand, demonstrating that, at least in some domains, the structure of conceptual knowledge does *not* vary across speakers of languages that partition the domain in different ways. The domain of motion events may serve as an example. Some languages, including English, typically encode the manner but not the path of motion in motion verbs (e.g., *stroll*, *creep*, *run*), while other languages, for example Greek, tend to encode the path rather than the manner (e.g., *anevéno*, *katevéno* for *to move up to* or *down to*, respectively). The equivalence view predicts analogous differences between English and Greek native speakers on nonverbal conceptual tasks, for example, categorizing visually presented scenes of motion events or judging their similarity. Specifically, English native speakers should pay relatively more attention to the manner than the path of the motions, while Greek native speakers should pay more attention to the path than the manner. Yet, empirical studies have found no difference between English and Greek speakers' performance on such tasks (e.g., Papafragou & Selimis 2010). Dissociations between lexicalization patterns and non-linguistic conceptual performance have

also been revealed in the domain of household containers and some other domains (see Malt, Gennari & Imai 2010).

## 6.2. Free-concepts view

With regard to the first problem mentioned above, an obvious alternative to the equivalence view is to acknowledge that not all concepts have a label. That is, in addition to *lexicalized concepts*, which are directly or indirectly connected with word forms, there are *free concepts*, which lack such connections. Interestingly, this view also allows one to cope with the second problem, concerning the findings from the cross-linguistic studies: People possess a huge repertoire of concepts, which is language-independent (e.g., all people possess concepts of motion events that include manner but no path information as well as concepts that include path but no manner information). A particular subset of concepts, which is language-specific, is lexicalized. The remaining concepts are free concepts. On linguistic tasks, people use lexicalized concepts. On nonverbal tasks, they may use either free or lexicalized concepts, depending on the precise nature of the given task. By these assumptions, the free-concepts view is compatible with virtually every finding concerning the (non)correspondence between the conceptual structures of speakers of different languages, despite the fact that conceptual structures are assumed to be universal.

The free-concepts view appears awkward as it implies that people possess an enormous number of concepts, many of which differ only slightly from each other. Moreover, the proposal that people draw on a particular subset of concepts when using language is not so far from the idea that lexical meanings are knowledge structures of their own. Let us consider this view in more detail.

## 6.3. Non-equivalence view

A theory postulating only one kind of knowledge structure for both lexical meanings and concepts may be an economical theory. However, whether possessing only one kind of knowledge structure for both lexical meanings and concepts is economical for the human mind is a different matter. Doubts arise when one considers the different functions that language and non-linguistic cognition have to serve. The requirements for successful communication, which is the primary function of language, differ in certain respects from what is useful for object recognition, feature prediction, action planning, and other non-linguistic cognitive tasks. Specifically, since communication is dependent on a common ground, an important constraint for lexical meanings is the shareability of the information they contain. By contrast, the information used in non-linguistic conceptual tasks need not be shared by many people. Thus, concepts may, and even should, include information deriving from a person's individual experience. In addition, lexical meanings, being based on social conventions, are probably relatively stable over time, whereas concepts should be easily malleable in order to be useful across changing life conditions. In sum, it seems reasonable to assume that concepts and lexical meanings are distinct, although related, knowledge structures (for additional arguments, see, e.g., Gleitman & Papafragou 2012; Malt, Gennari & Imai 2010; Vigliocco & Vinson 2007).

One possibility is that concepts and lexical meanings are stored in distinct mental sub-systems (as shown on the right side of Fig. 106.1) but are richly connected. Each concept may be linked to more than one meaning, and each meaning to more than one concept.

Another possibility, which we consider more plausible, suggests itself when shifting to a finer-grained level of analysis – that is, to the constituents of concepts and lexical meanings. Conceptual and lexical-semantic knowledge may involve a common stock of atomic representations, from which they form their own more complex structures. As we have discussed in Section 3 and 4.2, there are two fundamentally different views of atomic representations in conceptual knowledge – representations of individual exemplars and representations of features (and possibly their interrelations). These two views entail different conceptions of the relationship between conceptual and lexical knowledge, which we outline in the following paragraphs.

Recall that according to the exemplar view, a concept is a set of representations of exemplars encountered in the past. In a framework that we refer to as the **common-stock-of-exemplars framework**, word meanings are assumed to comprise exemplar representations as well. However, concepts and word meanings group the representations according to different principles. A concept is a set of representations of exemplars that are similar according to non-linguistic, conceptual criteria, whereas a word meaning is the set of representations of exemplars that have been associated with this label in the past. The set of exemplar representations constituting a particular meaning may share certain exemplar representations with the set constituting a particular concept. This overlap captures the degree and the respects in which a meaning corresponds to a concept. Note that there are not two separate mental subsystems for concepts and lexical meanings, at least not in the usual sense. Rather, concepts and meanings make use of a common stock of exemplar representations. Nevertheless they are in principle independent of each other, and may for instance gradually change over time in different ways depending on particular individual experiences. Thus, this framework can account for findings concerning the (non) correspondence between lexicalization patterns and nonlinguistic conceptual organization (cf. Malt et al. 1999 for a similar framework). However, whether or not the idea that lexical meanings are sets of stored exemplars stands the test in a wider range of language processing issues has yet to be seen (see also Sec. 5.1). Up until now the exemplar approach has received little attention in psycholinguistic research.

A framework that is easier to align with common psycholinguistic assumptions is what we call the **Common-Stock-of-Features Framework**. The core idea is that both conceptual knowledge and lexical-semantic knowledge involve a common stock of featural atomic representations but combine them into complex structures in a different way. This idea is instantiated in Ursino et al.'s connectionist model (Ursino, Cuppino & Magasso 2010). Instead of describing this sophisticated model in detail, let us point out some interesting aspects on the basis of a raw sketch of a model of this type (see Fig. 106.2). There are a large number of cognitive units representing elementary features which we will refer to as *microfeatures*. They are interconnected by excitatory or inhibitory connections of variable strength, with the strength of a connection reflecting the degree of statistical association or causal relationship between the respective microfeatures. Thus, conceptual knowledge is encoded in the connections among the units. A cluster of relatively strongly interconnected units can be considered a concept, but notice that there are no sharp boundaries between concepts.

The units representing microfeatures are also connected with units outside this network, for instance with units in the sensory, motor, and emotional systems (not indicated in Fig. 106.2). Furthermore, and what is most import to the present issue, with units representing the linguistic form of lexical items. For simplicity, we assume localist form representations, that is, each of these latter units represents a word form as a whole (for

distributed word-form representations, see, e.g., Dilkina, McClelland & Plaut 2008). The bundle of connections between microfeatures and a particular word form make up the meaning of the respective word. Note that despite using a common stock of microfeatures, concepts and word meanings are distinct knowledge structures. Conceptual knowledge is encoded in the weights of the connections *among* the microfeatures, whereas lexical-semantic knowledge is encoded in the weights of the connections between microfeatures and forms.

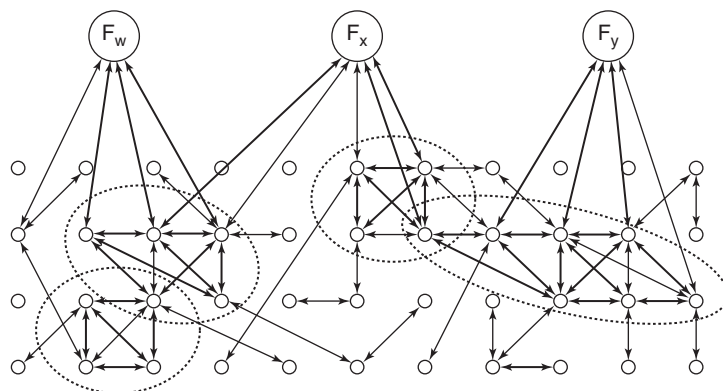


Fig. 106.2: A schematic illustration of a common stock of microfeatures for conceptual and lexical-semantic knowledge. Small circles indicate units representing microfeatures, big circles indicate units representing word forms. Arrows indicate connections, with their thickness representing connection weight (only excitatory connections having substantial weight are depicted). Dotted ellipses indicate clusters of strongly interconnected microfeatures, which may be regarded as concepts.

The cluster of microfeatures constituting a particular concept may overlap to some extent with sets of microfeatures connected to word forms. If there is a large overlap with one of these sets, then the concept may be considered a lexicalized concept. However, even if the overlap is maximal, the concept and the lexical meaning may still differ in their internal structure, since the connections that bind the microfeatures are different in the two cases. In addition, according to our previous considerations regarding specific requirements of communication, it is likely that concepts tend to be richer than the related word meanings. For example, the concept *BACHELOR* may include microfeatures representing the properties <charming> and <has no children> but possibly these microfeatures are not strongly connected with the form *bachelor*, that is, the meaning of *bachelor* may be lacking these features.

Interestingly, this framework also allows one to distinguish between homonymy (e.g., *bat*: animal / sports equipment) and polysemy (e.g., *opera*: musical drama / building). In general a word form is connected to a set of microfeatures most of which are relatively strongly connected to one another, i.e., which roughly belong to a common lump of features. In the case of homonymy, however, the word form (e.g., *bat*) is connected to different sets of microfeatures with hardly any connections between them. In the case of polysemy, the word form (e.g., *opera*) is connected to units from two or more overlapping feature lumps. The subset of features shared by the lumps captures what the different senses of the polysemous word share (e.g., has to do with music). The remaining units of the different feature lumps are barely connected to one another (cf. Rodd, Gaskell & Marslen-Wilson 2004 for a computational model of this sort).



Languages differ with regard to the composition of the sets of microfeatures that are picked out by words (e.g., a verb of motion may include or lack microfeatures representing the manner of motion). This does not a priori mean that the connections *among* the microfeatures, which make up the concepts, vary across speakers of different languages. Hence, it is possible that there is no correlation between cross-linguistic differences and performance on non-linguistic conceptual tasks. Precise predictions would require more specific assumptions about processing and learning mechanisms.

So far, we have been concerned with long-term memory structures (conceptual knowledge, lexical knowledge). Let us now briefly consider what the common-stock-of-features framework suggests with respect to working memory representations (for the distinction between long-term and working memory, see Sec. 1). Activation is fed into the microfeature network by various systems, including the sensory systems. For example, hearing a sound (e.g., barking) gives rise to the activation of units representing the features of this sound. These units in turn activate or deactivate other units, depending on whether the respective connections are excitatory or inhibitory. This complex process eventually leads to a relatively stable pattern of activated microfeatures, which includes not only microfeatures activated by the sensory input but also microfeatures strongly associated with them. Such a relatively stable pattern of activated microfeatures is what we consider a working memory representation. In our example, the working memory representation resulting from hearing the barking may include many microfeatures representing properties typical of dogs.

As to linguistic input, we assume that hearing or reading a particular word (e.g., “dog”) leads to an activation of the corresponding word-form unit. This unit in turn activates the microfeatures to which it is connected and thereby triggers a complex process in the network similar to the one described above. Again, the result is a particular pattern of activated microfeatures. This pattern is the working memory representation of the meaning of the given utterance (“dog”). Note that in this framework, word meanings are not just sets of microfeatures but rather knowledge structures that control the mapping of word forms to microfeatures (and – if we take language production into consideration – the reverse mapping as well).

It should further be noted that working memory representations derived from linguistic input do not differ in principle from ones derived from nonlinguistic input. Thus, although concepts and word meanings are clearly distinct knowledge structures, there is no analogous distinction for working memory representations in the common-stock-of-features framework. In fact, it is likely that information from various sources mix in working memory representations. Specifically, working memory representations derived from linguistic input are probably always contaminated by conceptual knowledge, as the microfeatures activated by a word form activate other microfeatures via their connections. This converges with the common belief that the linguistic meaning of a word or sentence underdetermines what listeners construe as the meaning of the utterance. Similarly, representations of nonlinguistic stimuli may be influenced by lexical knowledge, as the microfeature units activated by a nonlinguistic stimulus may feed activation to some word-form units, which in turn may feed activation back to microfeature units (cf. Papafragou & Selimis 2010 and article 107 (Landau) *Space in semantics and cognition* for on-line, transient effects of language). Finally, it should be borne in mind that conceptual and linguistic processing always takes place in a particular situation. The sensory-motor and higher cognitive systems constantly feed information into the network concerning the immediate physical environment, social situation, and current goals. Thus, working memory representations, no matter whether constructed for a nonverbal stimulus or an utterance, are always influenced by the situational context (cf. Barsalou 2009).

To summarize, the assumption that concepts are lexical meanings should be abandoned. Minimally, one needs to concede that people possess concepts that do not correspond to lexical meanings. However, it is more plausible that conceptual knowledge and lexical-semantic knowledge are distinct. This does not rule out that they are structurally and functionally closely interwoven with one another. It is even conceivable that conceptual knowledge and lexical-semantic knowledge involve the same set of atomic representations, and only differ in how they combine these atomic representations.

## 7. Concluding remarks

Research on conceptual knowledge is concerned with a wide spectrum of topics (of which we have addressed but a few). This is of little surprise considering the role of conceptual knowledge in mediating between perception, action, and higher cognitive processes. However, research on conceptual knowledge also reveals considerable heterogeneity of the fundamental views of what concepts essentially are. Do they encode rules of categorization, lists of features of category members, central-tendency information, domain-specific mini-theories, sets of exemplars encountered in the past, or bindings of modality-specific memory traces of past situations? None of these views can be dismissed. Each is supported by some empirical evidence, even though this evidence often comes from a limited type of experimental settings or paradigms. What should we conclude from this? Recent developments in research offer a promising perspective. Researchers are beginning to question some of the traditional tenets that may have hindered the development of an integrative framework for the different notions.

One traditional tenet is that the most important function of conceptual knowledge is to allow for categorization. However, in recent years an increasing number of researchers have recognized that conceptual knowledge serves many different functions besides categorization, including prediction (which we emphasized) and explanation, and that different functions make use of different kinds of information (see, e.g., Barsalou 2009; Markman & Ross 2003). This calls into question another fundamental belief in research on conceptual knowledge, namely that conceptual knowledge comes in discrete packets of information, in concepts. Why should we possess discrete packets of information, accessible in an all-or-none fashion, if, depending on the situation or task at hand, different pieces of these packets become relevant? Wouldn't a large network of knowledge be more plausible, from which the relevant pieces can be selected on the fly and tailored to the particular goals in the current situation? After all, even novel categories can easily be formed if necessary (see, e.g., Barsalou 1985 on *ad hoc* and goal-derived categories). Adopting this view of conceptual knowledge implies that a reframing of research in this domain is necessary. Instead of attempting to characterize the contents of concepts, the objective would be to discover what kinds of information about things is used in different situations (see Malt & Sloman 2007, Murphy & Ross 2010, and Papafragou & Selimis 2010, as examples of this approach). Research may eventually show that the different concept theories apply to different types of situations and tasks.

Intimately connected with the two aforementioned tenets is the assumption that concepts are word meanings. Indeed, a main reason why categorization is traditionally regarded a central function of conceptual knowledge is probably that concepts are taken to be word meanings. Ironically, it is exactly this assumption of a close relationship between conceptual knowledge and language that brought about the unfortunate situation that conceptual research is largely uninteresting for semantics, apart from some basic ideas



(see Sec. 1). However, the situation may change as the dominance of the notion of distinct concepts gradually wanes and researchers begin to take a closer look at what pieces of information are drawn from conceptual knowledge in performing a particular task and what the resulting working memory representation is like. Studies of this type, focusing on the conceptualization of things, situations and events in working memory are highly relevant for the question of how conceptually shaped representations are mapped onto linguistic structures and vice versa. They may therefore provide the basis for re-thinking the relationship between conceptual and lexical-semantic knowledge.

*We thank Susan Olsen, Paul Portner, and Claudia Maienborn for helpful comments to an earlier version of this article.*

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Stephanie Kelter, Berlin (Germany)  
Barbara Kaup, Tübingen (Germany)

## 107. Space in semantics and cognition

1. The geometries engaged by spatial language
2. Acquisition of spatial language: Empirical evidence for a specialized system?
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### Abstract

*Decades of research on the nature, acquisition, and mature use of spatial language reveal three major themes to be discussed in this chapter. First, spatial language is one of several cognitive systems that is specialized, reflecting pressures from the nature of our non-linguistic spatial representation and the nature of language as a symbolic system used for communication. The primitives for spatial language form a closed set and are likely to have evolved in response to these pressures. Second, acquisition involves selection from the set of primitives, partly via learning from input, with the latter subject to the same kind of maturational constraints as are found in phonology, morphology and syntax. Third, although having spatial language greatly increases representational power to express our thoughts, spatial language does not in any direct way change the underlying structure of human spatial thought.*

### 1. The geometries engaged by spatial language

Like all mobile species, humans possess a remarkably powerful capacity to negotiate physical space, moving from place to place in directed fashion, picking up and manipulating objects, attending to the locations of important objects and events, and making inferences about the locations of objects no longer in sight. In addition to these, however, humans possess the capacity to represent their experience of space using formats unavailable to other species: They can talk about space, and they can create external representations of space, such as drawings and maps. These additional functions emerge early in development, with little or no formal tutoring. The ease with which they are carried out invites the naive idea that there is a simple and straightforward mapping between our non-linguistic spatial representations (such as those underlying navigation and search) and the spatial representations that are encoded by language.

Several decades of research, however, have revealed that human spatial representational systems are specialized, tailored to the particular kind of function that they carry out. For example, the spatial system underlying our ability to navigate unknown spaces appears to engage representations that include metric properties of space such as angles and distances (Landau, Gleitman & Spelke 1981; Gallistel 1990; Klatzky et al. 1998). The ability to reorient ourselves after disorientation appears to engage representations of space that incorporate geometric descriptions of the environmental layout, but are blind to aspects of the environment that do not contribute to this geometric description (Cheng 1986; Gallistel 1990; Hermer & Spelke 1996). Object recognition and identification engage computations that analyze the stable axial and part structure of objects, and the spatial relationships among them (Biederman 1995; Palmeri & Gauthier 2004; Xu & Singh 2002).



Action on objects engages representations that are sensitive to the continually changing relative angles of the arm, wrist, hand, and fingers as they reach, grasp, and manipulate objects (Milner & Goodale 1995). Each of these spatial systems is functionally distinct from the others, engaging different kinds of spatial representations designed to solve different problems. Like each of these specialized systems, spatial language has its own unique computational requirements.

### 1.1. The closed class and spatial primitives

Most theorists would agree that the central conceptual elements underlying spatial language are those representing objects, places, paths, and motions. Each of these conceptual elements obeys two sets of constraints. First, each must be mapped to some linguistic form. In English and many other languages, objects are mapped to nouns (and/or NPs) and motions are mapped to verbs. Places encode static spatial relationships, and are typically mapped to prepositional phrases in English and often to post-positions or adpositions in other languages. Paths encode trajectories – spatial relationships in which objects move between and among points. These too are encoded by PPs in English and by similar elements in other languages. Talmy (1985) theorized that languages belong to different typologies according to the way that expression of the motion event is partitioned when it is mapped to its lexical and grammatical elements. Spanish and other so-called “verb-framed” languages tend to encode the path element in the verb, e.g. *subir* (‘go up’), *bajar* (‘go down’), *meter* (‘put in’), *poner* (‘take out’), often leaving the manner of motion to be encoded separately as an adverb. (This pattern occurs predominantly when the path is bounded; when the path is unbounded, Spanish and other verb framed languages can encode manner in the verb (see Papafragou, Massey & Gleitman 2002, for discussion). In contrast, English and other so-called “satellite-framed” languages tend to encode the path in a PP (e.g. Mary ran *out of the house*), with the main motion and its manner conflated and expressed in verbs such as *run*, *hop*, *skip*, *swim*, *fly*, etc. As a consequence of this major typological difference, languages like Spanish have more verbs that express different kinds of paths than do languages like English. Talmy’s well-known example contrasts the Spanish *La botella entró la cueva, flotando* with the English *The bottle floated into the cave*, emphasizing the different way that two languages can carve up the same event by assigning different conceptual elements to different forms.

Although this division of labor is important, it is also essential to know that English does have path verbs (e.g. *exit*, *enter*, *leave*, *flee*) and Spanish does have manner of motion verbs (e.g. *bailar*, ‘to dance’, *caminar*, ‘to walk’, *saltar*, ‘to jump’), so the division of labor is a tendency rather than an absolute rule. Perhaps more important is a deep but often unnoticed similarity across such typologically different languages: Regardless of language type, the kinds of paths that get encoded are quite limited, whereas the manners of motion are quite open. For example, the paths encoded by the some of the most frequent path verbs in Spanish include the same conceptual elements as those encoded by English prepositions. These conceptual elements include directions (up, down, to/towards, away from) and combinations of path with places (into, onto, out of, off of). In fact, the bulk of the path and place terms in English comprise a quite limited set – a closed class, according to Talmy – and the conceptual elements underlying these terms also show up as Path verbs in Spanish and other verb-framed languages. As Talmy (1983) pointed out, the closed class status of these elements – like other elements of grammar – make them

especially interesting in any theory of spatial language. They provide a special window into the nature of the spatial-conceptual elements that languages tend to encode, hence a window on this unique aspect of human spatial cognition.

The spatial properties relevant to linguistic encoding of Path and Place are surprisingly distinct from the kinds of spatial properties that are required by many other spatial cognitive systems, consistent with the specialization of spatial language. As noted by linguists such as Talmy (1983), spatial properties that are encoded by the closed class vocabulary of languages typically abstract away from metric properties such as specific angles or distances. The latter are encoded by the open class vocabulary – specifically by the infinite set of number words in combination with number terms (e.g. 3,000 feet above sea level). Landau & Jackendoff (1993) analyzed the set of 85 English prepositions and proposed several sets of properties that capture most of the relevant geometric relationships. They proposed that these properties are the primitive “features” from which all languages select. The idea that features and their combinations can capture the spatial meanings of the closed class vocabulary is consistent with the view of Talmy (1983) and Levinson & Wilkins (2006), among others. It is important to note that Landau & Jackendoff’s proposed list of features was *not* a claim that these features correspond to the meanings of English prepositions (cf. Levinson & Wilkins 2006). Rather, the claim is that the primitive features that can be derived from analysis of English prepositions are part of a universal base upon which all languages build their own stock of spatial terms. The variation across languages in the encoding of space (see sections 2 and 3 below) can best be understood as reflecting choices within this universal set of primitives, and/or ways of combining primitives (see also Levinson & Wilkins (2006). The proposed set of primitives could also be viewed as the starting point for the child learner (see section 2 below).

## 1.2. The spatial primitives for spatial language

The expression of Paths and Places require specifying a relationship between a “figure” object (in Talmy’s 1983 terms), a “ground” or “reference” object, and the path or place function, which specifies the spatial relationship between the two. For example, an expression such as “X is on Y” includes the figure (X), the reference object (Y), and the place-function (ON), which specifies the geometric function applied to the reference object. Sentences expressing manner of motion along a path, such as “X ran to Y”, could also be viewed as including a figure (X), reference object (Y), and the geometric function (directed path, TO, ending at Y). The spatial content of Path and Place terms is rather restricted (as one would imagine, from their closed class status.) As Talmy (1983) first pointed out, figure objects across languages have remarkably few geometrical requirements. That is, there are few prepositions that require a figure object shaped like a cigar or a cube; rather, most prepositions can combine with figure objects that vary widely in overall shape. With the exception (in English) of terms such as *along* or *through*, which require that the figure object be linear, or execute a linear-path, the figure’s exact geometry is often irrelevant. For example, it is natural to say “The ribbon lay *through* the tunnel” (linear object as figure), or “The ball bounced *through* the tunnel” (linear path as figure), but less natural to say “The ball lay *through* the tunnel” (non-linear object as figure). Thus the preposition *through* requires a linear figure object. Prepositions can also select figure objects for quantity, e.g. the terms *throughout* or *all over* require multiple



figure objects. But in general, there are few prepositions that require a specific geometry for the figure object. Talmy's (1985) discussion of Atsugewi shows that the figure object in basic locational expressions *can* require more geometric specification, as this language has roots for locational verbs that include meanings such as 'small, shiny, spherical object to move/be located' and 'runny, icky, material to move/be located'. But even the range shown by this language is limited.

In contrast to the sparse requirements for the figure object, the geometric specification for reference objects is richer, though still far less detail than would be required to recognize or identify the object as a member of some category (see, e.g. Landau & Jackendoff 1993; Landau, Smith & Jones 1998). The geometries that are relevant for reference objects include simple points (as in "near" Y) and lines (x is "along Y") as well as volumes (IN, INSIDE), surfaces (ON), and quantity (the contrast between *between* and *among*, though disappearing in English, is a contrast between two vs. three or more reference objects).

There also exist, in many languages, terms for which the reference object defines a 3-dimensional set of orthogonal axes with an origin that can be centered on a reference object (including one's self) or a place. Depending on the origin of the reference system, different sets of terms are used. For example, English has three sets of terms that engage reference systems. One set engages object-centered reference systems, i.e. those whose origins are the object itself (including one's own body). The axes of this reference system are then used to define six major regions that can be called the top, bottom, front, back, side, left or right of the object. The same axes can be used to define regions extending out in space but surrounding the object, as in above, below, (to the) left and right (or sides), in front of and behind the object. In many languages, including English, the terms that engage the object-based reference system and those that engage the space around the object are morphologically related, e.g. see Levinson (1994) on the use of animal body parts to define locations on and around other objects. For example, although the terms top/bottom only refer to object parts (whereas above/below refer to regions extending outward from the object), the terms left/right can refer to object parts or to the regions surrounding the object, and are distinguished only by combination with *the* for the former (e.g. *the left* of the box) or *to the* for the latter (e.g. *to the left* of the box). Finally, a third set of terms engages earth as the reference system, using terms north, south, east, and west. Speakers of different languages vary in the degree to which they use different sets of terms (such as right/left vs. east/west) to describe relatively small-scale spatial relationships, and a great deal of recent research has addressed the significance of these different tendencies (see Section 3.0, below).

In addition to limitations on the geometric structure of figure and reference objects, languages appear to encode a limited number of spatial relationships (in the closed class set of terms). For example, all languages encode distance, but the closed class set usually encodes relative distance (e.g. near, far, far and out of sight), coarse categorical direction (usually using the six orthogonal axis directions described earlier), and visibility (within view, out of view), and to a certain degree, occlusion. Beyond this, specific angles and distances can be encoded by language, of course, but this tends to occur using phrasal constructions; precise angle and distance depend on expressions from the number system.

Like the geometries relevant for Places, the structures relevant for Paths are limited. Jackendoff's (1983) analysis, building on the work of Fillmore (1971), Gruber (1965), and

others, proposes that there are three basic kinds of path. These include TO-paths, which encode the goal or endpoint of the path (by terms such as *to* or *towards* in English), FROM-paths, which encode the origin or starting point of the path (by terms such as *from*) and VIA-paths, which encode the path with reference to an intermediate reference object (term such as *by*, *via*). These paths – like many place terms – strip away from the specific and detailed geometry of the path, and encode only the beginning, endpoint, and direction of the path. When combined with a Place term, they can encode these as well as some aspects of the reference object geometry; for example, TO-paths ending in a volume (into), or a surface (onto), FROM-paths starting in a volume (out of) or surface (off of). Complex path geometries can be encoded, but they tend to engage open class words such as verbs, e.g. *The receiver zig-zagged/spiralled/twirled/somersaulted across the field*. Like other open class terms, verbs of this sort allow relatively detailed geometric distinctions among path geometries. In contrast, Path and Place terms are part of the closed class, and hence are limited in the kinds of geometry that they can draw on. It is this special status that makes their existence and their acquisition by children so interesting.

### 1.3. Where do these spatial primitives come from?

Because there is a limited number of spatial primitives, and because they show up across different languages, it is natural to ask about their origin. Like other kinds of grammatical markings – such as aspectual marking – the closed class of spatial terms is linked to important categories of meaning. But the spatial primitives invite a special temptation to look for their origin in systems other than language. One possibility, of course, is that these spatial-semantic primitives have their origins in systems of non-linguistic spatial representation, i.e. that they are not specific to language. Just like the set of phonetic distinctions – universally available to all babies before language learning proceeds – the spatial semantic primitives could be part of the foundation for perceiving and interacting with the spatial world. The explanation for the infant's universal sensitivity to phonetic features usually invokes some initial perceptual space (an attractor space) that is the foundation for learning one's language-specific phonemes. This space need not be specific to humans; indeed there is evidence that chinchillas are sensitive to many of the relevant distinctions (see Kuhl 2000). The analogy for spatial features would be an initial space that – like the space for phonetic features – would have areas of key “salience” that serve as attractors for the categories most important to humans and other species. Such areas might be, for example, the relationship of containment (INSIDE/OUTSIDE), support or attachment (ON/OFF), degree of fit (TIGHT/LOOSE FIT), directions (UP/DOWN or TO/FROM), and so forth.

The attempt to trace the origins of such concepts to non-linguistic spatial systems is not new. Early papers by E. Clark (1973) and H. Clark (1973) speculated that the child's non-linguistic concepts of basic categories such as up/down or containment/support might serve as the foundation for learning spatial terms. Indeed, recent studies have shown that pre-linguistic infants are sensitive to many of spatial properties that later are encoded in spatial terms across different languages. Baillargeon and colleagues have shown that infants are sensitive to many of the spatial relationships that are foundational to languages, for example, the relationships of support, containment, occlusion, etc. (Aguiar & Baillargeon 1998; Baillargeon & Hankosummers 1990; Hespos & Baillargeon 2006). The available conceptual repertoire is broader than that which is needed for learning any

particular language, suggesting a set of universal spatial-conceptual distinctions that may later be adopted as relevant semantic features as the child learns his native language. For example, Hespos & Spelke (2004) showed that 5 month-old babies growing up in English speaking households are sensitive to the distinction between “tight fit” and “loose fit”. This distinction is encoded by different verbs in the basic vocabulary of Korean speakers, *kkita*, *nehta*, *nohta* (Choi 2006); hence babies may learn quite early that it is a semantic feature in their language; in contrast, babies who are learning English may not adopt this as a semantic feature until somewhat later, when they learn verbs such as *insert* that may encode the property of tight fit.

There are several possible ways to think about the origins of these spatially relevant primitives. Mandler (2004) has proposed that these concepts precede language and are the product of a process she calls “perceptual analysis”, whereby meaningful units are extracted from the less interpreted perceptual array. She proposes that, as infants come to attend more closely – or examine – objects and their spatial relationships, concepts relevant to the later acquired spatial language are constructed. This view has the benefit that it delivers up conceptual units that will be easily mapped to language; but there is no clear and detailed mechanism for how such “perceptual analysis” occurs.

Another possibility would be to deliver the primitives directly from another existing system, with vision as the most obvious (and well-understood) candidate. One of the most pressing problems within vision science is explaining how rich spatial relationships are computed by the visual system. As an example, Ullman (1984) has beautifully described the great computational difficulty of computing the simple relationship of “inside/outside”. Some current solutions involve cognitive operations – “visual routines” – that may be able to compute whether a point is inside or outside of a bounding contour in a relatively automatic way. The deployment of some visual routines – resulting in perception of certain spatial properties appears to require focused attention (Cavanagh, Labianca & Thornton 2001). For example, focused attention is required for the stable binding of property conjunctions, such as color and location. Vision scientists have long thought that a single feature (e.g. color *x*) can be detected without focused attention: In a display containing a single red line together with multiple green lines, the red line seems to “pop out”. But detecting combinations of features (e.g. a red line in a group of red circles and green lines) appears to require focused attention. It is at least tempting to think that the kinds of spatial relationships whose construction requires either visual routines, or focused attention, might provide candidate primitive spatial relationships from which language could draw.

The idea that spatial primitives for language might share their origin with other spatial systems – vision, in particular – is consistent with the theory advanced by Landau & Jackendoff (1993), who proposed that some of the properties of spatial primitives could be traced to the nature of the visual system, in particular, the distinction between “what” and “where” (Ungerleider & Mishkin 1982). Building on Talmy’s analysis of the geometric nature of the closed class spatial vocabulary, Landau & Jackendoff argued that the spatial representation of objects draws on two quite different kinds of representation, depending on whether the objects are being named (as category members – “what”) or located (“where”). In the former case, the spatial-geometric representation of objects is rather rich, characteristic of the non-linguistic object recognition system. In the latter case, when objects are being located, their spatial-geometric representations are quite coarse, with figures represented as points or lines and reference objects represented as

volumes, surfaces, and sets of orthogonal axes centered on an origin. Recent reformulations of the what/where distinction in vision suggest that the “where” system might be better thought of as a “how” system, engaging geometries required for acts such as reaching and grasping; so the mapping between spatial language and these two visual systems is not one to one. Still, the large differences in how objects are represented for the two purposes of naming vs. locating suggest that the visual system has the capacity to represent objects in both of these ways. If the visual system represents objects coarsely in the “where/how” system, but in richer geometric detail in the “what” system, this would correspond to the differences in detail for objects when they play the role of figure and reference object (coarse), compared to their geometric detail when named (highly detailed). Many questions remain, however, about when and how the visual system might compute the coarser representations of object shape required for the roles of figure and ground in spatial expressions. If the computation of coarse object geometries and their related spatial relationships should prove to be an output of visual routines, the latter could supply a crucial link to help us understand the nature and origin of the primitives underlying spatial language. Given the computation of these primitives, languages could then select from them, and children’s learning would be occasioned by experience with the relevant contrasts in the linguistic environment around them. Thus, the acquisition of the closed class of spatial terms would be quite analogous to the acquisition of one’s native language phonemes.

It should be noted that, even if visual routines can be shown to support the construction of basic spatial relationships, this can only help answer the question of where *spatial* features that are computable by the visual system come from. Some aspects of spatial term meanings are likely to involve force dynamic properties (e.g. Talmy 1988), and it is unclear whether these properties are computable by the visual system, or are solely conceptual in nature. Moreover, analysis of properties computable by vision are not likely to completely explain the extensively generalized use of spatial terms to encode spatial relationships that are much farther removed from visual representations. For example, even so simple a term as *in* can be used to encode full physical enclosure (a ball *in* a tube), partial enclosure (an apple *in* a bowl), or virtual enclosure (the code *in* the computer program). The question of what underlies these generalizations is thorny, and no complete answers exist. However, Herskovits (1986) gives us some purchase by listing the wide range of uses for the basic spatial prepositions in English; Lakoff (1987) and Brugman (1988) emphasize the extensive metaphoric use of spatial terms in English; and Malt et al. (1999) provide some interesting ideas about how basic meanings of words for containers are extended by mechanisms such as convention, pre-emption, and chaining.

## 2. Acquisition of spatial language: Empirical evidence for a specialized system?

Whatever the origins of the spatial semantic primitives, there are important questions about how these primitives become deployed for the purposes of language. Even supposing that the small set of primitives is available prior to language learning, different sets of features (or different combinations thereof) will be selected by different languages, producing some real differences in the kinds of spatial relationships that are encoded by the basic terms of a language. By analogy with the acquisition of one’s native phonemes,

one can ask three basic questions: Is there evidence that infants are sensitive to all of the relevant primitives prior to language learning? If so, then what mechanisms produce shaping by the linguistic environment, i.e. how does the child learn which features are selected by his or her language and which are not? Is there any special window of time during which this learning must take place in order to achieve native competence?

## 2.1. Are infants sensitive to all relevant spatial primitives before learning language?

Recent results suggest that infants are sensitive to many of the spatial categories that later will be encoded in their language. Broad spatial concepts such as containment, support, and occlusion are present even within the first six months of life, although there are also significant developmental changes in the infant's ability to use these concepts across all physical situations (Aguiar & Baillargeon 1998; Baillargeon 1991, 2004; Baillargeon & Hankosummers 1990). Presumably, these concepts will serve as the foundation for the early acquisition and use of spatial terms such as *in* and *on*, which are among the earliest produced and understood (E. Clark 1973; Johnston & Slobin 1979). Infants of 8 and 9 months of age are also sensitive to an independent contrast that has been described as cross-cutting the spatial relationship encoded by English *in* and *on* (Bowerman 1996). This contrast is between tight and loose fit, encoded in Korean by the verb *kkita* compared to *nehta* or *nohta*. Actions in which objects come into tight fit with each other (e.g. a peg put tightly *in* a hole or one lego placed tightly *on* another) are likely to be encoded by speakers of Korean using *kkita* whereas similar actions that do not involve such fit are encoded with other verbs (e.g. a peg put into a wide well or a lego placed on a shelf; see Bowerman 1996). The apparently striking difference in the encoding of such simple spatial events in English and Korean has led to a great deal of research activity designed to determine what the status of "tight" and "loose" fit are in the infant's pre-linguistic conceptualizations. Hespous & Spelke (2004) found that 5 month-olds growing up in English-speaking homes are sensitive to this distinction, even though basic spatial prepositions in English do not encode this degree of fit (tight/loose). McDonough, Choi & Mandler (2003) found that 9 month-olds in both English-speaking and in Korean-speaking homes are sensitive to the tight fit/loose fit distinction. These results suggest that the primitive features corresponding to "containment/enclosure", as well as those corresponding to "tight/loose fit" are both among the primitive features available to infants who must then select among them as they learn their native language. By analogy with the literature on phoneme development, this suggests an available set of primitives, some of which will be selected as children learn their lexicon. The particular set of primitives selected for obligatory lexical encoding may differ over languages, as suggested by Bowerman's (1996) analysis.

Some intriguing results further suggest that there may be asymmetries or marking within primitive features such as "tight/loose fit". Evidence suggests that there may be an asymmetry in the extent to which infants are sensitive to tight vs. loose fit (Casasola 2006; Choi 2006). In Choi's study, English-speaking infants who were familiarized with "tight fit" relationships looked longer at other tight fit relationships than loose fit ones; but infants who were familiarized with loose fit relationships did not look longer at one than the other. A related pattern was recently shown among adults who were asked to make similarity judgments between familiarized events (tight or loose fit) and test events

(Norbury, Waxman & Song 2008). When adults were familiarized with tight fit events, they did not view loose fit events as similar; but when they observed loose fit events, they did view tight fit events as similar. These findings suggest there may be a natural marking between the values of the “tight vs. loose fit” feature, or perhaps that loose fit is the default assumption, and tight fit is “special”. If so, infants who hear a term applied to a “tight fit” relationship may assume that it does *not* generalize to loose fit, and they would have to learn that it does, through positive evidence of hearing the *same term* applied to, e.g. both tight and loose fit actions. At the same time, infants who hear a term applied to a “loose fit” relationship might assume that it *does* generalize to tight fit (of a particular kind), and would have to learn that it does not, again by hearing a *different* term for the two types of events. Intriguingly, when comparing English to Korean speaking toddlers, Choi (2006) found weakened sensitivity to tight fit among the toddlers learning English, and Choi suggested that they were learning to ignore tight fit as an important semantic distinction in their native language. However, this appealing story is likely to become more complex as we learn more about how the lexicon encodes both tight/loose fit across languages, and how it encodes spatial relationships. For example, Kawachi (2007) has questioned whether the distinction between Korean *kkita* and *nohta/nehta* is really one of “fit”, and proposes that *kkita* is actually a manner of motion verb whose distribution is quite different from its counterparts *nohta/nehta*. Clearly, our understanding of how children select semantic features for encoding in language will depend strongly on our understanding of how they work in the target language.

Infants also appear to be sensitive to categories underlying the acquisition of (English) terms *above* vs. *below*, and *left* vs. *right*. In several studies, Quinn (1994) familiarized 3-month olds to displays in which a dot was displayed either above or below a line. The infants were then tested with displays in which the test dot was equidistant from the original dot at one of two locations: either above or below the same line. Infants looked longer at the dot that was in the contrasting category, relative to the original dot, showing that they are sensitive to differences corresponding to the category above vs. below. The same kind of effect was shown for categories left and right, although at a somewhat later age (Quinn 2004). Although the words for these relationships are not acquired until well into the third year of life, and development of some aspects of their use extends much later, Quinn’s evidence shows that the underlying conceptual basis for these axis-based terms is in place prior to learning language. In a sense, this is not surprising, as representation of location within different reference systems is known to be a hard-wired aspect of human representation of space, as well as that of other species (Gallistel 2002).

The acquisition of path terms invites related questions: Are infants sensitive to the relevant primitives for path terms prior to language learning? Following Jackendoff’s analysis, the major path types include TO-paths (which encode paths moving to the goal or endpoint), FROM-paths (which encode paths moving from the source or origin) and VIA-paths (which encode paths moving past an intermediate reference object). These can be combined with place primitives, to produce, e.g. terms such as *into* (TO-path ending in a volume), *out of* (FROM-path starting in a volume), *onto* (TO-path ending on a surface), etc. Given that infants are sensitive to properties such as containment and support, the key question is whether they are sensitive to the differences embodied in the three-way distinction among TO-paths, FROM-paths, and VIA-paths. Considerable research has shown that English-speaking children and adults show an asymmetry between



TO and FROM paths, with a bias to omit linguistic encoding of FROM-paths when it is a grammatical option (Lakusta & Landau 2005). The same bias has been shown among children learning Japanese (Lakusta et al. 2006) and broader literature suggests that the asymmetry is reflected in children's and adults' non-linguistic representation of events (Lakusta & Landau 2012; Regier & Zheng 2003, 2007), in substitutions of path terms among brain-damage patients (Ihara & Fujita 2000) and among deaf children who have no exposure to a formal linguistic system (Zheng & Goldin-Meadow 2002).

Recent research shows the same asymmetry in pre-linguistic infants. Lakusta et al. (2007) familiarized 12 month-old infants to animate events in which a toy duck moved either along a path to one of two goal objects (e.g. TO-path, ending in box A) or along a path from one of two source objects (e.g. FROM-path, starting at box A). The goal (or source) objects' locations were then switched, and babies were shown events in which they saw the duck move to (a) the same goal/source (now in a new location), or (b) a new goal/source (now in the old location). Infants looked longer to events in which the duck moved to the new goal or source object, indicating that they were sensitive to which object was the goal (or source) rather than its location. However, infants were only sensitive to the changes in the source object when the source objects themselves were very salient (e.g. bright and highly decorated), suggesting that the infants were less sensitive to changes in source paths than goal paths. Lakusta et al. directly tested this hypothesis by pitting highly salient sources (e.g. a brightly decorated red box) against less salient goals (e.g. a plain red box). Infants were familiarized to events in which the duck moved from the salient source to the less salient goal; they were then tested on events in which the duck moved from a new salient source to the old goal, or the old salient source to a new goal. Infants looked longer when the duck moved to the new goal object, showing that they were more sensitive to (or attended more) to the goal object, and presumably, the TO-path. These findings suggest that pre-linguistic infants are sensitive to the two major path types (TO-paths and FROM-paths) and that the asymmetry observed between the two in language among children and adults is present even prior to language. Combined with the evidence on sensitivity to other primitives underlying place terms in languages, these data suggest that infants may be sensitive to all possible primitives prior to learning language. Future research will be required to determine whether infants are sensitive to other spatial primitives, and whether there is additional evidence of markedness relationships within the set of primitive features.

## 2.2. How is language learning shaped by input, and is the semantic space altered?

Given the cross-linguistic variation in spatial semantics, it follows that children must learn which primitives are realized in their native language. This means that the semantic space must be shaped in accord with the linguistic environment. A significant amount of learning is accomplished by the time children are two years old. Bowerman (1996) elicited language from children learning English, Dutch, and Korean. The children were shown sets of joining and separating events (e.g. putting together two bristle blocks; removing a hat from a doll, etc.) and were prompted to describe the event to the experimenter, by asking them to "Tell me what to do". The production data showed that children followed some clear universal patterns, but they also showed obvious language-specific effects at

even the youngest ages tested (2 to 2–1/2 years of age). For example, regardless of what language was being learned, children never used the same term to apply to events that joined two parts AND events that separated two parts. This suggests that the two opposing directions or results of the events (joining/separation) were likely marked as distinctly different types, leading to marking with different forms. It seems likely that the distinction between separation and joining more generally is a pre-linguistic distinction as well, thus a candidate for a universal spatial-cognitive and semantic distinction.

At the same time, different types of joining and separating acts were distinguished over languages, even for the youngest children. Children learning English grouped together a wide range of joining events under the expressions (put) *on*, including events as diverse as such as putting on a hat, putting two legos together, and putting a ring on a pole. This relatively broad class of events, collapsed under the same expression (verb + *on*) was similar, though not identical to that of English-speaking adults, who sub-categorized the events by using additional expressions such as *put together* and *join*. The space for children learning Korean differed from that of English-speaking children by including specific verbs encoding the donning of different kinds of clothing; the partitioning was even more finely differentiated among Korean speaking adults, including distinctions of degree of fit and methods of joining. Although the application of spatial expressions to different event types was not as fine-grained among children as among adults, it is clear that even young children learn quite rapidly to activate certain language-specific primitive feature combinations and de-activate others.

A particularly telling comparison is found in Bowerman's (1996) analysis of production for separating events among children learning English vs. Dutch. Children learning English formed two separate categories, labeled by *off* vs. *out*, with the former collapsing events such as "top off pen", "ring off pole", "shoes off", "dress off"; and the latter collapsing event such as "legos out of bag" and "doll out of bathtub". For English speakers, these naturally form two categories of separation, with the latter involving removal from some concave cavity and the former involving removal of various other types. Children learning Dutch collapsed all of these instances under one expression, *uit* (English "out"), thus appearing to violate some presumably "natural" division between the removal from cavity vs. other kinds of removal. Bowerman notes that this is puzzling, until one examines the pattern of production among Dutch speaking adults. They apply *af* (English "off") to the non-clothing exemplars covered by English *off*, but collapse together the removal of clothing with removal from a cavity, under the Dutch term *uit* (English "out"). Bowerman correctly notes that, if universal non-linguistic distinctions are the sole basis for early learning, one might expect Dutch children to ignore this anomaly and sort things the same way as English speaking children (or vice versa, depending on what one thinks is the most natural categorization). Instead, the children appear to discover some meaning that will make some sense of the variety of events that are expressed by *uit*, and end up conjecturing that it covers many different kinds of removal, thus collapsing all three types of removal (tops off pens, shoes off feet, legos out of bag). At some point, they of course notice that there is a further distinction to be made, and add to their lexicon the term *af*, creating two categories from the one. Dutch speaking adults apparently do not consider the two kinds of *uit* to be coherently related to each other; according to Bowerman (1996), they are surprised to reflect on the apparent anomaly, revealing that they likely store the two *uit* meanings separately.



This example reveals the crucial role of linguistic input in the learning process; not surprisingly, since spatial language does vary cross-linguistically, and therefore learning through exposure must be important. What is the mechanism? Landau & Shipley (2001) carried out a study that shows how powerful the role of labeling distribution is in moving the learner towards their specific language. Three year-olds were shown two objects (object A, object E) that were perceptually quite different; however, object E had been produced by a program that morphed object A into the new object E. There were also three intermediate items that had also been created by morphing and represented the states between A and E (B, C, D), thereby creating a set of five objects all related by morphing (A, B, C, D, E). One group of children was told that object A was “a dax”, and that object E was also “a dax”. A second group of children was told that A was “a dax” and that E was “a rif”. All children were then shown the entire series of five objects, one at a time, and asked “Is this a dax?” Children who had heard objects A and E labeled with the same count noun accepted all objects (ends and intervening objects) as members of the dax category. But children who had heard the two objects labeled with different count nouns accepted objects A through E as members of the “dax” category in declining order, with A accepted at 100%, E at close to zero, and objects after C declining sharply in acceptance. Landau & Shipley suggested that children assume that if two objects – no matter how different – are labeled with the same name, they are members of the same category; but if labeled with different names, they must be members of different categories. This principle will allow broader categories to be readily broken down into sub-categories by clear marking with a novel linguistic term. This could be the mechanism whereby children learning Korean separate “removing a hat” from other kinds of removal. It could also be the mechanism whereby children learning Dutch eventually learn to separate the non-cavity removals from the other removal events, once they hear the distinguishing marker. This proposal is consistent with Bowerman’s (1996) emphasis on the importance of learning in the acquisition of spatial language, and is similar to proposals emphasizing constraints on word learning more generally (see Bloom 2002).

It is important to note that the strong effects of learning do not in any way obviate the need for a complementary set of universals that will constrain children’s conjectures. Universals are needed to explain why children are never observed to collapse joining events with separating events; why they show strong asymmetries in the acquisition of path terms; and why they show evidence of sensitivity to semantic-like elements before learning language at all. The pressing issue is how these universals interact with learning mechanisms to produce native language learning.

### 2.3. Is there a maturational timetable for learning spatial terms?

The analogy to other areas of language acquisition – especially phoneme acquisition – invites the question of whether there is a maturational timetable under which spatial term learning is optimal. In the case of phonemes, we know that 6 month-old infants are sensitive to all phonemic contrasts that have been tested, whether or not they are part of the native language system that will be learned (Kuhl 2000). By 12 months old, infants are still sensitive to those that are part of their target (native) language system, but not to those that do not play a role in non-native systems (Saffran, Werker & Werner 2006; Werker & Tees 1999). Adults have difficulty discriminating non-native contrasts (though there are exceptions, see Kuhl 2000 for review), and this global pattern of development is

thought to reflect the progressive selection of native language-relevant features and phonemes, with the progressive weakening of sensitivity to non-native phonemes. The same general pattern – early acquisition and selection of native language structure, together with increasing difficulty in learning non-native aspects of structure – has been attested in studies of morphology and syntax (Johnson & Newport 1989). Could the same be true for spatial terms?

On one hand, it seems intuitively plausible that spatial terms might be different from other aspects of language typically considered to be the essence of language structure, such as phonology, morphology, and syntax. After all, spatial terms are somewhat like open class elements in that they appear to have content that is accessible to our larger conceptual systems. Moreover, they seem to encode properties of space that are accessible to us – properties such as containment, support, location along an axis, etc. On the other hand, Talmy (1983, 2000) and others have argued that the closed class set of spatial terms – which I have argued reflect primitives and their combinations – is more like other closed class forms such as tense and aspect than open class terms. If so, the developmental pattern of early shaping and later closure could be similar to phonology, morphology and syntax.

We have already seen that there is evidence for early shaping of the semantic space for predicates of joining and separating (Bowerman 1996; Choi & Bowerman 1991). There is also evidence for early closure of the semantic space. Munnich (2002) and Munnich & Landau (2008) created large sets of static spatial scenes that sampled two kinds of distinctions often found in languages of the world. The first sampled relationships of containment and support, distinguished by English terms *in* and *on*. The second sampled relationships along the vertical axis, distinguished by English terms such as *above/below*, *on/above*, *under/below*, etc. Following the work of Johnson & Newport (1989), Munnich & Landau tested native speakers of Spanish or Korean who had learned English at different ages (ranging from well under 8 to their mid-20's). At the time of test, participants were between 18 and 65 years old, had spent a minimum of 5 years immersed in an English speaking environment, and had all received undergraduate or graduate training at a university in the U.S.

People were given a battery of 80 spatial scenes, and were instructed to describe each using basic spatial terms of English. Half of the battery tapped the obligatory English contrast between *on* and *in* and the other half tapped the obligatory English contrast between *on* and *above*. For example, the *on/in* contrast was tested with pairs of scenes that showed the same objects in a relationship clearly encoded by *on* vs. *in* in English (e.g. pretzels *in* a bag vs. *on* the same bag). These scenes were randomly distributed throughout the battery so that people would not be likely to purposefully contrast opposing pairs. Native Spanish speakers might be expected to have difficulty with the *on/in* distinction, since Spanish encodes both relationships with a single term *en*, and Korean speakers might be expected to have difficulty with the second distinction, since Korean encodes *on/above* with the single term *ue ni*.

Results showed clear effects of age of acquisition on production and use of English spatial terms. The overall scores for the basic battery were negatively correlated with age of acquisition, showing that people who had learned English at a later age scored worse than those who had learned it an earlier age. There were no indications, however, that the two native language groups differed on which contrasts they found difficult. The lack of effect could be due to real and general effects of learning at a later age regardless of one's

first language, or it could be due to an insufficiently sensitive test battery. To compare these effects with other, well-established effects of age of acquisition on mastery of English morphology and syntax, all participants were also given the morphology and syntax batteries used by Johnson & Newport (1989). Results of this battery replicated the effects found by Johnson & Newport, with Munnich & Landau's second language learners of English showing a negative correlation between performance and age of acquisition. Thus the results of the spatial battery were consistent with those from tests of morphology and syntax, indicating that late learners of English perform worse than early learners.

These results suggest that spatial language – like aspects of language more traditionally considered core aspects of linguistic structure – are subject to effects of age at which the language is learned. The closed class system of spatial terms may be subject to the same biological learning mechanisms as those involved in learning phonology, morphology, and syntax.

### 3. Effects of spatial language on spatial cognition: Does language influence thought?

Given evidence of substantial cross-linguistic differences in spatial language, it was perhaps inevitable that there should be a resurgence of scientific interest on Whorf's hypothesis. Although Whorf's original hypothesis focused on the coding of time among the Hopi, empirical research has subsequently examined a range of domains including object individuation, number, color, and space – all quite fundamental cognitive categories for which Whorfian effects could radically change cognition. At the point of this writing, there is active investigation of the potential effects of language on thought in each of these domains, with groups of scientists proclaiming victory on each side of the debate. Two main hypotheses have been advanced. One is that learning a particular language radically affects one's non-linguistic "thought" (Levinson 2003; Lucy & Gaskins 2003). A second is that learning *any* language radically affects the nature of non-linguistic thought, primarily by changing computational resources through the use of linguistic format (Carey 2004; Gordon 2004; Spelke 2003). Counter-arguments to both hypotheses can be made, however, on both theoretical and empirical grounds. Theoretically, language can only encode what already exists in thought, hence there can be no permanent effects on the structure of thought caused by learning a particular language (Gleitman et al. 2005; Landau, Desalegn & Goldberg 2010; Munnich & Landau 2003). Taking spatial reference frames as an example, it is unclear how exposure to language could *cause* people to create the representations needed to use these frames of reference. More likely, the representations are there to begin with, and languages select which of the different kinds of reference frames they will encode. Similarly, learning *any* language must entail being able to represent what is eventually encoded by language.

The empirical evidence for strong Whorfian effects of both types is at present, weak at best. One widely cited set of findings comes from Levinson and colleagues (Levinson 2003; Pederson et al. 1998) and involves the use of different reference frames to encode object locations. Pederson et al. first presented linguistic evidence that languages differ systematically in the frames of reference that speakers prefer to use when encoding small object arrays. Speakers of English, Dutch, and other languages use terms such as *right* and

*left*, which engage body-centered and object-centered frames of reference (e.g. the spoon is to my right, or to the left of my coffee cup). Speakers of other languages, including Tzeltal, prefer to use terms that engage a geocentric frame of reference to describe such locations, essentially the equivalent of English speakers saying “the spoon is to the north of me”. Given these tendencies, Levinson and colleagues proposed a Whorfian hypothesis: non-linguistic spatial behavior would be strongly affected by the speaker’s language. They carried out a set of tasks that were putatively non-linguistic, for example, asking people to observe some animals arranged horizontally in a row in front of the speakers, then asking them to turn 180 degrees and walk to another table, where they were to place the animals in the same spatial relationships as the original array. English and Dutch speakers tended to construct the new array as if they had encoded the original in a body-centered reference system (e.g. same left to right locations, relative to the body) whereas speakers of Tzeltal tended to construct the new array as if they had encoded the original in a geocentric system. Levinson (2003) concluded that the language speakers learned affected their non-linguistic thought.

These findings have been disputed on numerous grounds, and have been subject to both empirical and theoretical scrutiny. Some of the most compelling objections come from Li & Gleitman (2002) who argued that the observed phenomenon could have just as easily been driven by culture and physical environment as by language itself. In several experiments, they showed that English speaking college students could be biased to use either of the reference frames, depending on surrounding cues in the environment, consistent with a large body of literature on animal and human spatial orientation dating back almost a century.

Although these experiments focus on one phenomenon and one aspect of spatial terminology that varies across languages, numerous additional experiments have shown that there are no compelling effects of language that produce long-term, permanent effects on nonlinguistic cognition. The paucity of evidence on these effects, together with the presence of *some* real effects of language on cognitive processing led Landau, Dessalegn & Goldberg (2010) to propose a new hypothesis about the effects of language on cognition. This hypothesis suggests that many (if not all) of the effects claimed to support a Whorfian position are actually the result of momentary interactions between language and non-linguistic processes, whereby language can be seen to drive attention, and thereby modulate the selection of what is to be encoded. Elegant studies in the vision literature show the power of such temporary modulation, with small differences in the onset of linguistic instruction serving to make adults’ visual search far more efficient (Spivey et al. 2001). Recent studies show that language can have powerful effects on children’s ability to hold in memory combinations of visual features that are otherwise hard to store (Dessalegn & Landau 2008).

Examples of such momentary effects are abundant in the literature. Malt and colleagues (Malt et al. 1999) examined linguistic and non-linguistic categorization of containers by speakers of English, Chinese, and Spanish, and found that their linguistic categorizations were quite different from each other, but their non-linguistic similarity judgments were quite similar to each other. This suggests that there is an underlying similarity space (or spaces) that is non-linguistic, and that language serves to pick out a particular set of relevant properties. Other studies have similarly shown that, even where there are large differences in adults’ *linguistic* encoding of motion events (e.g. manner vs. path) or static spatial location (e.g. the obligatory encoding of *on* vs. *above* in English but

not Japanese or Korean), non-linguistic differences across speakers are not found (Gennari et al. 2002; Munnich, Landau & Doshier 2001; Papafragou, Massey & Gleitman 2002). Indeed, when people prepare to describe an event, their gaze will be directed to the element of the scene likely to be encoded in the verb of their native language (e.g. manner for English speakers; path for Greek speakers); but when they are merely inspecting the scene without preparing to describe it, eye gazes are no different across speakers of different languages (Papafragou, Hulbert & Trueswell 2008).

Similarly, numerous studies have shown that young children's attention can be driven towards different object properties depending on what syntactic frame is used (e.g. count nouns drive attention to object category and/or the object's shape for artifacts; adjectives drive attention to surface properties; mass nouns drive attention to non-individuated entities, e.g. substances; Landau, Smith & Jones 1998; Smith, Jones & Landau 1996; Waxman & Klibanoff 2000). Lakusta & Landau (2005) found that children have a strong bias to encode events using goal-oriented verbs (i.e. verbs that take TO-path prepositions, such as *give*, *throw*, *send*) over source-oriented verbs (e.g. *get*, *catch*, *receive*). However, one need only provide a "hint" verb that is source-oriented for children to reverse this tendency, showing that language can serve to drive attention to different aspects of the very same event (see also Fisher et al. 1994).

The idea of momentary effects of language driving change in cognition is consistent with a large body of empirical data, and is reminiscent of an early hypothesis on the effects of cross-linguistic differences on color memory – the idea that encoding in memory might naturally engage language (Kay & Kempton 1984). It accounts for effects observed even in putative nonlinguistic tasks, such as Levinson's, which could readily be accounted for by temporary linguistic encoding. It is consistent with the idea that language can only encode what can already be encoded in non-linguistic representations.

#### 4. Summary

Spatial semantics has long been a touchstone for theories of the relationship between language and cognition. Because we perceive space, move about in space, and think about space, it has often been assumed that the mapping between these systems and spatial language must be relatively simple and direct. However, the past few decades of study have revealed that spatial semantics is remarkably complex in its own right, exhibiting properties that show the necessary reflexes of its relationship to other aspects of spatial cognition but also show special properties that mark its linguistic nature. Discoveries of cross-linguistic differences in the way that space is expressed have raised important questions about the nature of the universal set of primitives and its role in acquisition, the role of learning in selecting from this set, and the maturational constraints that hold for this learning. All of these have opened up new and exciting lines of research that are still in their infancy. The same discoveries have also invited a return to classical questions about the role of language in human thought. Indeed, the study of spatial language is now enjoying a new vigor – well-deserved for its central role in human cognition.

*Preparation of this chapter was supported in part by NINDS RO1-050876 and Research Grant# FY-12-04-46 from March of Dimes Birth Defects Foundation*

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*Barbara Landau, Baltimore, MD (USA)*

## XXII. Semantics and computer science

### 108. Semantic research in computational linguistics

1. Introduction
2. Computational semantics in the logical framework
3. Statistical methods in computational semantics
4. Current developments
5. Conclusion
6. References

#### Abstract

*Computational semantics is the branch of computational linguistics that is concerned with the development of methods for processing meaning information. Because a computer system that analyzes natural language must be able to deal with arbitrary real-world sentences, computational semantics faces a number of specific challenges related to the coverage of semantic construction procedures, the efficient resolution of ambiguities, and the ability to compute inferences. After initial successes with logic-based methods, the mainstream paradigm in computational semantics today is to let the computer automatically learn from corpora. In this article, we present both approaches, compare them, and discuss some recent initiatives for combining the two.*

#### 1. Introduction

In this article, we give an overview of the state of the art in *computational semantics*, i.e. the branch of computational linguistics that deals with the processing of meaning information. The goal of computational linguistics is to develop methods for the automatic analysis and generation of natural language. Ultimately, it aims at creating computer systems that approximate the language skills of an average human speaker. But there are also more immediate and tangible real-world applications, including, for instance, information extraction systems that acquire content for a relational database from large-scale collections of business reports; spoken-language or multimodal interfaces that enable the convenient interaction of users with information systems (e.g., interfaces to healthcare websites or interactive museum guides); or machine translation systems that transfer text or speech input from a source language to a target language. All of these applications require some amount of semantic processing, although not necessarily at a very fine level of detail.

The task of semantic processing can generally be decomposed into two subproblems, namely the problem of computing a formal representation of the meaning of an expression (the *semantic construction* problem) and the task of determining the relation between such formal representations (the *inference* problem). Inference is required, for instance, when a question-answering system determines whether an answer candidate in a document collection actually answers a given question, or when an automatic summarization system must figure out to which extent two sentences describe the same event (and can therefore be compressed into one).

The classical approach to computational semantics uses some form of first-order or higher-order logic for the formal semantic representations and some form of Montague Grammar-style process for semantic construction, and solves the inference problem using programs called *theorem provers*, which can test logic formulas for entailment. This tradition of computational semantics shares its formal and conceptual framework with the mainstream of semantic research in linguistics and the philosophy of language (which we will refer to as “theoretical semantics” in this article). It strongly benefits from the wealth and detail of earlier research in these disciplines.

However, there are a number of challenges that are specific to computational semantics and call for different methods. The aim of computational semantics is to implement human language skills in computer systems – at least partially, in concrete applications. The methods that are used for this must therefore be cast into precisely formalized algorithms. One crucial aspect that drives the development of new approaches is that these algorithms must be *efficient*, even in the face of the massive *ambiguity* that arises in real-world sentences. Second, the computer systems used in computational semantics must be able to process any arbitrary sentence or discourse that can arise in the respective application scenario. The system must have *wide coverage* with respect to semantic construction, and it must also have access to the appropriate large-scale *knowledge bases* that can support the inferences that are necessary for the task at hand. It is hard to achieve all of these goals at once.

The history of computational semantics is defined by attempts to handle these problems, and we will outline some of the most prominent approaches in this article. The classical logic-based approach, which we discuss in Section 2, has made great progress in terms of processing efficiency, but still falls short of practical usability in terms of coverage and performance on the disambiguation task. As a consequence, computational semantics experienced a fundamental paradigm shift around the turn of the century; current mainstream research focuses on statistical models of word and sentence meaning (Section 3). These models have much better coverage, at the expense of the level of detail, precision, and conceptual clarity of the semantic representations. We conclude with an outlook on some novel directions of research, which are aimed at comparing and integrating the worlds of logical and statistical methods (Section 4).

## 2. Computational semantics in the logical framework

Computational approaches to semantic analysis must deal with two issues. First, they must be able to determine a formal semantic representation for a given input expression; in the case of ambiguity, they also must be able to choose the contextually appropriate reading. This is called the *semantic construction* problem. Second, they must be able to relate different meaning representations to each other to detect equivalence, entailment or inconsistency between different sentences. This is the *inference* problem. Analogous problems occur in natural language generation.

Early research in artificial intelligence (AI) focused on approaches to these problems that were largely disconnected from linguistics. One influential approach was Conceptual Dependency theory (Schank 1975). Semantic representation was done without logic: Word meanings were encoded as graphs made up of a limited number of uninterpreted atomic concepts and relations (partly inspired by Fillmore’s (1968) role semantics). From these, sentence representations were constructed by merging smaller graphs into larger

ones using a collection of graph rewriting rules. The approach worked to some extent for sentences and texts expressing simple assertive information. However, it did not generalize easily to more complex types of information involving cardinality, quantification, negation, modality, conditional and temporal relations. These were modeled by simply attaching tags to graph edges.

Modern computational semantics started with the use of logics with well-defined model-theoretic interpretations, following the Montagovian revolution in theoretical semantics. This allowed the use of principled inference rules that were justified by soundness and completeness with respect to the model theory. Over the years, a logic-based “standard model” of computational semantics emerged: A semantic representation in first-order or higher-order logic is computed compositionally based on a syntactic analysis, and meaning relations between expressions of language are implemented using standard inference engines for logic. We refer the reader to the textbook by Blackburn & Bos (2005) for details about the standard model. Below, we sketch some of the most important methods in this paradigm.

## 2.1. Semantic construction

**Compositional semantics.** In the early 1970s, Richard Montague presented a framework for a strictly compositional interpretation of natural-language sentences in terms of type theory, including a formal treatment of quantifier scope (Montague 1973). His work not only provided the basis for modern semantic theory, but has also had great influence on the development of computational semantics. “Standard model” computational semantics takes it as given that we can assign lambda terms to lexicon entries, combine them by traversing the parse tree bottom-up, and compute lambda terms for larger phrases compositionally out of those for smaller phrases, using functional application and beta reduction. An abbreviated example for the derivation of one reading of the sentence “every man loves a woman” is shown in Fig. 108.1.

Montague’s original framework was based on an idiosyncratic version of categorial grammar. Computational linguists mostly used the formalism of *unification grammar*,

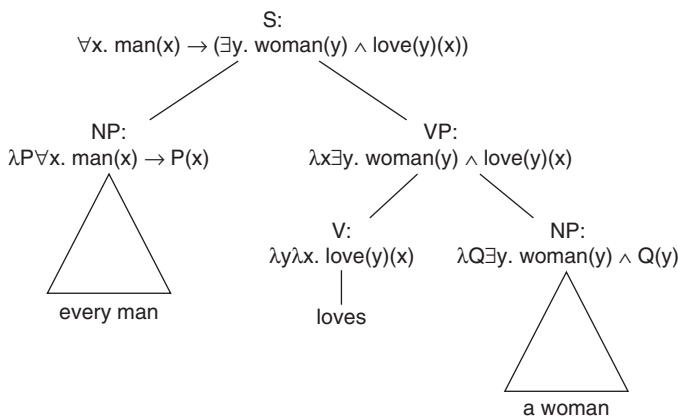


Fig. 108.1: A Montague-style derivation of a semantic representation for the sentence “Every man loves a woman”.

i.e., phrase-structure grammar extended with feature unification, when they first started developing large-scale grammars in the 1980s. Unification grammars such as LFG (Dalrymple et al. 1995) and HPSG (Pollard & Sag 1994) offered an elegant and simple way to compute predicate-argument structures by filling the argument positions of a head with the semantic contributions of its complements using unification (see e.g. Pereira & Shieber 1987). These methods were later extended to cover more complex problems in semantic construction (Dalrymple 1999; Copestake, Lascarides & Flickinger 2001).

**Dynamic semantics.** A number of “non-local” semantic phenomena turned out to be challenging for compositional semantic construction methods. For instance, anaphoric expressions establish coreferential links with antecedents at arbitrarily distant positions in the discourse; ellipsis requires us to copy parts of the antecedent’s semantics into the target representation. Furthermore, structural ambiguities, e.g. of quantifier scope, undermine the tidy parallelism of syntactic and semantic structure posited by Montague Grammar.

In order to represent anaphora and, to some extent, ellipsis, the use of Discourse Representation Theory (DRT; Kamp 1981; Kamp & Reyle 1993; see article 37 (Kamp & Reyle) *Discourse Representation Theory*) has enjoyed much attention in computational semantics. DRT conceives of meaning not in terms of truth conditions, but as context-change potential; in its standard version, it models the anaphoric potential of a text through a set of discourse referents, which are a constitutive part of the semantic representation. Dynamic Predicate Logic (Groenendijk & Stokhof 1991; see article 38 (Dekker) *Dynamic semantics*) is a closely related formalism that enables a compositional model-theoretic interpretation of anaphora. However, standard DRT employs a top-down, non-compositional algorithm for semantic construction. Computational applications typically combine DRS representations with higher-order logic and lambda abstraction, in order to enable a surface compositional derivation of DRSeS, such as Compositional DRT (Muskens 1995) and Lambda-DRT (Kohlhase, Kuschert & Pinkal 1996).

A second issue is that computational applications for processing anaphora cannot skirt the issue of identifying the antecedent of an anaphoric expression in a given text. The possible antecedents are restricted by the hard accessibility constraints of DRT to some degree; they can be narrowed down further by modeling focusing mechanisms based on the global structure of the discourse (Grosz & Sidner 1986; Grosz, Joshi & Weinstein 1995; Asher & Lascarides 2003; see article 75 (Geurts) *Accessibility and anaphora* for more on the theoretical aspects). However, these systematic approaches to anaphoric reference leave many cases of referential ambiguity unresolved. The development of methods for *coreference resolution*, which link phrases in a given discourse that refer to the same entity, is an active field of research in computational linguistics (see e.g. Ng 2010; Stede 2011).

**Quantifier storage approaches.** One non-local aspect of semantic construction that has received particular attention in computational semantics is scope ambiguity. From a perspective of theoretical linguistics, the basic problem of semantic construction for sentences with scope ambiguities was essentially solved by the Quantifier Raising (QR) operation in Montague Grammar. However, QR-based approaches cannot be used effectively in computational semantics because the development of efficient parsing algorithms becomes very complicated, and it is inconvenient to develop large grammars. A second major challenge for a computational treatment of scope is that the number of

readings quickly becomes very large as the sentence grows longer, and the algorithm must still remain efficient even when this happens. Algorithms for semantic construction can differ by a huge degree in this respect; recent underspecification-based methods can perform tasks that used to be completely infeasible (requiring years of computation time for one sentence) in milliseconds.

A first step towards removing the reliance on QR was *quantifier storage*, which was first proposed by Cooper (1983) and then refined by Keller (1988). The key idea in Cooper Storage was to replace Montague's treatment of scope ambiguity by a storage technique for quantifiers: Nodes in a (phrase-structure) syntax tree are assigned structured semantic representations, consisting of *content* (a  $\lambda$ -expression of appropriate type) and *quantifier store* (a set of  $\lambda$ -expressions representing noun phrase meanings). As the parse tree is traversed bottom-up, noun phrases may either be applied in situ to form new content; for the example sentence "every man loves a woman," this leads to narrow scope for the object, in essentially the same way as in the Montague-style derivation of Fig. 108.1. Alternatively, we may move the content into the quantifier store at any NP node (as shown at the node for "a woman" in Fig. 108.2) and then retrieve an item from the store and apply it to the content at the sentence node. This enables the non-deterministic derivation of different scope readings of a sentence from a surface-oriented phrase-structure grammar analysis.

A related approach was proposed by Hobbs & Shieber (1987) first, and later generalized to *Quasi-Logical Form* (QLF; Alshawi & Crouch 1992), which became a central part of SRI's Core Language Engine (CLE; Alshawi 1990): During parsing, preliminary semantic representations (QLFs) are built up, which contain the quantifier representations in the argument positions of their main predicate. In a second step, rewrite rules on the QLFs move quantifiers to their appropriate position, leaving a variable behind to bring about proper binding. For the above example, this system would first derive the QLF term  $\text{love}(\langle \text{every}, x, \text{man} \rangle, \langle \text{some}, y, \text{woman} \rangle)$ , from which it would derive the two readings in Fig. 108.1 and Fig. 108.2 by either scoping  $\langle \text{every}, x, \text{man} \rangle$  over  $\text{love}$  first and then  $\langle \text{some}, y, \text{woman} \rangle$  over the result, or vice versa.

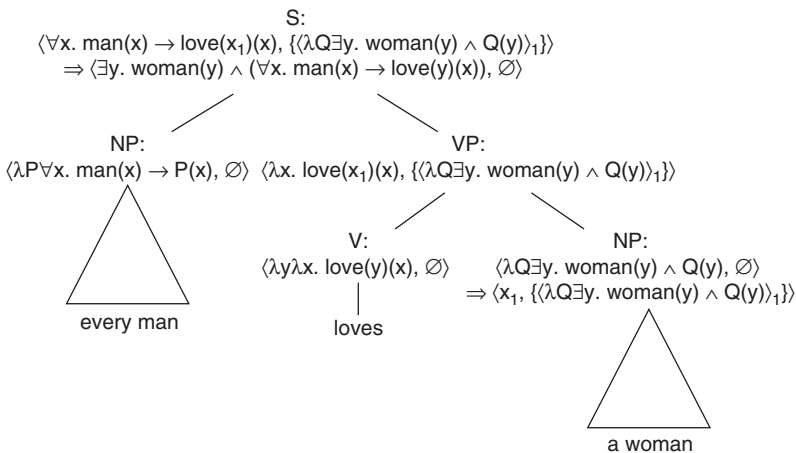


Fig. 108.2: A Cooper Storage derivation for the second reading of the sentence "Every man loves a woman".

**Underspecification.** As grammars grew larger in order to extend their coverage of free text, a further problem emerged. In a sentence with multiple scope ambiguities, the number of readings can grow exponentially with the number of quantifiers or other scope-bearing operators (such as negations or modal operators) in the sentence. The following sentence from Poesio (1994), which has  $(5!)^2 = 14400$  readings in which each quantifier and modal operator takes scope in its own clause alone, illustrates this problem. In practice, the problem is even worse because large-scale grammars tend to make generalizing assumptions (e.g., that all noun phrases take scope) that can cause innocent-looking sentences to be assigned millions of readings.

- (1) A politician can fool most voters on most issues most of the time, but no politician can fool every voter on every single issue all of the time.

The standard approach to handling massive ambiguity like this in large-scale grammars today is *underspecification*. Underspecification approaches derive a compact representation of all readings from the syntactic analysis, and proceed to single specific readings only by need, and after irrelevant readings have been filtered out by inferences. Most underspecification approaches that are used in practice specify the parts from which a semantic representation is supposed to be built, plus constraints that govern how the parts may be combined. For instance, the *dominance graph* (Egg, Koller & Niehren 2001; Althaus et al. 2003) for the earlier example sentence “every man loves a woman” is shown in Fig. 108.3a. The parts of this graph may be combined in all possible ways that respect the dotted dominance edges, yielding the two trees in Fig. 108.3b,c. These trees represent the semantic representations that we also derived in Fig. 108.2.

Most modern large-scale grammars use underspecification in one form or another. HPSG grammars use Minimal Recursion Semantics (MRS, Copestake et al. 2005). The Glue Logic system used by many LFG grammars (Dalrymple 1999) can be seen as an underspecification approach as well; note that some recent LFG grammars also use a simpler rewriting mechanism for semantic construction (Crouch & King 2006). Underspecification-based semantic construction algorithms have also been defined for Tree Adjoining Grammars (Kallmeyer & Romero 2008; Gardent 2003). Hole Semantics (Blackburn & Bos 2005) is a particularly easy-to-understand underspecification formalism. The algorithmic

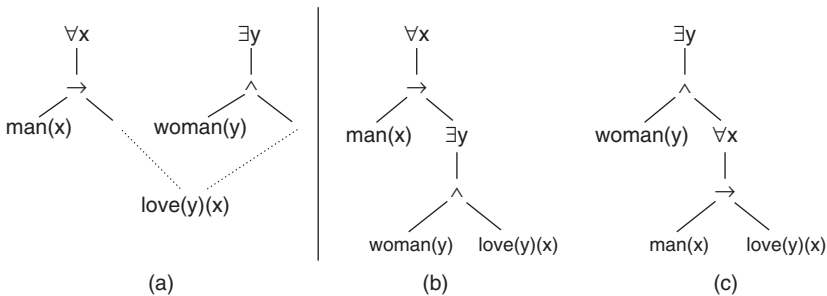


Fig. 108.3: A dominance graph for “every man loves a woman” (a), along with the two trees it describes (b,c).

foundations of underspecification have been worked out particularly well for dominance graphs, into which MRS and Hole Semantics can be translated. Dominance graphs also support powerful inference algorithms for efficiently reducing the set of possible readings without even computing them (Koller & Thater 2010). For more information about underspecification, we refer to article 24 (Egg) *Semantic underspecification* in this handbook.

One popular grammar formalism in computational linguistics that follows the original Montagovian program more directly is Combinatory Categorical Grammar (Steedman 2000; Bos et al. 2004). CCG is a variant of categorial grammar, with which it shares a very elegant and direct mapping of syntactic to semantic representations. Although this forces CCG into modeling semantic ambiguities as syntactic ambiguities, CCG can still be parsed efficiently by representing both kinds of ambiguity together in a parse chart.

## 2.2. Inference

The major added value of logic as a representational framework in computational linguistics is its suitability for the development of provably correct *inference procedures*. Because logical deduction is backed by the truth-conditional concept of logical entailment, it is possible to define under what conditions a deduction system is sound and complete, and to develop such systems. This is crucial when we model the processes which people perform when interpreting or producing an utterance – e.g., deriving relevant implicit information from the utterance’s semantic interpretation, integrating meaning information into their knowledge, or reducing ambiguity by the exclusion of inconsistent interpretations.

For first-order predicate logic, *theorem provers* – that is, computer programs that test formulas for validity or unsatisfiability – have become efficient enough to support the practical application of deduction systems. Theoretically, first-order logic is undecidable; but theorem provers, which were originally designed for mathematical applications, have nonetheless achieved an impressive average performance on standard tasks. Currently, a variety of highly efficient off-the-shelf theorem provers are available which can be used as general purpose inference engines for natural language processing (Riazanov & Voronkov 2002; Hillenbrand 2003); there are also tools called *model builders* which can test a formula for satisfiability and build satisfying models for them (McCune 1998; Claessen & Sörensson 2003). There has been some research on theorem provers for dynamic logics, such as DRT (van Eijck, Hegueiabehere & O Nuallain 2001; Kohlhase 2000), but these provers have not been engineered as thoroughly as standard first-order provers, and it is more efficient in practice to translate dynamic logic into static logic and use the standard tools (Bos 2001). One example for an end-to-end system of the “standard model”, involving semantic construction and the use of first-order theorem provers, is Bos & Markert (2005).

It is known that first-order logic is not expressive *enough* to represent genuinely higher-order or intensional phenomena in natural language, such as embedding under propositional attitudes. Some researchers have directly applied theorem provers for higher-order logic (e.g., Andrews & Brown 2006) to natural-language inference tasks; see e.g. Gardent & Konrad (2000). However, higher-order theorem provers are much less efficient in practice than first-order provers. To compensate for this restriction, computational semantics has a strong tendency towards avoiding higher-order constructs, choosing first-order analyses



in the case that semantic theory offers them as an option, and sometimes even using first-order representations to approximate phenomena that would be modeled appropriately with higher-order logic only (e.g. in the “ontological promiscuity” approach (Hobbs 1985); see also Pulman (2007) for a more recent case study).

Conversely, one can explore the use of logics that are *less* expressive than first-order logic in order to maximize efficiency, for restricted tasks and applications. *Description logics* (Baader et al. 2003) are a family of fragments of first-order logic designed to model terminological knowledge and reasoning about the membership of objects in the denotation of concepts, of which the KL-ONE system is an early representative (Brachman & Schmolze 1985). They are supported by very fast reasoning systems (Haarslev & Möller 2001; Tsarkov, Horrocks & Patel-Schneider 2007). Because they offer only restricted types of quantification, however, they have mostly been used for small domains or for specific problem, such as the resolution (Koller et al. 2004) and generation (Areces, Koller & Striegnitz 2008) of referring expressions.

Historically, another fragment of first-order logic that experienced widespread use in computational semantics is *Horn Clause Logic*, which underlies the programming language Prolog. Horn Clause Logic is limited by its inability to express true logical negation, which in Prolog must be approximated as “negation by failure”: A negation  $\neg A$  is considered as true iff  $A$  cannot be proved from the database. Prolog has been widely used in computational linguistics (Pereira & Shieber 1987; Blackburn & Bos 2005) – among other reasons, because it can model the full process of natural-language understanding including parsing, semantic construction, and inference uniformly, by using logical deduction. However, its use has declined due to the availability of fast theorem provers and of NLP software libraries for mainstream programming languages, as well as the growing importance of numeric processing for statistical methods (see Section 3 below).

A final challenge is the modeling of *common-sense reasoning*. Inference steps needed in the process of natural-language understanding may be valid only in the typical case, and thus their results can be overwritten, if more specific contradicting information is added. Knowing that Tweety is a bird allows us to infer that Tweety can fly; adding the information that Tweety is a penguin forces us to revise the derived information. This raises the inference task to another level of difficulty. Standard predicate-logic deduction just adds information, extending the knowledge base in a monotonic way, and has no mechanism for knowledge revision. Several alternative logic frameworks supporting *non-monotonic deduction* have been proposed, most importantly default logic (Reiter 1980), abductive reasoning (Lipton 2001), and auto-epistemic logic (Moore 1985). Of these, default logic (particularly in the context of SDRT, Asher & Lascarides 2003) and abductive reasoning (i.e., reasoning from observations to the best explanation, particularly in the text understanding framework of Hobbs et al. 1993) have become influential in computational semantics.

### 2.3. Knowledge resources for computational semantics

So far, we have sketched how logic-based semantic representations can be automatically built, and how inferences with these representations can be efficiently computed using theorem provers. To make real use of these systems, we need wide-coverage knowledge

bases, which provide us with facts about the meaning of predicates and constants. Consider the following examples:

- (2) a. Socrates is a man.  
All men are mortal.  
b. Socrates is mortal.
- (3) a. Bill bought a convertible.  
b. Bill bought a car.
- (4) a. John went shopping.  
b. Did he bring enough money?
- (5) a. Which genetically caused connective tissue disorder has severe symptoms and complications regarding the aorta and skeletal features, and, very characteristically, ophthalmologic subluxation?  
b. Marfan's is created by a defect of the gene that determines the structure of Fibrillin-11. One of the symptoms is displacement of one or both of the eyes' lenses. The most serious complications affect the cardiovascular system, especially heart valves and the aorta.

The range of inferences that we can draw from semantic representations alone without any additional knowledge is very limited. We may be able to do simple syllogistic reasoning as in (2); but the vast majority of intuitively plausible inferences require additional background knowledge. The inference in (3) requires the lexical-semantic information that convertibles are cars; to make sense of the dialogue sequence (4), we must have common-sense knowledge about what happens when people go shopping. The example (5) gives an impression of the complex inferences that a natural-language interface to a medical information system must be able to draw, and of the kind and amount of domain knowledge which is required for this.

Theorem provers support such inferences if they have access to logical knowledge bases which contain this information. Unfortunately, the amount of knowledge which may in principle be relevant for inference is huge, and so hand-crafting comprehensive knowledge bases is a very expensive and cumbersome task. In general, coverage is at present a much harder problem for logic-based inference than efficiency.

Certain types of lexical-semantic knowledge are provided by WordNet (Fellbaum 1998), with impressively wide coverage for English and a variety of other languages (Vossen 2004; Hamp & Feldweg 1997). WordNet distinguishes various *senses* of each word in the lexicon, groups them into *synsets* of synonymous senses, and specifies different semantic relations between these synsets, such as hyponymy (subsumption) and meronymy (part-of). Other resources, such as FrameNet (Baker, Fillmore & Cronin 2003) and VerbNet (Kipper-Schuler 2006) contribute information about described situation type, thematic roles, and alternative syntactic realization patterns for lexical expressions, in particular verbs. For a more detailed discussion of lexical-semantic resources and methods for acquiring lexical-semantic knowledge, see article 110 (Frank & Padó) *Semantics in computational lexicons* in this handbook.

However, there are many kinds of knowledge which are not formalized in WordNet and related resources. Examples are script-like information as in the supermarket example above, or stereotypical properties of concepts such as the ability of birds to fly. While it can be debated whether such knowledge should be packaged into the lexicon as components of word meaning or whether it is non-linguistic common-sense knowledge about the world, there is no doubt that such knowledge is necessary for full text understanding; see also article 32 (Hobbs) *Word meaning and world knowledge*. Because of the magnitude of the task, few attempts have been made to comprehensively axiomatize world knowledge by hand. One notable exception is the Cyc project (Lenat 1995); its aim is to hand-axiomatize enough knowledge that an automated system could then learn more knowledge from natural language text. At the time of writing, Cyc contains five million assertions about several hundreds of thousands of concepts, and has recently become freely available for research purposes as ResearchCyc (Matuszek et al. 2006). Because it aims at massive coverage, Cyc is a rather heavyweight system. It is also optimized for fine-grained reasoning on the conceptual level, rather than for natural-language processing and inference. For instance, Cyc distinguishes between 23 different senses of spatial “in”, all of which have different axioms. This degree of ambiguity causes substantial problems for ambiguity resolution, and therefore Cyc can be of only limited use for language-related semantic processing tasks.

### 3. Statistical methods in computational semantics

The “standard model” we have presented so far enables us to compute logic-based meaning representations, which can be used by theorem provers to draw inferences. This works efficiently and with impressive accuracy, if hand-crafted grammars and knowledge resources are available that cover all information that is required for the interpretation. However, logic-based semantic methods run into a number of fundamental problems:

- Natural language is extremely ambiguous, and understanding of utterances implies *ambiguity resolution*: the determination of a contextually appropriate reading. Underspecification methods enable an efficient representation of semantic ambiguity, but they make no attempt to resolve it. A particular challenge is word-sense disambiguation, because lexical ambiguity comprises a large and extremely heterogeneous class of individual phenomena.
- Modeling *inference* for open-domain text understanding with logic requires us to encode a huge amount of *world knowledge* in logic-based knowledge bases, as we have discussed. Such knowledge bases are not available; even large-scale efforts at manual resource creation like WordNet and Cyc have coverage problems.
- Despite the progress in hand-crafting large grammars with semantic information, many free-text sentences cannot be completely analyzed by these grammars: Knowledge-based grammar processing still faces *coverage* problems. Because traditional algorithms for semantic construction can only work on complete parses, no semantic representations can be computed for these sentences. That is, semantic construction procedures are not *robust* to coverage problems.

As a consequence, logic-based methods for computational semantics have not been very successful as part of applications in language technology. In retrospect, this is not

entirely surprising. As we know from psycholinguistics, human language use and language learning are not purely categorical processes, but are strongly influenced by statistical expectations. This awareness of preferences speeds up the interpretation process, and in particular enables people to disambiguate expressions effortlessly and in real time. In the nineties, computational linguistics as a whole experienced a “statistical turn”. The basic idea behind *statistical* (or, more generally: *data-intensive*) methods is to let a computer system discover statistical regularities in language use in large text corpora (or even the entire Internet), and then exploit them to analyze previously unseen texts or discourses. Because the system learns from data, this approach is also called *machine learning*. The idea was first worked out in the area of automatic speech recognition, and was later applied successfully to syntactic parsing. Today, it is the dominant paradigm in semantic research in computational linguistics as well.

Logic-based and data-intensive approaches are complementary in their strengths and weaknesses. Data-intensive approaches typically take a very shallow view on language from a linguistic point of view. The models they build of natural-language expressions have little to say about issues such as the logical structure of a sentence. They are typically not related to logic, perhaps not even based on a full syntactic parse of the sentence, and the inferences they support are judged to a standard of practical usefulness rather than logical correctness. However, these models can automatically learn information that is implicit in large text corpora, achieving wide coverage with comparatively little human effort. This gives us tools for addressing the coverage problems listed above. Furthermore, the knowledge provided by statistical methods is soft preferential knowledge, in terms of frequencies or probability estimates, which support disambiguation tasks well, and may even be appropriate for modeling defeasible common-sense knowledge.

We assume that a reader of this handbook is less familiar with machine learning techniques than with logic-based approaches. Therefore, the presentation in this section will be more basic than in the rest of the article. We try to give a flavor of statistical methodology, and at the same time provide a short overview of three prominent areas of research in computational semantics: *word-sense disambiguation*, *semantic role labeling*, and the modeling of *semantic relatedness*. These topics and other research in statistical computational linguistics are discussed at greater length in the standard textbooks by Jurafsky & Martin (2008) and Manning & Schütze (1999).

### 3.1. Word-sense disambiguation: Basics in statistical semantics

**Word-sense disambiguation.** Lexical ambiguity is pervasive in natural languages, and the determination of the contextually appropriate word meaning, known as *word-sense disambiguation* (WSD), has long been recognized as a hard problem in computational linguistics. Over fifty years ago, Yehoshua Bar-Hillel argued in his famous report on automatic translation (Bar-Hillel 1960) that “a translation machine should not only be supplied with a dictionary but also with a universal encyclopedia”. For example, to appropriately translate “the box was in the pen” into another language, a computer program must know about typical sizes and shapes of boxes and pens to conclude that “pen” is used in the “enclosure” sense rather than the “writing implement” sense. Bar-Hillel commented that any attempt to solve this problem with knowledge-based methods was “utterly chimerical and hardly deserves any further discussion”.

We can get a first grasp on the problem of WSD from lexical-semantic resources that define an inventory of possible word senses for each word of a language. Two such resources for English are WordNet (Fellbaum 1998) and Roget's Thesaurus (Chapman 1977). WordNet lists Bar-Hillel's two senses for the noun "pen", along with the senses "correctional institution" and "female swan". English WordNet contains about 29,000 polysemous words, each of these with 3 different senses on average. Neither of these resources contains the information (e.g., box and pen sizes) that is necessary to reliably determine the sense in which a word was used in a given sentence.

**Machine learning and WSD.** WSD in early large-scale NLP systems was typically done by hand-written rules that were developed specifically for the application and the relevant domain (see e.g. Toma 1977; Hobbs, Jerry R., Douglas E. Appelt et al. 1992; Koch, Küssner & Stede 2000). Early attempts at defining generic rule-based methods for WSD are (Wilks 1975; Hirst & Charniak 1982). The weighted abduction approach by Hobbs et al. (1993) supported a generic, logic-based mechanism for disambiguation, but suffered from efficiency issues and required a large hand-coded knowledge base to work.

By contrast, statistical approaches attempt to solve the WSD problem by automatically learning the choice of the appropriate word sense from text corpora. The fundamental idea of such a machine learning approach is to build a *classifier*, which for each occurrence of a word  $w$  in some context  $c$  determines the sense  $s$  of this occurrence of  $w$ . This classifier is automatically learned from observations in a text corpus, in which each occurrence of each word has been manually *annotated* with its sense; one corpus that has been annotated with WordNet senses is the SemCor corpus (Landes, Leacock & Tengi 1998).

Machine learning approaches in which the training data is assumed to be annotated in this way are called *supervised*. The context  $c$  is usually approximated by a collection  $f$  of *features* that can be automatically extracted from the text. The machine learning system is trained on the annotated training corpus, i.e., it observes the pairs of sense annotations and extracted feature instantiations, for all instances of  $w$ , and derives from these data a *statistical model* of the correlation between feature patterns and word senses. The system can then be executed on unseen, unlabeled documents to label each word token automatically with its most plausible word sense, given the feature information extracted from the token's context.

Different approaches to statistical WSD are distinguished by the features they use and the machine learning method. The simplest choice for the features is to use *context words*. For instance, Yarowsky's (1995) system automatically identified the context words *life*, *animal*, and *species* as strong statistical indicators of the biological sense of the target word *plant*, and *manufacturing*, *equipment*, and *employee* as strong indicators of its "factory" sense. To address the disambiguation problem in a systematic way, we might determine the 2000 most frequent content words  $w_1, \dots, w_{2000}$  in the corpus. For any occurrence of a target word  $w$ , we could then assign the feature  $f$  the value 1 if the context word  $w_i$  occurs within a window of  $n$  words (for  $n = 5, 10, 30, \dots$ ) before or after  $w$ , and 0 otherwise. Approaches to machine learning differ substantially in the exact way in which they make use of the feature information to solve their classification task. For an overview of different approaches to machine learning, see Mitchell (1997), Russell & Norvig (2010), or Witten, Frank & Hall (2011).

**Modeling context.** The choice of features is a crucial part of designing a successful machine-learning-based WSD system: Since only the information encoded in features is visible to the machine learning system, the design of the feature space entails a decision about the information made available to the disambiguation process. The simplistic view of context as a set of cooccurring content words can be refined by adding more features representing different kinds of information. We can, e.g., include precedence information (does the context word occur to the left or to the right of the target?) or use positional information (does the context word occur as the immediate left and right neighbor of the target instance?). We may enrich the context information with linguistic information provided by available, reasonably efficient and reliable analysis tools: Using lemma and part-of-speech information is standard; adding syntactic information through shallow syntactic parsing is another frequently chosen option.

In principle, it would be desirable to use deeper and more informative context features than this. However, extracting such features tends to be expensive (it may again require large hand-crafted grammar and knowledge resources) or extremely noisy, if it can be done at all. Nevertheless, even the simple context-word approach can capture a remarkable amount of information on different levels of contextual knowledge and their interaction, however. Consider the following example; the common noun *dish* is ambiguous between a “plate” and a “food” sense.

(6) Yesterday night we went to a restaurant; I ordered an expensive dish.

The verb *order* contributes selectional preference information for its object position, and *restaurant* provides relevant topical or situational information. The two pieces of contextual evidence interact in a way that supports a strong prediction of the “food” sense of *dish*. Explicit modeling of the inference process leading to the correct reading would require very specific common-sense knowledge. A simple statistical model is able to predict the effects of this interaction with good results, based on the simple co-occurrence counts of these context words.

**Measuring system performance.** A machine learning system generalizes from observations without human intervention, and typically only has access to shallow features. The goal in designing such a system is therefore never that it is infallible. Instead, the aim is to balance maximum coverage with making relatively few mistakes. In order to examine the quality of such a system, one *evaluates* it on data for which the correct responses are known. To this end, one splits the manually annotated corpus into two separate portions for training and testing. The machine learning system is trained on the training corpus, and then used to classify every single word in the test corpus. One can, e.g., compute the *accuracy*, i.e., the percentage of word tokens in the test corpus for which the system computed the annotated word sense. This makes it possible to compare the performance of different systems using well-defined measures.

WSD has been an active field of research in computational semantics for the last two decades. An early successful WSD system was presented by Yarowsky (1992). One can get a sense of the current state of the art from the results of the “Coarse-grained English All Words Task” (Navigli, Litkowski & Hargraves 2007), a competition advertised for the SemEval 2007 workshop. This task consists in annotating the words in a given corpus with a coarse-grained sense inventory derived from WordNet. The random baseline, which assigns each word a

random sense, achieved an accuracy of about 52% on this task. Because one sense of a word is often strongly predominant, the simple policy of assigning the instances of each word always its globally most frequent sense achieves 79% accuracy on the dataset, which is a much more demanding baseline for WSD systems. On the other hand, the *inter-annotator agreement*, i.e. the percentage of tokens for which the human annotators agreed when creating the SemEval 2007 test data was 94%. This is usually taken to indicate the upper bound for automatic processing. The best-performing WSD system in the 2007 competition reached an accuracy of about 88%, beating the most-frequent-sense baseline significantly. Although the WSD system does not reach human performance yet, it does come rather close. Recent overview articles about WSD are McCarthy (2009) and Navigli (2009).

### 3.2. Semantic role labeling: The issue of feature design

**Semantic roles.** WSD algorithms predict atomic meaning representations for lexical items in a text. In order to compute a semantic representation for an entire sentence, we must compose these lexical meaning representations into larger structures. Recent research has focused on the computation of *predicate-argument structures* as the first step in the semantic composition process. This is not a trivial problem, because the syntactic realization of semantic argument positions is subject to considerable variation. The central theoretical concept relating syntactic complements and semantic arguments is that of a *semantic role*. The practical task of computing predicate-argument structures is called *semantic role labeling*, (SRL).

The first issue that one needs to address in SRL is what inventory of semantic roles to use. Fillmore (1968) originally proposed a small universal set of *thematic roles*, such as “agent”, “patient”, “recipient”, etc.; see also article 18 (Davis) *Thematic roles*. This assumption has turned out to be impractical for wide-coverage lexicons, because it is impossible to map the variation and conceptual wealth of natural-language semantics cleanly to such a small role inventory. For example, in the description of a commercial transaction in (7) does the subject “China Southern” fill the *agent* role (since it pays money to Airbus), or the *recipient* role (since it receives planes from Airbus)?

(7) China Southern buys five A380 planes from Airbus.

**FrameNet and PropBank.** Research on SRL in computational linguistics therefore tends to use semantic role inventories which do not assume universal semantic roles, either in FrameNet (Fillmore & Baker 2010) or in PropBank style (Palmer, Gildea & Kingsbury 2005).

FrameNet organizes the lexicon into *frames*, which correspond to situation types. The FrameNet database currently contains about 12,000 lexical units, organized into 1,100 frames. Semantic roles (called *frame elements*) are then assumed to be specific to frames. For example, the verbs “replace” and “substitute” (as “exchange” and “switch”, and the nouns “replacement” and “substitution”) evoke the REPLACING frame; core roles of this frame are *Agent*, *Old*, and *New*. The names of these roles are meaningful only within a given frame. This makes the role concept of FrameNet rather specific and concrete, and makes it possible to annotate role information with high intuitive confidence. Two major corpora that have been annotated with FrameNet data are the Berkeley FrameNet Corpus (Baker, Fillmore & Cronin 2003) and the SALSA Corpus for German (Burchardt

et al. 2006). An example that illustrates how different verbs can induce the same predicate-argument structure in FrameNet is shown in (8).

- (8) a. [<sub>Agent</sub> Lufthansa] is replacing<sub>REPLACING</sub> [<sub>Old</sub> its 737s]  
       [<sub>New</sub> with Airbus A320s].  
       b. [<sub>Agent</sub> Lufthansa] is substituting<sub>REPLACING</sub> [<sub>New</sub> Airbus A320s]  
       [<sub>Old</sub> for its 737s].

The PropBank approach proposes an even more restricted notion of a semantic role. PropBank assumes specific roles called *arg0*, *arg1*, *arg2*, ... for the senses of each verb separately, and thus only relates syntactic alternations of the same predicate to each other. Role label identity between complements of different verbs is not informative, as the examples in (9) illustrate:

- (9) a. [<sub>Arg0</sub> Lufthansa] is replacing [<sub>Arg1</sub> its 737s]  
       [<sub>Arg2</sub> with Airbus A320s].  
       b. [<sub>Arg0</sub> Lufthansa] is substituting [<sub>Arg1</sub> Airbus A320s]  
       [<sub>Arg3</sub> for its 737s].

Of the two approaches, FrameNet is the more ambitious one, in that it supports a more informative encoding of predicate-argument structure than PropBank role labeling. However, annotating a corpus with PropBank roles is easier and can be done much more quickly than for FrameNet. As a consequence, exhaustively annotated corpora are available for several languages; the English PropBank corpus is a version of the Penn Treebank (Marcus, Santorini & Marcinkiewicz 1993) in which the arguments of all verb tokens are annotated with semantic roles.

**Semantic role labeling systems.** The SRL task for FrameNet or PropBank can be split into two steps. First, because roles are specific to FrameNet frames or PropBank verb senses, we must determine the frame or sense in which a given verb token is being used. This is a WSD task, and is usually handled with WSD methods.

Assuming that each predicate in the sentence has been assigned a frame, the second step is to identify the arguments and determine the semantic roles they fill. The first system that did this successfully was presented by Gildea & Jurafsky (2002) – originally for FrameNet, but the approach has also been adapted for PropBank (see Palmer, Gildea & Kingsbury 2005). It uses a set of features providing information about the target verb, the candidate role-filler phrase, and their mutual relation. Most of the features refer to some kind of syntactic information, which is typically provided by a statistical parser. Features used include the phrase type (e.g., NP, PP, S); the head word of the candidate phrase; the voice of the head verb; the position of the candidate phrase relative to the head verb (left or right); and the path between candidate phrase and head verb, described as a string of non-terminals. Based on this information, the system estimates the probability that the candidate phrase stands in certain role relations to the target predicate, and selects the most probable one for labeling.

**Feature design and the sparse data problem.** The Gildea & Jurafsky system (as well as more recent approaches to WSD) uses syntactic information, but only looks at a handful of specific features of a syntax tree; much of the available information that the syntax tree



contains is hidden from the machine learning system. Even a human annotator would sometimes have difficulties in predicting the correct semantic roles given just this information. If the SRL system assumes that it has full syntactic information anyway, why does it ignore most of it? Couldn't its performance be improved by adding additional features that represent more detailed syntactic information?

This question touches upon a fundamental challenge in using statistical methods, the *sparse data problem*. Every statistical model is trained from a limited set of observations in the corpus, and is expected to make accurate predictions on unseen data. The reliability of these predictions depends greatly on the size of the training corpus and the number of features. If we add features, we increase the number of possible combinations of feature-value pairs, i.e., the size of the *feature space*. For a given size of the training data, this means that certain feature-value combinations will be seen only once or not at all in training, which implies that the estimate of the statistical model becomes too inaccurate to make good predictions. *Smoothing* and *back-off* techniques can improve the performance of systems by assigning some kind of positive probability to combinations that have never or rarely been seen in training. But even these methods ultimately reduce the system's predictions on rare events to educated guesses.

The trade-off between informativity and occurrence frequency is one of the major challenges to statistical NLP. Sensible *feature design*, i.e. selecting a feature set which provides maximal information while keeping the feature space manageable, is a task where combined technical and linguistic expertise is required.

**Further reading.** For a more detailed introduction to standard SRL, we refer the reader to Jurafsky & Martin (2008). Just as for WSD, a good starting point to get a sense of the state of the art is to look at recent SRL competitions (Carreras & Marquez 2004, 2005; Hajic et al. 2009).

### 3.3. Semantic relatedness: Minimizing supervision

All data-intensive methods we have described so far are supervised methods: They require manually annotated corpora for training. The sparse data problem we just mentioned arises because annotating a corpus is costly and time-intensive, which limits the size of available corpora (Ng 1997). Conversely, this means that supervised methods can only be used with relatively inexpressive features.

*Data expansion* methods attempt to work around this problem by partially automating the annotation process. These methods train an initial model on a small amount of manually annotated *seed data*; use this model to identify instances in a large unannotated corpus whose correct annotation can be predicted with high confidence; add the automatically annotated instances to the corpus; use the extended corpus to retrain the model; and then repeat the entire process in a “bootstrapping cycle”. Such *semi-supervised* methods have been quite successful in early WSD systems (Yarowsky 1995), and more recently also for SRL (Fürstenau & Lapata 2009). Another strategy of reducing annotation effort is known as *active learning*: A model is trained on a seed corpus, but it is then used for the identification of low confidence instances. Specifically annotating these low-confidence cases will usually add more relevant information than annotating large numbers of cases that the learning system already “is certain about” (Settles 2009).

**Learning from unannotated text.** A class of popular approaches take this idea one step further, by requiring no manual annotation of training corpora at all. They are in particular attractive for the acquisition of world knowledge and lexical knowledge, because these tasks require large amounts of training data to achieve thematic coverage. An early representative of this tradition is Hearst (1992), who learned hyponym relations between words by considering occurrences of patterns like “an X such as Y”. If this string occurs significantly more frequently than would be expected from the frequencies of X and Y alone, the system infers that Y is a hyponym of X. The approach was later generalized to other semantic relations, e.g. to meronymy (Girju, Badulescu & Moldovan 2006) and certain semantic relations between verbs (Chklovski & Pantel 2004).

Although such pattern-matching approaches sometimes find incorrect pairs (the top Google hit for the above pattern at the time of writing was “a fool such as I”), their great advantage is that they can operate on raw text and require no annotation effort. They can even be used on the entire Web, with certain caveats that are discussed e.g. by Keller, Lapata & Ourioupina (2002), and therefore achieve huge lexical coverage. However, these approaches still require human intervention in the specification of the patterns for which the corpus should be searched. To alleviate the problem, Ravichandran & Hovy (2002) present a bootstrapping approach that can simultaneously learn patterns and instances of the relation.

**Distributional models.** A more radical approach to the problem of learning knowledge from unannotated corpora is offered by methods which automatically learn from co-occurrence frequencies what expressions are *semantically similar* and do not even require the specification of search patterns. The basic idea, known as the *Distributional Hypothesis*, is that words with similar meaning tend to occur together with the same words. The basic insight can be traced back to the 1950s (Harris 1951). The catchy phrase “You shall know a word by the company it keeps” is due to Firth (1957).

In its basic version, distributional semantics approximates word meaning through counts of context words occurring in the neighborhood of target word instances. Take, as in the WSD example above, the  $n$  (e.g., 2000) most frequent content words in a corpus as the set of relevant context words; then count, for each word  $w$ , how often each of these context words occurred in a context window of  $n$  before or after each occurrence of  $w$ . Fig. 108.4 shows the co-occurrence counts for a number of target words (columns), and a selection of context words (rows) obtained from a 10% portion of the British National Corpus (Clear 1993).

|            | factory | flower | tree | plant | water | fork |
|------------|---------|--------|------|-------|-------|------|
| grow       | 15      | 147    | 330  | 517   | 106   | 3    |
| garden     | 5       | 200    | 198  | 316   | 118   | 17   |
| worker     | 279     | 0      | 5    | 84    | 18    | 0    |
| production | 102     | 6      | 9    | 130   | 28    | 0    |
| wild       | 3       | 216    | 35   | 96    | 30    | 0    |

Fig. 108.4: Some co-occurrence vectors from the British National Corpus.

The resulting frequency pattern encodes information about the meaning of  $w$ . According to the Distributional Hypothesis, we can model the semantic similarity between two words by computing the similarity between their cooccurrences with the context words. In the example of Fig. 108.4, the target *flower* co-occurs frequently with the context words *grow* and *garden*, and infrequently with *production* and *worker*. The target word *tree* has a similar distribution, but the target *factory* shows the opposite co-occurrence pattern with these four context words. This is evidence that trees and flowers are more similar to each other than to factories.

Technically, we represent each word  $w$  as a vector in a high-dimensional vector space, with one dimension for each context word; the value of the vector at a certain dimension  $v$  is the co-occurrence frequency of  $w$  with  $v$ . We define a similarity measure between words based on their respective vector representations. A commonly used measure is the *cosine* of the angle between the two vectors, which can be computed easily from the co-occurrence counts. It assumes the value 1 if the vectors' directions coincide (i.e., the proportions of their context-word frequencies are identical), and 0 if the vectors are orthogonal (i.e., the distributions are maximally dissimilar). In the 5-dimensional word-space of our example, we obtain a high distributional similarity between the targets *tree* and *flower* (cosine of 0.752, representing an angle of about  $40^\circ$ ), and a low similarity (cosines of 0.045 and 0.073, respectively, representing angles of about  $85^\circ$ ) between either of the two and the target *factory*, as illustrated in Fig. 108.5.

**Discussion.** Standard distributional models offer only a rough approximation to lexical meaning. Strictly speaking, they do not model semantic similarity in terms of the “likeness” of lexical meaning, but a rather vague notion of “semantic relatedness”, which includes synonymy, topical relatedness, and even antonymy (Budanitsky & Hirst 2006). This is in part because the notion of context is rather crude. A deeper problem is that textual cooccurrence patterns provide essentially incomplete and indirect information about natural-language meaning, whose primary function is to connect language to the world. We will come back to the issue in Section 4.4.

Nevertheless, distributional approaches to semantics are attractive because they are *fully unsupervised*: They do not require any annotation or other preparatory manual work, in contrast to the supervised and semisupervised methods sketched above. Therefore, one gets wide-coverage models almost for free; the only prerequisite is a text corpus of sufficient size. In particular, distributional models can be easily obtained for languages for which no lexicon resources exist, and adapted to arbitrary genre-specific or domain-specific

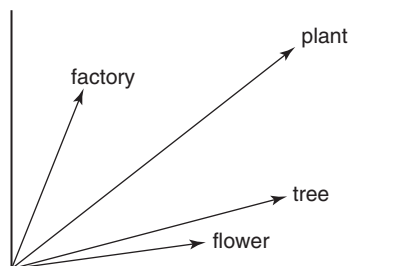


Fig. 108.5: Graphical illustration of co-occurrence vectors.

sub-languages. They have proven practically useful for several language-technology tasks. Examples are word-sense disambiguation (McCarthy & Carroll 2003; Li, Roth & Sporleder 2010; Thater, Fürstenau & Pinkal 2011), word-sense induction (Schütze 1998), information retrieval (Manning, Raghavan & Schütze 2008), and question answering (Dinu 2011).

**Contextualization.** An obvious flaw of the basic distributional approach is that it counts *words* rather than *word senses*. Because of lexical ambiguity, the distributional pattern of a word is therefore a mixture of the distributional patterns of its individual senses. While ideally each occurrence of *plant* should be either highly similar to *factory* or to *tree*, the model will uniformly assign them a value that is somewhere in between, as indicated by the *plant* arrow in Fig. 108.5.

Dealing with this problem is tricky; adding word-sense information to the corpus is not a real option, since this would throw us back to supervised methods, requiring expensive manual annotation. An approach that has received recent attention is to *contextualize* a target instance, by modifying its meaning with information provided by its actual context words (using algebraic operations on the respective vector representations, such as addition or component-wise multiplication). The effect is that the vector of an occurrence of *plant* in the context of *water* is “pulled” towards the vector of *tree*, thus modeling a preference for the botanical word sense (Schütze 1998; Mitchell & Lapata 2008; Erk & Pado 2008; Thater, Fürstenau & Pinkal 2010).

**Refining distributional similarity measures.** The basic approach of distributional similarity modeling has been refined in various ways. Different alternative measures for the association of a target word with the context and for computing similarity between a pair of target words have been proposed. Recent work makes frequent use of “hidden variable” techniques (Dinu & Lapata 2010), which were originally developed for Information Retrieval (Landauer, Foltz & Laham 1998; Schütze 1998). Syntactic information has been added to the model in different ways in order to achieve a finer-grained analysis of distributional similarity, e.g. in the contextualization approaches of Erk & Padó (2008) and Thater, Fürstenau & Pinkal (2010). Lin & Pantel (2001) present an interesting syntax-enriched variant of distributional semantics, which generalizes to *multiword relational patterns*. Their system can discover, for example, that “X solves Y” and “X finds a solution to Y” are paraphrases, based on the fact that the frequency distributions of fillers for the X and Y slots are similar. Work on contextualization and syntactic refinement has initiated a discussion about compositionality in distributional semantics – that is, methods for computing distributional representations for complex expressions from distributional information about individual words (Mitchell & Lapata 2008; Grefenstette & Sadrzadeh 2011).

Unsupervised methods for semantic relatedness are currently a very active field of research, and it will be interesting to see how the area will develop in the future. For a recent detailed overview over the state of the art, see Turney & Pantel (2010).

## 4. Current developments

We conclude our overview with a discussion of some recent developments in computational semantics. We will look at a general evaluation scheme for computational semantics systems (*textual entailment*, Section 4.1), an approach to shallow logic-based inference that may be a starting point for bringing logic back into broad-coverage computational

semantics, *natural logic*, Section 4.2), approaches to the automated learning of wide-coverage semantic construction resources (Section 4.3), and approaches to learning data-intensive models that ground word meaning directly in the real world (Section 4.4). Common to all of these approaches is that they are in their early stages, and there is no telling whether they will be successful in the long run; but they are all promising, active research areas, which may contribute to bringing knowledge-based and data-intensive semantics closer together in the future.

#### 4.1. Textual entailment

As we have argued above, *inference* is the touchstone for computational semantics. It is the capability of supporting inferences that makes semantic processing potentially useful in applications. The performance of a semantic processing method is therefore strongly dependent on its performance in modeling inference. While the evaluation of WSD or SRL systems is straightforward, the question of how to assess a system's performance on the more global task of modeling inference appropriately has long been an open issue in the computational semantics community.

**FraCaS.** A first step in this direction was the creation of a test suite of inference problems by the FraCaS project in the 1990s (Cooper et al. 1996). Each problem consisted of a premise and a candidate conclusion (phrased as a yes/no question), plus information about their logical relation; systems could then be evaluated by making them decide the logical relation between the sentences and comparing the result against the gold standard. Two of the about 350 examples are shown below:

- (10) *P*: ITEL won more orders than APCOM  
*Q*: Did ITEL win some orders?  
 → *YES*
- (11) *P*: Smith believed that ITEL had won the contract in 1992  
*H*: Had ITEL won the contract in 1992?  
 → *UNKNOWN*

The FraCaS testsuite was hand-crafted to cover challenging semantic phenomena (such as quantifiers, plural, anaphora, temporal reference, and attitudes), while minimizing the impact of problems like syntactic complexity and word-sense ambiguity. This made it a valuable diagnostic tool for semanticists, but it also limited its usefulness for the performance evaluation of semantic processing systems on real-world language data, in which syntactic complexity is uncontrolled and word-sense ambiguity is prevalent.

**RTE.** A milestone in the development of an organized and realistic evaluation framework for natural-language inference was the *Recognizing Textual Entailment*, *RTE*) challenge initiated by Ido Dagan and his colleagues in the PASCAL network (Dagan, Glickman & Magnini 2006). The RTE dataset consists of pairs of sentences (a *text* *T* and a *hypothesis* *H*) derived from text that naturally occurred in applications such as question answering, information retrieval, and machine translation, plus an annotation specifying whether each sentence pair stands in an “entailment” relation.

In RTE, “entailment” is defined as follows:

“We say that *T* entails *H* if the meaning of *H* can be inferred from the meaning of *T*, as would typically be interpreted by people. This somewhat informal definition is based on (and assumes) common human understanding of language as well as common background knowledge.” (Dagan, Glickman & Magnini 2006)

For instance, the following sentence pair from the second RTE challenge (Bar-Haim et al. 2006) is in the entailment relation.

- (12) *T*: In 1954, in a gesture of friendship to mark the 300th anniversary of Ukrainian union with Russia, Soviet Premier Nikita Khrushchev gave Crimea to Ukraine.  
*H*: Crimea became part of Ukraine in 1954.  
 → YES

Crucially, “textual entailment” is not a logical notion; it is a relation between textual objects. The above definition has been criticized for its vagueness and for its insufficient theoretical grounding, in that it blurs the distinction between logical entailment, common-sense inference, presupposition, and conversational implicature (Zaenen, Karttunen & Crouch 2005). However, it was deliberately intended as a specification of a pre-theoretic concept, which is neutral with respect to any particular semantic theory. Determining textual entailment seems to be a quite natural task for people, and is motivated from applications (Manning 2006); one effect of this is that annotators agree quite well on RTE-style entailment judgments (Bos & Markert 2005), whereas agreement on the precise and theoretically well-motivated distinctions tends to be difficult. For instance, it is doubtful whether the following logical reformulation of (12) is logically or analytically sound, given the semantics of the predicates and the sortal information about the argument fillers.

- (13) give-to(Khrushchev, Crimea, Ukraine)  
 $\models$  become-part-of(Crimea, Ukraine)

However, (12) is still a clear case of entailment in the sense of the above definition.

For the RTE challenge, two datasets were created, intended as training and evaluation corpus, respectively. They contained 800 sentence pairs each, annotated with respect to entailment. Participating systems could be tuned on the training corpus, which was made available several weeks in advance. For evaluation, they had to automatically determine for the unseen sentence pairs in the test corpus whether they stand in the entailment relation or not. Performance was measured in terms of accuracy, i.e. the percentage of sentence pairs on which the system’s judgment agreed with the annotation in the test corpus. The RTE challenge has established itself as a yearly event, with new datasets every year, and some variation in dataset and evaluation design.

**RTE systems.** The simplest reasonable baseline system for textual entailment recognition is one which checks for word overlap between *T* and *H*: It takes the percentage of words in the second sentence that occur in the first sentence as well as an indicator for entailment, and returns “yes” if this percentage exceeds a certain threshold. Such a system might classify (12) as a positive entailment case because “Crimea”, “Ukraine”, “in”, and “1954” occur both in *H* and *T*. A word-overlap system typically gets about 60% of the

sentence pairs right, depending on the particular instance of RTE. The accuracy can be increased by combining word overlap with semantic similarity measures (Jijkoun & de Rijke 2005; Glickman, Dagan & Koppel 2005), but the potential for such purely shallow and knowledge-lean improvements seems to be limited.

Pure logic-based systems, located at the other end of the spectrum, have completely failed at the RTE task, which was shown impressively by Bos & Markert (2005). They applied a state-of-the-art logic-based system along the lines of Section 2. Where this system claims entailment for a given sentence pair, its judgment is quite reliable; but because it only claimed entailment for less than 6% of the pairs, it gave far fewer correct answers overall than a simple word-overlap model. This demonstrates the severity of the knowledge bottleneck in logic-based semantics, which we mentioned above.

A standard system architecture that emerged from the experiences in RTE combines syntactic and semantic knowledge with machine learning technology. A typical inventory of knowledge types includes syntactic dependency information contributed by knowledge-based or statistical parsers plus lexical semantic information taken from WordNet or distributional models, potentially complemented by semantic role information (FrameNet, PropBank) and lexical semantic and world knowledge from other sources (e.g., DIRT (Lin & Pantel 2001), VerbOcean (Chklovski & Pantel 2004), or the YAGO knowledge base (Suchanek, Kasneci & Weikum 2008)). This information is used as input to a supervised machine-learning system, which learns to predict the entailment status of a sentence pair from features indicating structural and semantic similarity. Systems enhanced with linguistic knowledge in such ways typically outperform the purely overlap-based systems, but only by a rather modest margin, with an accuracy around 65% (see e.g. Giampiccolo et al. 2007 for an overview).

A notable exception is Hickl & Bensley (2007), a system submitted by an industrial company (LCC) in the RTE-3 Challenge, which achieved 80% accuracy, using a variety of rich resources in a machine learning approach. A second LCC system (Tatu & Moldovan 2007) used a special-purpose theorem prover (Moldovan et al. 2007) and reached a high accuracy as well. Although neither the knowledge repositories nor the details about the method are available to the public, it is likely that the success of these systems stems from language and knowledge resources of various kinds that have been built over years with enormous manpower, accompanied by a consistent optimization of methods based on repeated task-oriented evaluations. This suggests that at the end of the day, the decisive factor in building high-performing systems for entailment checking is not a single theoretical insight or design decision, but rather the availability of huge amounts of information about language and the world. The key difference between the logic-based and machine-learning paradigms is that the latter degrades more gracefully when this information is not sufficiently available.

**Discussion.** Between 2005 and 2010 a total of about 300 different systems in total were evaluated. This has helped a lot in providing a clear picture of the potential of different methods and resources on the task. However, the RTE Challenges reveal a current state of the art that is not entirely satisfactory. Statistical systems appear to hit a ceiling in modeling inference. This is not just a technical problem: the fundamental shortcoming of purely text-based approaches is that they do not model the truth conditions of the sentences involved, and therefore cannot ground entailment in truth. It is difficult to imagine how a notion of inference for semantically complex sentences can be approximated by a

model that does not in some way or another subsume the conceptual framework of logic-based semantics. On the other hand, direct implementations of the logic-based framework do not solve the problem either, because such systems are rendered practically unusable by the lack of formalized knowledge. Resolving this tension remains the central challenge for computational semantics today.

## 4.2. Natural logic inference

One promising direction of research that might help solve the dilemma is to model truth-based entailment directly in natural language, without resorting to explicit logical representations. The idea is old – indeed, before the introduction of formal logic, it was the only way of analyzing inference –, but was revived and formalized in the 1980s by Johan van Benthem under the heading of *natural logic* (van Benthem 1986; Sanchez-Valencia 1991). Consider the following examples:

- (14) a. Last year, John bought a German convertible.  
b. Last year, John bought a German car.

To determine the entailment relation between (14a) and (14b), we need not compute the respective logical representations and employ a deduction system. We just need to know that “convertible” is a hyponym of “car”. The argument does not apply in general. Replacing “convertible” with “car” in “John didn’t buy a convertible” or “John bought two convertibles” has different semantic effects: In the former case, entailment holds in the inverse direction, in the second, the two sentences are logically independent. The differences are due to the different monotonicity properties (in the sense of Barwise & Cooper 1981) of the contexts in which the respective substitutions take place. In addition to knowledge about lexical inclusion relations, we need syntactic information, a mechanism for monotonicity marking, and monotonicity or polarity information for the functor expressions (in the sense of categorial grammar or type theory).

**Natural logic and RTE.** MacCartney & Manning (2008) and MacCartney (2009) propose a model for textual entailment recognition which is based on natural logic and extends and complements the framework in several aspects. Compared to the original approach of Sanchez-Valencia, they use a refined inventory of semantic relations. Wide-coverage knowledge about lexical semantic relations is obtained from WordNet, with distributional similarity as a fallback. Monotonicity handling includes the polarity analysis of implicative and factive verbs (Nairn, Condoravdi & Karttunen 2006), in addition to the standard operators (negation, determiners, conjunctions, modal expressions) and constructions. Their full model also processes sentence pairs that require multiple substitutions, deletions, or insertions; the global entailment relation between the sentences is computed as the joint entailment effect of the individual edit steps.

Because the preposition “without” introduces a downward monotonic context, the system can thus make the correct, but nontrivial judgment that (15a) and (15b) do not entail each other, based on the edits shown in (16).

- (15) a. Some people are happy without a car.  
b. Some professors are happy without an expensive convertible.



- (16) Some SUBST(people, professors) are happy without an  
 INSERT(expensive) SUBST(car, convertible).

The global entailment relation between the sentences is computed as the joint entailment effect of the single edit steps. Because the preposition “without” is downward monotonic in its internal argument, the system can thus make the correct, but nontrivial judgment that (15a) and (15b) do not entail each other, based on the edits shown in (16).

MacCartney’s NATLOG system has been shown to achieve an accuracy of 70% on the FraCaS test suite. This demonstrates that the system can handle logically non-trivial inference problems, although some phenomena, like ellipsis, are outside the system’s coverage. On the RTE-3 test set, the system has an accuracy of 59%, which does not exceed the performance achieved by simple word-overlap systems. However, the positive message is that the natural-logic-based approach is able to avoid the robustness issues that make semantic construction for standard logic-based systems so difficult. Combining NATLOG with the shallow Stanford RTE system (de Marneffe, Marie-Catherine and Bill MacCartney and Trond Grenager and Daniel Cer and Anna Rafferty and Christopher Manning 2006) increases the accuracy of the shallow system from 60.5% by 4%, which proves that the “deep” inferences captured by the natural-logic-based system are able to complement shallow RTE methods in a substantial way.

**Discussion.** The natural logic approach does not capture all inferences that a predicate logic approach would. It does not deal with inferences that require multiple premises, and can only relate sentence pairs in which the lexical material is exchanged while the global structure stays the same (e.g., de Morgan’s Law is outside its reach). However, the approach does cover many inference patterns that are relevant in natural language, and the overhead for semantic construction and the disambiguation of irrelevant parts of sentences is eliminated, because no translation to logical representation is required.

#### 4.3. Statistical methods in semantic construction

One reason for the low performance of logic-based inference systems in the standard framework of computational semantics is the lack of wide-coverage semantic construction procedures. Natural logic gets around the problem by dispensing with semantic construction altogether. An alternative that has recently been explored is the use of machine learning techniques for the automatic assignment of rich semantic representations.

To get a better idea of the task, it is helpful to consider its relationship to systems for syntactic parsing. The two problems are similar from a high-level perspective, in that both compute structured linguistic representations for natural language expressions. The dominant approach in syntactic parsing is to apply supervised statistical approaches to syntactically annotated corpora, in order to learn grammars and estimate the parameters of a syntactic probability model. For semantic construction, statistical approaches have been much less successful. Even for Semantic Role Labeling, the results are noisier than for syntax. The assignment of complex logical structures as representations for full sentences is harder, due to the fine granularity of the target representations and the difficulty of finding surface features that are indicative of deep semantic phenomena. This makes the specification of annotation guidelines that would allow non-experts to reliably annotate a corpus challenging.

Nevertheless, a considerable amount of research in the past few years has investigated the use of supervised learning in semantic parsers, trained on small domain-specific corpora. Logical annotations are typically obtained by converting the annotations from existing corpora, e.g., the Geo880 corpus (Zelle & Mooney 1996; Tang & Mooney 2000) of 880 geographical queries and the ATIS corpus (Dahl et al. 1994), a corpus of about 5000 spoken queries to a travel planning system. Both of these corpora were originally annotated with database queries that correspond to the natural-language query. When these are converted into lambda terms, examples look as follows:

- (17) What states border Texas?

$\lambda x. \text{state}(x) \wedge \text{borders}(x, \text{texas})$

- (18) on may four atlanta to denver delta flight 257

$\lambda x. \text{month}(x, \text{may}) \wedge \text{day\_number}(x, \text{fourth}) \wedge \text{from}(x, \text{atlanta}) \wedge$   
 $\text{to}(x, \text{denver}) \wedge \text{airline}(x, \text{delta}) \wedge \text{flight}(x) \wedge \text{flight\_number}(x, 257)$

Current approaches for training semantic parsers typically employ methods from statistical machine translation, such as probabilistic synchronous grammars (Chiang 2007). These grammars simultaneously describe a tree for the syntactic representation of the natural-language string and a tree for the semantic representation, i.e. the lambda term. Because the syntactic parses are not explicitly given in the corpora mentioned above, these approaches assume a very permissive syntactic grammar, which allows many ungrammatical analyses of the input expression in addition to the grammatical ones. They then estimate parameters for a probability model that makes the ungrammatical analyses improbable, and maps the grammatical analyses to the correct semantic representations.

One key challenge that research in this area must overcome compared to pure syntactic parsing is that the annotated structures are not syntax trees, but lambda terms, which can be rewritten by  $\alpha\beta\eta$ -equality. The exact way in which this problem is addressed depends on the grammar formalism that a particular system uses. Wong & Mooney (2007) use a synchronous context-free grammar with an extra mechanism for representing variable binding. Zettlemoyer & Collins (2005) and Kwiatkowski et al. (2010) instead use probabilistic CCG grammars (Steedman 2000), which model the combination of lambda terms directly. The best-performing systems today achieve an accuracy of about 89% exact matches on the Geo880 corpus and still about 82% on the ATIS speech corpus (see Kwiatkowski et al. (2011) for an overview), which demonstrates that the method is feasible in principle. These are very promising numbers, but it is important to keep in mind that these methods have so far been applied only to relatively small corpora from limited domains, and it remains to be seen how well they will scale up.

#### 4.4. Grounded models of meaning

Standard systems of distributional semantics learn meaning information purely from text; but semantics, unlike syntax or morphology, is essentially concerned with the relationship of language with the outside world. Children do not learn what “chair” means by hearing people talk about chairs, but by observing chairs in connection with hearing the word “chair”. Certain regularities in the real world are reflected in statistical patterns in texts (chairs are used for sitting, so the word “chair” frequently co-occurs with the word “sit”).

But ultimately it is unsurprising that computer systems cannot learn the full semantics of words and sentences, when they are exposed to a much poorer and fundamentally incomplete stimulus.

While the simulation of human meaning acquisition in a full-fledged realistic environment is not feasible, a number of alternative methods have been explored to integrate restricted layers or pieces of extralinguistic information into the learning process. One option is the creation of multimodal corpora consisting of visual material – e.g., pictures or videos – labeled with linguistic descriptions. Large-scale data collections of this kind can be obtained through Internet-based experiments or games; examples are the Google Image Labeler (von Ahn & Dabbish 2004), which lets people annotate pictures with textual descriptions, and the Microsoft Research Video Description Corpus (Chen & Dolan 2011), which was collected by asking people to describe the activities shown in short YouTube videos.

Data of this kind can be used in two ways. First, one may completely disregard the nonlinguistic information, and use picture and video IDs just as indices of the natural-language expressions. This tells the system that the different descriptions of the same picture refer to the same scene: they are proper paraphrase candidates and definitely will not contain contradictory information. A similar effect is obtained by corpora containing parallel texts, which are known to describe the same event. For instance, Titov & Kozhevnikov (2010) use collections of alternative weather forecasts for the same day and region. Their system learns that “cloudy” and “sunny” stand in a different semantic relationship than “cloudy” and “overcast”: while both pairs occur in similar linguistic contexts, the former but not the latter are identified as describing two different states of sky cover, because they do not co-occur as descriptions of one world state.

Other approaches have taken the further step of analyzing the contents of the picture or video, typically using methods from computer vision, in order to let the computer system learn an actual mapping of language to extralinguistic objects. For example, Marszałek, Laptev & Schmid (2009) train a machine-learning system to identify instances of activities such as “drinking” in movies. Their training data is the movie itself together with textual descriptions of the current scene collected from subtitles and movie scripts. Learning a mapping between words and the external world is a problem that is frequently considered in cognitive robotics (Gold & Scassellati 2007; Kruijff et al. 2007), where a human user may explicitly teach the robot how to interpret spoken utterances in its environment. This also adds an *interactive* dimension to the process of automated language learning.

The core problem of mapping language to the extralinguistic environment can also be studied in more abstract settings. This has the advantage that the learning system can access the environment more directly. For instance, a system can learn the meaning of expressions referring to actions in a simulated robot soccer game (Chen, Kim & Mooney 2010), and the interpretation of help texts as actions in the Windows GUI, such as clicking buttons or entering text into certain input fields (Branavan et al. 2009). A middle ground is struck by approaches trained on virtual 3D environments (Orkin & Roy 2007; Fleischman & Roy 2005). An instructive account of alternative methods to connect language to real world or virtual reality is given in (Roy & Reiter 2005).

All these approaches to learning meaning representations are necessarily constrained in that they consider only some modalities and some aspects of non-linguistic information. Nevertheless, they form an exciting avenue of future research. From the perspective

of semantic theory, they are perhaps most interesting because they open up a new direction in which the use of computers can support research on natural language meaning: as an instrument which connects natural-language expressions with large quantities of data about objects, properties, and events in the real world in a meaningful way.

## 5. Conclusion

Determining the meaning of a natural-language expression is crucial for many applications in computational linguistics, and computational semantics has long been a very active field of research. An approach to computational semantics that is to be useful for such applications must balance the depth of the linguistic analysis with the ability to compute such analyses reliably with wide coverage, i.e. for arbitrary sentences. Research in computational semantics is characterized by navigating this tension between depth and coverage.

In this article, we have sketched a number of prominent approaches in our field. Direct implementations of logic-based theories of semantics managed to overcome initial efficiency problems and, to some extent, deal with the massive amount of ambiguity that such approaches face in practice. However, making wide-coverage semantic construction robust and acquiring wide-coverage knowledge resources for inferences remain open problems. By contrast, data-intensive approaches have had very impressive successes in extracting useful semantic information from text corpora. But they tend to work with shallower meaning information than logic-based approaches; deeper representations still require a modeling effort by humans. The most promising recent research brings these two paradigms together, and combines them with novel ideas for models of meaning that are grounded in the environment. In our view, this makes the present a very exciting time for research in computational semantics indeed.

## Acknowledgments

We gratefully acknowledge Ingo Reich, Caroline Sporleder, Stefan Thater, and Margaret Delap for valuable comments on this article. Several examples are due to Collin Baker, Josef Ruppenhofer, and Gerhard Weikum. Finally, we thank Claudia Maienborn for the infinite patience and cheerfulness with which she handled the perpetually almost-finished state of our manuscript.

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Manfred Pinkal, Saarbrücken (Germany)  
Alexander Koller, Potsdam (Germany)

## 109. Semantics in corpus linguistics

1. Introduction
2. Corpus linguistics and semantics
3. Theoretical semantics and corpora
4. Semantic annotation
5. Distributional semantic models
6. References

### Abstract

*Linguistic corpora are a rich source of data for semantic analysis, and researchers have begun to use these corpora in innovative ways to improve the depth and breadth of semantic theory. Building on a long tradition within classical corpus-linguistics, which has focussed on word meaning and collocation, theoretical and computational linguists have in recent years used large-scale corpora to study a range of semantic phenomena, from negative polarity and adjectival meaning to anaphora and discourse. In addition, corpora have been annotated with sophisticated semantic information about word meaning, semantic role assignment, discourse structure, anaphoric linking and time and event reference, among other things, bringing closer the goal of an integrated semantic interpretation scheme. Large scale distributional analysis has also emerged as an important avenue for lexical investigation.*

You shall know a word by the company it keeps.  
J.R. Firth (1957)

### 1. Introduction

These are boom times for corpus linguists. Corpus linguistics – the analysis of collected linguistic performance data – has undergone tremendous growth in recent

years (Kytö & Lüdeling 2008, 2009), due in large part to the wide availability of vast quantities of electronic text. Most newspapers and other periodicals have electronic editions, and many now appear only in electronic form. Large numbers of books have been digitized and made available in whole or in part (Hart 1990; Vincent 2007). In addition, non-traditional forms of publication such as informational web pages, internet newsgroups, weblogs, public chat-rooms, and electronic mailing lists generate oceans of new text in a wide variety of languages and genres on a daily basis (Pimienta, Prado & Blanco 2009).

A vast assortment of text (and recorded spoken language) has been assembled into corpora for linguistic analysis, including large opportunistically assembled collections, such as the English Gigaword corpus (Graff et al. 2007) and the *WaC* Web-Corpora (Baroni et al. 2009), carefully crafted “balanced” corpora, such as the British National Corpus (Aston & Burnard 1998), the Corpus of Contemporary American English (Davies 2009) and the German Reference Corpus (Kupietz & Keibel 2009), and smaller corpora with sophisticated linguistic annotation such as the Penn Treebank (Marcus, Santorini & Marcinkiewicz 1994) and the TIGER Corpus (Brants et al. 2004). In addition, the ubiquity of world-wide-web search-engines such as Google and Bing has effectively put a extremely large, multilingual corpus at the fingertips of virtually every working linguist (Kilgariff & Grefenstette 2003).

Convenient access to large linguistic corpora is changing not only the way linguists work, but what questions they ask. Questions about subtle patterns of use and about shifts in these patterns are increasingly the focus of attention for linguists of all kinds (as well as for researchers in allied fields; Michel et al. 2011 make fascinating use of a massive multilingual diachronic corpus to track cultural shifts). It is now possible to determine in a few minutes, for example, whether conjoined temporal expressions such as *weeks and months* are typically iconically ordered or not (they are), or whether *going to* has displaced *will* as the premier marker of future reference in English (it hasn’t; see Language Log’s 2003 series of “Breakfast Experiments”). This shift in focus has brought about a renewed interest in (and debate over) the role of quantitative information in grammatical theory and the relationship between grammar and usage (Bod, Hay & Jannedy 2003; Newmeyer 2003), and with it a new role for corpus-based investigation in the formal study of language (Meurers 2005). In semantics, the availability of corpus data has sparked a renewed focus by theoreticians on lexical semantic issues and on the scope of empirical predictions made by analyses, with an increased appeal made to distributional data and discussion of variation.

While the use of corpus data in semantics research is coming to be more and more common, even to the point of pervading computationally-oriented work, the relationship between corpus-based linguistic analysis and theoretical semantics is tied up in longstanding debates about the nature of linguistic evidence and the goals of linguistic theory. In the next section we will discuss this issue briefly, outline the views of traditional corpus linguists on semantics and discuss the relationship of corpora to linguistic theory in general. We will then turn to a brief discussion of some of the ways in which corpora have been used to further theoretical natural language semantic investigation. In section 4, we turn to semantic annotation of corpora and describe a number of semantic annotation schemes developed by computational linguists. Finally, current work on distributional models of semantics, which characterize word meaning on the basis of statistical properties of its distribution in text, is briefly reviewed.

## 2. Corpus linguistics and semantics

There is a long tradition of corpus-based language study which has stood in contrast to generative linguistics. Linguists in this tradition, which has been centered in the United Kingdom and traces its origin back to Quirk (1960), have often emphasized that they are primarily concerned with the study of “meaning” (Sinclair 2004; Teubert 2005; Stubbs 2009) rather than the study of form or structure. The intuitive, socially-grounded, textual conception of meaning which has been their focus contrasts radically with the referential, truth-conditional tradition of contemporary semantic theory. Facts about truth and entailment, which Cresswell (1982) called the most certain things that we know about meaning, and which constitute the central empirical explananda of contemporary semantic theory, cf. article 1 (Maienborn, von Heusinger & Portner) *Meaning in linguistics*, are taken by many corpus-linguists to be outside the acceptable domain of investigation. Instead, meaning is discussed primarily in intertextual terms, with a focus on non-logical lexical relations such as semantic field and collocation. The UCREL lexicon, for example, which was developed in this tradition (Piao et al. 2005), classifies words according thesaurus-style semantic fields (e.g., *Food and Farming*, *Education*) rather than the logical relations that structure the more classical WordNet lexicon (Fellbaum 1998).

In Teubert’s (2005) overview of the goals and methods of corpus linguistics, he emphasizes the primacy of the study of meaning, but he is careful to distinguish the corpus-linguist’s view of meaning from that of the “traditional linguist.” For the corpus-linguist, he claims, meaning is a paraphrase relation, a relation among words and not a relation between words and the “real world.” Meaning for him is also independent of the intentions of the speaker. The meaning of a word is a generalization over its paraphrases: “the meaning of ... *lemon* is everything that has been said about lemons” (Teubert 2005: 7). It is a property that emerges from the text rather than something that guides its creation. The mechanisms of compositional interpretation are also outside the scope of study. According to Teubert, the corpus linguist “looks at phenomena which cannot be explained by recourse to general rules” (Teubert 2005: 5). Although not all corpus linguists adhere to this perspective, which is more characteristic of the programmatic “corpus driven” view than of the methodological “corpus based” approach (Hardie & McEnery 2010), it does remain a pervasive undercurrent in much corpus-linguistic work, which contrasts starkly with the perspective of contemporary linguistic semantics.

The traditional corpus-linguist is concerned with meaning in much the way a lexicographer is, with a focus on the particular and the lexical. Especially since the publication of the Collins-COBUILD Dictionary, the use of corpora has become central to the working lexicographer (Sinclair 1987; Hanks 2007; Atkins & Rundell 2008). This has led to a shift in how dictionaries are produced and what they contain. Many publishers now maintain “monitor” corpora, designed specifically for use in updating dictionaries (McEnery, Xiao & Tono 2006). In addition, vast quantities of phrasal information are being compiled in contemporary dictionaries, particularly those designed for non-native speakers of a language, often containing long lists of phrasal patterns for each word, with discussion of meaning variation and examples of use drawn from a wide range of texts (Herbst 1996).

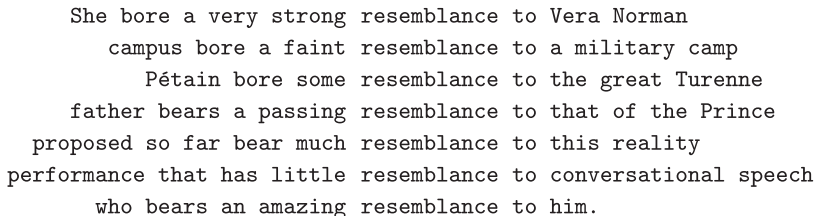
This lexicographic focus on phrasal meaning led John Sinclair, who long championed corpus-based lexicography (Sinclair 1984), to articulate what might be called the corpus-linguists theory of meaning (Sinclair 1996, Sinclair 1998). Noting the range of very particularized meanings associated with phrases in which the singular noun *eye* is used – *turn*

*a blind eye to, in the public eye, with the naked eye* – Sinclair argued that the unit of meaning is not the word (or lexeme) but an “extended lexical unit” or ELU. Sinclair characterized ELUs in terms of four aspects: COLLOCATION, the relationship between the abstract ELU and the observable word tokens; COLLIGATION, the relationship between the ELU and abstract grammatical categories; SEMANTIC PREFERENCE, the relationship between an ELU and its semantic field; and SEMANTIC PROSODY, what role the ELU is playing in the larger discourse. The phrase *with the naked eye* realizes an ELU in which *naked* and *eye* are collocates. This same ELU is also realized by the phrase *to the naked eye*, and so *with* and *to* are colligates in this ELU. The *naked eye* ELU is a manner adverbial, semantically selecting for visual actions, and is used to imply difficulty, its “semantic prosody.”

The central task of semantic corpus investigation, for Sinclair, was to unearth ELUs in text. This kind of work has been significantly aided by the introduction of computational tools for corpus analysis and manipulation, such as automatic concordancers, corpus query systems, key word in context (KWIC) displays and automatic collocation extractors (Garside, Leech & Sampson 1987; Stubbs 2001; Barlow 2004; Cheng, Greaves & Warren 2006). A common technique for this kind of phraseological investigation involves simply identifying the most frequent collocates for a given target word and classifying the lexical frames of the collocation pair in intuitive semantic terms. As illustrated in Figure 1, the noun *resemblance* appears in three characteristic phrasal forms with its most frequent collocate *bear*. On Sinclair’s view, *bear* and *resemblance* are the central collocates in an ELU that is used to indicate degree of similarity, which has three characteristic phrasal forms:

- (1) a. BEAR no *or* little **resemblance** to ...
- b. BEAR a passing *or* physical **resemblance** to ...
- c. BEAR a strong *or* striking *or* uncanny **resemblance** to ...

It is the ELU as a whole that bears meaning, a meaning which, according to Sinclair, is not compositionally determined by the constituting lexical items. On this view, what is traditionally seen as ambiguity is instead a word’s (perhaps arbitrary) participation in a number of different extended lexical units. For example, the verb *bear* is not ambiguous; it simply occurs in collocation with *resemblance* as part of the EMU illustrated in (1) and in collocation with *fruit* in a different ELU, this one having a semantic preference for plants (*the tree bore fruit*).



```

She bore a very strong resemblance to Vera Norman
campus bore a faint resemblance to a military camp
Pétain bore some resemblance to the great Turenne
father bears a passing resemblance to that of the Prince
proposed so far bear much resemblance to this reality
performance that has little resemblance to conversational speech
who bears an amazing resemblance to him.
  
```

Fig. 109.1: KWIC display of concordance for *resemblance* in the BNC

The differences between traditional corpus linguistics and contemporary semantics are well illustrated by contrasting Sinclair's discussion of the verb *budge* with the treatment of such items in the formal semantics literature, cf. article 64 (Giannakidou) *Polarity items*. Sinclair characterized this word as part of an Extended Lexical Unit which contains *budge* and an accompanying negative element as collocates. The negative element can be realized by many colligates (e.g. *didn't budge* or *refused to budge*) and occurs "to the left" of *budge* in the phrasal frame. In addition, the *budge* ELU has a semantic preference for grammatical subjects which denote movable entities (literally or figuratively) – such as people or door handles, and the use of the *budge* ELU in a discourse seems to imply that there have been attempts at movement that have failed (the semantic prosody). In the contemporary formal semantic tradition, the distribution of *budge* and similar negative polarity items is characterized by the logical properties of the contexts in which they appear. On Ladusaw's (1979) well-known account, for example, *budge* is taken to be licensed when it is in the syntactic scope of downward entailing operators, a class which includes negation, but also the antecedent of a conditional and other non-negative elements. Of course, the notions of scope and entailment which are central to this account are outside the domain of investigation for corpus linguists in the tradition of Teubert and Sinclair.

While the theoretical commitments of traditional or corpus-driven corpus linguists are largely incompatible with those of contemporary semantic theory, the methodology which is employed – large scale investigation of usage data – has entered mainstream semantics, and there are increasingly-many corpus-based analyses of semantic phenomena. It should be noted that the existence of well-designed corpora, annotated with linguistic features such as the parts-of-speech, clausal and sentence boundaries as well as easy-to-use to corpus exploitation software has made this kind of investigation much more widespread (Christ et al. 1999; Bird & Liberman 2001).

### 3. Theoretical semantics and corpora

In one of the first studies integrating modern corpus methods with semantic theory, Barker (1998) analyzed the English suffix *-ee*, characterizing the relationship between such verb/noun pairs as *stand* and *standee*. Barker used corpus-based quantitative productivity measures (Baayen & Lieber 1991) to show that *-ee* is indeed a productive suffix – and thus that its analysis must be compositional – and made reference to a large corpus of *-ee* derived nouns, which he compiled, to inform this analysis. The corpus data showed that there are many cases (*amputee*, for example), for which the denotation of the derived *-ee* noun does not appear to be related to the source verb's thematic arguments (e.g., the Agent or Patient of *amputate*). To account for the entire range of data, Barker introduced the more general semantic notion of "episodic linking" (Barker's corpus-based perspective on this phenomenon was taken up more recently on a web-scale by Mühleisen 2010.) Barker's study illustrates important ways in which corpus investigation can inform semantic theory: It can extend the empirical reach of a theory and it can underscore the relevance of certain data to analysis. Barker showed both that a compositional account of *-ee* affixation was needed and that the predictions of prior such analyses were not borne out by the data.



As Partee (1979), points out, theoretical semantics (and theoretical linguistics in general) typically addresses only a selected sample of idealized data. These data are gleaned from the literature, from introspection, from conversation and chance encounter, with an ill-understood idealization process selecting data which are relevant to the theoretical question at hand. This unconstrained, haphazard process has made researchers uncomfortable about its reliability (e.g., Schütze 1996). Corpora can play an important role in moderating this idealization process (Meurers 2005; Pullum 2007) by confronting theoretical claims with a wide range of data. Sæbø (2004) illustrates this by examining the distribution of Free-Choice *any* from a corpus-linguistic perspective. Corpus-based investigation of polarity items and their licensing environments has been an active area of research for a number of years (Hoeksema 1997, Richter, Sailer & Trawiński 2010). Because of the close relationship between the distribution of negative polarity items (NPIs) and their licensing operators, researchers have been able to work in two directions: characterizing the set of licensing operators by observing the distribution of polarity items and specifying the set of NPIs by observing their distribution with known licensors (Soehn, Trawiński & Lichte 2010).

In the context of Free-Choice *any*, Sæbø evaluated the empirical predictions of Kadmon & Landman's (1993) well-known and widely accepted theory and compared it to those of Dayal's (1998) competing approach. On the Kadmon & Landman theory, FC *any* is hypothesized to be a domain-widened version of the generic indefinite, and is taken to be licensed whenever the generic indefinite is. Sæbø discovered that many uses of FC *any* – nearly half the occurrences in his corpus – were in sentences such as (2), in which generic *a* would be infelicitous, however.

- (2) Ruth resigned herself to the irony of reading a murder mystery; but, at the moment, Ruth would have read {anything/??a thing} to escape her own imagination.

Such examples had gone unnoticed (or unremarked) by linguists committed to the domain-widening analysis. In addition to unearthing this fact, Sæbø also discovered that nearly every occurrence of FC *any* in his corpus was in the scope of a modal expression (or in an implicitly-modal context). The corpus data, then, would appear to support Dayal's alternative "modal-licensing" theory on which FC *any* must be licensed by a modal operator scoping over it. Sæbø suggests that this investigation is indicative of the role corpus study can play in theoretical semantics, as the corpus provides a readily-available, theory-neutral source of naturalistic data against which a given theory can be tested.

Harris & Potts' (2009) study of appositives illustrates this point further. Potts (2005) had claimed that appositives and expressives are invariably speaker oriented. Counterexamples to this claim had appeared in the literature, and Harris and Potts sought to assess these counterexamples. Assembling a 177 million word corpus, they were able to provide convincing evidence that indeed non-speaker-oriented appositive attribution (as in *Israel says Arad was captured by Dirani, who may have then sold him to Iran*) is a systematic part of the grammar. Harris & Pott's study is notable also because it illustrates a way in which the relationship of corpus-data to linguistic theory has changed as the size of corpora have grown. It was once certainly true that most constructions of theoretical interest, such as the sentence-final non-restrictive relative clauses adjoined to attitude-verb complements that Harris & Potts were investigating, couldn't be expected to occur

frequently enough in a corpus for such data to be relevant to theoretical debate. In the early 1 million word Brown Corpus (Francis & Kučera 1982), for example, there are just six sentences of this type, all of them speaker-oriented. As available corpora have grown larger, however, we increasingly find realistic data from corpora used to support theoretical claims in a wide range of studies, taking advantage of what Meurers (2005) called the “rich variation” of corpus data. We are approaching a time, it seems, that corpus-evidence will be available for any construction of interest.

Corpus data isn’t always used to test a theory, however, sometimes corpus data are simply used to provide evidence that a semantic observation is actually part of a productive process that deserves analysis. Heycock & Zamparelli (2005), for example, used data from the British National Corpus to show that coordinated nominals such as *friend and colleague* are used productively with both the joint (*she as a friend and colleague*) and the split (*her friend and colleague argued*) interpretation. The existence of many clearly non-idiomatic, split-interpreted coordinated DPs motivated their effort to rethink the the syntax and semantics of coordination, cf. article 65 (Zamparelli) *Coordination*.

Corpora are also used to provide evidence for subtle semantic distinctions otherwise hard to support. Kennedy & McNally (2005) used corpus counts in the BNC to argue for a classification of gradable predicates, cf. article 23 (Kennedy) *Ambiguity and vagueness*. They show that gradable adjectival participles exhibit a near-complementary distribution with the modifiers *very*, *much* and *well*. Although the contrasts are subtle (compare *much acquainted*, *well acquainted*, and *very acquainted*), the actual distributions are striking, as illustrated in Table 109.1.

Tab. 109.1: Distribution of degree modifiers in the BNC (adopted from Kennedy & McNally (2005))

|             | <i>WELL</i> | <i>VERY</i> | <i>MUCH</i> |
|-------------|-------------|-------------|-------------|
| acquainted  | 56          | 0           | 0           |
| protected   | 58          | 2           | 0           |
| documented  | 213         | 0           | 1           |
| educated    | 78          | 3           | 0           |
| needed      | 2           | 0           | 211         |
| criticised  | 0           | 0           | 19          |
| praised     | 1           | 0           | 17          |
| appreciated | 12          | 0           | 124         |
| surprised   | 0           | 151         | 1           |
| worried     | 0           | 192         | 0           |
| frightened  | 0           | 92          | 0           |
| interested  | 0           | 335         | 10          |

In related work, Sassoon (2010) used corpus data to buttress her claim that ratio modifiers (*twice/half*) do not combine with negative adjectives such as *short*, showing that such expressions as *twice as short* appear dramatically less frequently than do expressions such as *twice as tall*.

In many cases, the range of empirical phenomena becomes much clearer when large amounts of data are brought to bear. For example, one of the puzzles in the literature on the resultative construction has been to account for the pattern of acceptability illustrated (3).

- (3) a. wipe the table clean/dry/\*dirty/\*wet
- b. hammer the metal flat/smooth/\*beautiful/\*safe/\*tubular

Wechsler (2005) made use of Boas’ (2000) extensive corpus study of this construction, containing over 6000 occurrences, to explore the semantic properties of adjectives appearing in it. He showed both that the pattern of acceptability illustrated in (3) is reflected in usage data – those adjectives that have been claimed to be ruled out are, indeed, quite rare in this construction – and that the adjectives that do appear in this construction can be characterized as being minimal standard, closed-scale adjectives, in terms of Kennedy & McNallys classification scheme. Because the data for the Kennedy & McNally classification and for acceptability in the resultative construction are both delicate, the weight of lexical evidence emerging from the corpus study was crucial to uncovering this generalization.

Finally there are cases in which hidden aspects of the range of variation that had not been noted previously are revealed through corpus investigation. Beaver, Francez & Levinson (2005), for example, examined the rates of use of different quantifying determiners in canonical (non-existential) sentences and in existential (*there*-subject) sentences, as measured through internet search. Traditional semantic accounts have suggested that there is a clear and categorical distinction between “weak” quantifiers such as *a* and *some* and “strong” quantifiers such as *every* and *most*, cf. article 69 (McNally) *Existential sentences*. As illustrated in Figure 109.2, the corpus data reveal a more variegated pattern, however. While “weak” and “strong” quantifiers are seen to have quite different distributions, it is clear that many more factors influence use than just this contrast.

In each of these cases, usage data has been brought to bear on questions of theoretical interest by examining lexical distribution. To investigate more abstract semantic phenomena,

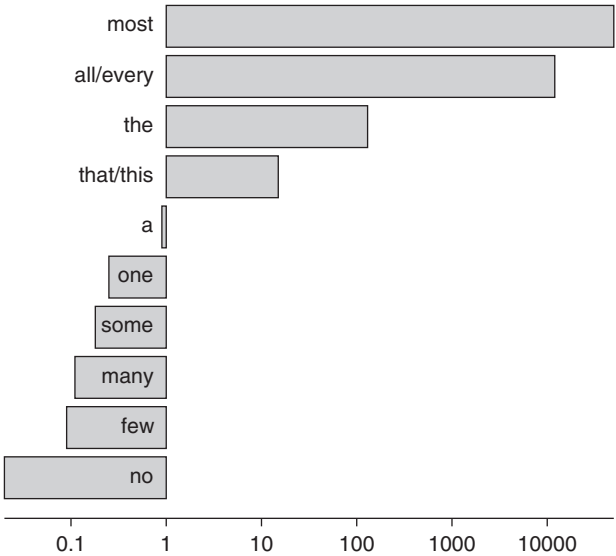


Fig. 109.2: Canonical to existential ratios (log), after Beaver, Francez & Levinson (2005).

such as anaphoric binding or argument role assignment, requires more than information about raw lexical distribution, however. It requires that corpora be annotated with information about the intended interpretation of a given utterance. This kind of SEMANTIC ANNOTATION has been carried out – in large part by computational linguists – for a range of semantic phenomena, from lexical interpretation to event ordering to anaphora-antecedent relations. In the next section we turn to semantic annotation. (It should be noted that the term “semantic annotation” is used in a related way in the context of the SEMANTIC WEB for the annotation of content in internet web-pages, cf. article 111 (Buitelaar) *Web Semantics*.)

#### 4. Semantic annotation

Computational linguists have treated semantic annotation as a way of extracting from speakers information about aspects of the interpretation of a text which are of particular interest. Much research in semantic annotation has focussed on three fundamental aspects of meaning: Reference, word meaning, and semantic role assignment. Consider the first two sentences of the Brown corpus:

- (4) The Fulton County Grand Jury said Friday an investigation of Atlanta’s recent primary election produced “no evidence” that any irregularities took place. The September-October term jury had been charged by Fulton Superior Court Judge Durwood Pye to investigate reports of possible “irregularities” in the hard-fought primary which was won by Mayor-nominate Ivan Allen Jr. (Francis & Kučera 1982)

The task of NAMED ENTITY ANNOTATION involves specifying the objects that the nominal expressions in a text refer to (e.g. determining the referents of *Fulton County*, *Durwood Pye*, and *Friday*), typically by associating the expressions with entities in a database. The task of WORD SENSE ANNOTATION involves specifying the intended meaning for an ambiguous word in context (e.g., the word *charge* here refers to an order and not an accusation). The task of SEMANTIC ROLE LABELING involves specifying what role entities play in the events described (e.g., Pye is the person doing the charging and not the person being charged). Additional types of semantic annotation are: TIME AND EVENT ANNOTATION – specifying the temporal relations that hold among the events described in a text (e.g., the election victory was before the investigation); COREFERENCE ANNOTATION and ANAPHORA ANNOTATION – identifying expressions in a text that co-refer or are referentially dependent (e.g., *Fulton County Grand Jury* and *September-October term jury* corefer); and DISCOURSE ANNOTATION – specifying discourse relations that hold among clauses (e.g., the second sentence in (4) provides background for first).

Semantic annotation tasks can be roughly classified into two types: *language-oriented* annotation and *content-oriented* annotation. Language-oriented annotation involves the association of words and phrases in a corpus with information in a lexical database. Such annotation makes use of a language-particular resource such as a dictionary. Content-oriented annotation involves associating linguistic elements in a corpus with non-linguistic values – time stamps, dollar amounts, or items in a database such as a list of names or gazetteer of places. The most prominent content-oriented annotation schemes are those developed as part of the Translingual Information Detection, Extraction and Summarization (TIDES) program (Cieri & Liberman 2002) and the Automatic Content Extraction (ACE) initiative (Doddington et al. 2004).

#### 4.1. Annotation methodology

Creating a semantically annotated corpus, of whatever sort, involves three subtasks: the design of an annotation scheme (or “annotation language”), the selection of a corpus to be annotated, and the specification of how to apply the annotation scheme to the corpus, in the form of an annotation guideline. For complex annotation tasks such as time and event annotation, the annotation guidelines (and the annotation language) tend to undergo a series of modifications in the face challenges met by annotators in the course of preliminary corpus-annotation. As Zaenen (2006) points out, the intuitive accessibility of many semantic concepts belies the complexity of natural language semantic analysis, and annotation languages and guidelines – particularly those designed by computational linguists with practical goals in mind – often fail to be adequately researched. This often leads to a series of extensive revision in the face of problematic cases. For example in a time and event annotation task, annotators might come across the phrase *September-October term jury* in (4) and wonder how, or even whether, it should be annotated, a question that involves non-trivial considerations about the lexical semantics of the noun *jury*. Or in a coreference task, the question of whether *the hard fought primary* corefers with *Atlanta’s recent primary election* might come up. These cases are adjudicated on a case-by-case basis and documented in the annotation guidelines (e.g., “temporal adverbials modifying expressions referring to individuals or groups of individuals need not be annotated”). Annotation guidelines tend to be long documents full of detailed discussion of individual cases and how they were adjudicated; the TimeML annotation guideline (Sauri et al. 2006) is about six times as long as the TimeML specification (Pustejovsky et al. 2003a), for example.

To evaluate the clarity of the annotation guidelines, the difficulty of the annotation task and the quality of the annotators, quantitative measures of INTER-ANNOTATOR AGREEMENT are used. The most common of these is the inter-annotator AGREEMENT RATE, which is computed by comparing multiple independent annotations of the same corpus. High inter-annotator agreement indicates that the annotation task and annotation guidelines are well-chosen and that the annotators can apply them consistently. Inter-annotator agreement rates on semantic annotation tasks vary from under 60% for certain word sense annotation tasks (Ng, Lim & Foo 1999) to nearly 95% for certain semantic role labeling tasks (Palmer, Gildea & Kingsbury 2005). A measure which is more useful for comparing across annotation schemes is the  $\kappa$  coefficient, which Carletta (1996) imported from the field of content analysis (Cohen 1960; Krippendorff 1980). This value measures the degree to which annotators agree beyond what would be expected by chance. A  $\kappa$  value of 0 corresponds to agreement at rates expected by chance. This measure has become the *de facto* standard for measuring inter-annotator agreement (Artstein & Poesio 2008), with values above 0.70 taken to indicate reliable annotation.

Further complexity in measuring inter-annotator agreement arises when annotation is not just simple classification, but where partial agreement is common, as in the case of co-reference annotation (Passonneau 2004), or where there are complex semantic relations among the annotations, as in the case of temporal annotation (Katz & Arosio 2001). For example in a temporal annotation task with annotators specifying the order of events in a texts, consider comparing the annotations in (5).

- (5) Ann<sub>1</sub>: **before**(a,b), **before**(a,c)  
 Ann<sub>2</sub>: **before**(a,b), **before**(b,c)

The most straightforward measurement, which counts exact agreement (giving a 50% agreement rate here), fails to take into account the implicit information contained in  $\text{Ann}_2$ . A measure based on information would seem appropriate, but such measures face challenges in handling inconsistent annotations (as in comparing  $\text{Ann}_2$  with  $\text{Ann}'_1$ : **before**(a,b), **before**(a,c), **before**(c,b)). It is still quite unclear how exactly to measure partial “semantic agreement.”

In the next sections we briefly describe a range of semantic annotation schemas. While we don't seek to be exhaustive, the range of schemes discussed provides a snapshot of the current state of the art (see also article 112 (Frank & Padó) *Semantics in computational lexicons*). We will first overview some of the major language-oriented semantic annotation schemes and then the major content-oriented schemes.

## 4.2. Language-oriented annotation

Language-oriented annotation involves associating elements of a linguistic resource – a lexicon, for example – with tokens in a corpus. Miller (1995) identified two strategies for annotation: the “targeted” (or “lexicon-based”) approach, and the “sequential” (or “corpus-based”) approach. On the targeted approach, lexical entries are primary and the corpus is used as a resource for testing and improvement of the lexicon. On the corpus-based approach, the corpus is primary, and words in the corpus are annotated as they come, with the lexicon serving only as a resource for the annotation. Targeted annotation yields a set of illustrative cases for each entry in the lexical resource without generating a true annotated corpus, while corpus-based annotation yields a fully annotated corpus but might not lead to the creation of a complete lexicon. To mitigate the deficiencies of each strategy, language-oriented annotation efforts have often incorporate some aspects of both.

### 4.2.1. Word senses annotation

The task of word-sense annotation is illustrated in (6):

- (6) a. Next to her was a white haired gentleman wearing a *cap*<sub>1</sub> and heavy rural looking jacket.
- b. A *cap*<sub>2</sub> is included to cover the hole not used for mounting.

The ambiguous word *cap* is annotated with a specification of the intended meaning, here the clothing sense in (6a) and the covering sense in (6b). Sense annotation clearly requires that annotators be provided with a sense inventory, a set of senses and sense descriptions for each word. Indeed, the first large-scale word-sense annotation project, the HECTOR lexicon project (Atkins 1992; Glassman et al. 1992), a joint effort of Oxford University Press and DEC, involved the parallel development of an annotated 300,000 word corpus and an inventory of senses covering 500 words. Since the mid-1990s, however, word-sense annotation for English has almost exclusively used WordNet as a sense inventory (Ng & Lee 1996; Landes, Leacock & Tendi 1998; Passonneau et al. 2010).

WordNet, which was conceived of as a “dictionary based on psycholinguistic principles” (Miller et al. 1990), is a sophisticated lexical resource, encoding not only a senses for each word, but a range of semantic relations among these senses (Miller 1995;

Fellbaum 1998), such as *synonymy*, *antonymy*, *hyponymy*, and *meronymy*, cf. article 21 (Cann) *Sense relations*. Incorporating two decades of incremental improvement WordNet currently encodes semantic information for nearly 150,000 words of English (Miller & Fellbaum 2007). There have been two large-scale sense-annotation projects based directly on WordNet. In the SEMCOR project (Landes, Leacock & Teng 1998) all the occurrences of nouns, verbs, adjectives and adverbs that appear in a subset of the Brown corpus – in total 234,843 – were annotated with WordNet sense tags. In the DSO project (Ng & Lee 1996), a similar number of tokens taken from a more limited set of the most frequent ambiguous nouns (121) and verbs (70) were annotated.

Word-sense annotation has proved to be surprisingly difficult task (Fellbaum, Grabowski & Landes 1998). Ng, Lim & Foo (1999) compared the annotations in the overlapping parts of the SEMCOR and DSO corpora, finding an interannotator agreement rate of just 57%, with  $\kappa$  values of less than 0.4. One explanation for this difficulty is that WordNet encodes finer-grained distinctions than annotators can easily draw (Palmer, Dang & Fellbaum 2007). For example, WordNet distinguishes four physical movement senses of the verb *shake*, distinguishing manners of vibration from tremors to swaying. In a sentence such as *His arm shook*, however, it is hard to know which is intended, or even if the speaker intended to draw a distinction at all. Two factors that have been shown to improve inter-annotator agreement on word sense tagging are training (Kilgariff 1999; Passonneau et al. 2010) and targeted crafting of the sense inventory (Ng, Lim & Foo 1999; Palmer, Dang & Fellbaum 2007). It was found that using syntactic criteria such as subcategorization frame to help draw sense distinctions was particularly helpful to annotators.

#### 4.2.2. Semantic role annotation

Semantic role annotation involves specifying for each predicate in a sentence what semantic role its syntactic arguments and adjuncts play (Márquez et al. 2008; Palmer, Gildea & Xue 2010), cf. article 18 (Davis) *Thematic roles*. The Proposition Bank, or PropBank (Palmer, Gildea & Kingsbury 2005), and FrameNet (Baker, Fillmore & Cronin 2003) represent the two most prominent such schemes.

PropBank is a set of semantic role annotations for the syntactic arguments and adjuncts of verbal predicates in the syntactically-annotated Penn Treebank corpus. The roles used for annotation are specified in a lexical resource, the Frameset inventory. The set of frames for *open*, given in (7), serves as the basis for the annotation in (8), for example.

- (7) Frameset **open.01**, “cause to open”  
 Arg0: agent  
 Arg1: thing opened  
 Arg2: instrument
- (8) [<sub>Arg0</sub> John] opened [<sub>Arg1</sub> the door] [<sub>Arg2</sub> with his foot]

In contrast to word-sense annotation, PropBank semantic role annotation is quite reliable (with  $\kappa$ -scores above 0.9). Note that in PropBank each sense of each verb is provided with its own set of semantic roles. VerbNet (Kipper-Schuler 2005) is a related lexical resource which encodes more abstract information about semantic frames. VerbNet frames

are associated with classes of verbs, rather than single verbs, and contain generalized semantic roles, such as Agent and Patient. Also related is the NomBank project (Meyers et al. 2004), which has sought to annotate the arguments of nominal predicates, with Framesets constructed to provide direct mapping between roles for verbs in PropBank and roles for derivationally-related nouns in NomBank, so that *John's opening of the door with his foot* would be annotated analogously to (8).

The other major semantic role annotation project is FrameNet (Baker, Fillmore & Cronin 2003; Ruppenhofer et al. 2010). While PropBank is primarily a corpus-annotation effort, FrameNet is primarily a lexical-resource development effort. Building on Fillmore's (1982) insight that much in the semantic representation of a predicate is encoded in the semantic frames that the predicate evokes, cf. article 29 (Gawron) *Frame Semantics*, the FrameNet lexicon seeks to provide a complete semantic representation of a predicate through the information encoded in the role specifications. In FrameNet, words are associated with sets of very fine-grained semantic roles (called "frames") which are evoked by the word. These specify characteristic aspects of the typical situations described by the word; the verb *fry*, for example, evokes the APPLY\_HEAT frame, which has the associated semantic roles COOK, FOOD and HEATING\_INSTRUMENT. Other verbs evoking this frame are *bake*, *poach* and *roast*. These roles are used to annotate sentences by associating the roles with words and phrases, as illustrated in (9).

(9) [COOK Matilde] fried [FOOD the catfish] [HEATING\_INSTRUMENT in a heavy iron skillet]

FrameNet roles are associated with rich semantic information. A **Cook** is an agent, likely to be a person, acting intentionally to achieve a goal. FrameNet frames are not limited to encoding information for verbs; semantic frames for nouns, adjectives, adverbs, and prepositions are part of FrameNet. FrameNet, like WordNet, has been developed in a lexicon-driven manner, with annotation of sentences from the BNC used to explore the ranges of meanings associated with individual lexical elements. FrameNet's lexical database of more than 10,000 lexical entries has been used to annotate over 135,000 sentences from the BNC (Ruppenhofer et al. 2010), with inter-annotator agreement reported on both frames and roles to be approximately 90%.

FrameNet-style lexical resources and annotated corpora are under construction for a number of languages, including Italian, German, Japanese, Spanish, and Hebrew (Boas 2009). The SALSA project (Burchardt et al. 2009) is particularly noteworthy, having used a FrameNet-style semantic resource for the annotation of the German TIGER treebank (Brants et al. 2004) in a sequential, corpus-driven way. Since FrameNet is semantically rich, it was largely possible for the SALSA team to use frames developed for English words to annotate German sentences. The Assistance frame, for example, (which is evoked by *help*, *aid*, etc.) was used to annotate the German verb *helfen* as in (10):

(10) [HELPER Luise] hilft [CO-AGENT Hans, [GOAL das Geschirr zu spülen]

Multilingual FrameNet annotation presents a number of interesting opportunities for investigating cross-linguistic similarities and differences in lexicalization patterns and patterns of subcategorization and argument selection (Padó & Lapata 2009).



#### 4.2.3. Discourse and dialog annotation

Researchers interested in discourse and dialog have been involved in the annotation of a variety of semantic/pragmatic relationships that hold among phrases or utterances. One strand of research describes the structure of a text via the DISCOURSE COHERENCE RELATIONS that hold among discourse segments, cf. article 74 (Kehler) *Cohesion and coherence*. Another body of work involves the analysis of dialog and the flow of conversation in terms of sequences of DIALOG ACTS or CONVERSATIONAL MOVES (Franck 1979; Traum 2000). Each of these research programs has had an important corpus-based component.

Interpreting connected discourse involves determining how the pieces of a discourse are understood with respect to one another. It is commonly assumed that units of discourse—clauses or sequences of clauses (*discourse segments*) are linked by a small number of discourse-coherence (“rhetorical”) relations, cf. article 39 (Zeevat) *Rhetorical relations*. Corpus-based investigation of these relations has involved the annotation of naturally occurring text with information about which relations hold among what elements in the text. Carlson, Marcu & Okurowski (2001) used Mann & Thompson’s (1988) tree-based Rhetorical Structure Theory as the basis for their discourse structure annotation scheme, marking the rhetorical relations between clauses and sets of clauses using a set of 78 relations (e.g., *evidence*, *reason*, *purpose*, *consequence*, *question-answer*, etc.). As illustrated in (11), the annotation involved both specifying the segments to be related (here the discourse segments marked 1, 2 and 3) and specifying the relations among the discourse segments.

- (11) [Norfolk is likely to draw down its cash initially]<sub>1</sub> [to finance the purchases]<sub>2</sub> [and thus forfeit some interest income.]<sub>3</sub>  
 2 is the **purpose** of 1; 3 is a **consequence** of 1–2

This scheme was applied to 385 Wall Street Journal articles from the Penn Treebank. On average there were about 56 discourse segments per article. In a similar task, Wolf & Gibson (2005) used a more parsimonious set of 12 discourse relations—based on Hobbs’ (1985) ontology of coherence relations – *cause-effect*, *condition*, *violated expectation*, *elaboration*, etc. – and relaxed the adjacency requirement commonly assumed for discourse relations. Both Carlson, Marcu & Okurowski (2001) and Wolf & Gibson (2005) report very high inter-annotator agreement on the annotation of discourse relations (with  $\kappa$  scores over .80 reported for both schemes). Wolf & Gibson also report that 12.5% of the discourse relations annotated in their corpus relate non-adjacent segments, indicating significant deviation from the tree-structure commonly assumed for discourse relation structures.

Discourse relations are often signaled overtly by discourse connectives or cue phrases, such as *because*, *for example*, *since* or *then*, as in (12), cf. article 76 (Zimmermann) *Discourse particles*.

- (12) *Since* [the drought reduced U.S. stockpiles], [they have more than enough storage space for their new crop]

Discourse connectives are typically ambiguous – *since*, for example, has both temporal and causal senses. The Penn Discourse Treebank (PDTB) (Miltsakaki et al. 2004; Prasad et al. 2008) is a discourse-connective annotation of the entire Wall Street Journal subpart of the Penn Treebank, in which 40,000 explicit and implicit discourse connectives were

annotated using a hierarchical set of discourse-relations sense tags. PDTB annotation involved specifying both the intended relation and the elements related (as suggested in (12)). Overall inter-annotator agreement was reported as quite high for both tasks, with agreement even at the finest grain being over 80%.

Corpus-based analysis has also played a central role in research on multi-agent dialog, and there have been a number of targeted dialog collection projects in which data is collected from pairs or groups of individuals engaged in some sort of goal-oriented cooperative problem solving task. In the HCRC MapTask project, for example, a corpus of 128 wayfinding dialogs was collected, in which pairs of speakers conversed about navigating a fictional domain. These dialogs were then annotated with dialog structure information indicating the type of dialog move for each utterance (Anderson et al. 1991; Carletta et al. 1997), as illustrated in (13).

- |         |                                           |                  |
|---------|-------------------------------------------|------------------|
| (13) G: | And then, have you got the pirate ship?   | <b>QUERY</b>     |
| F:      | Mmhmm.                                    | <b>REPLY-YES</b> |
| G:      | Just curve from the point, go right . . . |                  |
|         | go down and curve into the right          |                  |
|         | til you reach the tip of the pirate ship  | <b>INSTRUCT</b>  |
| F:      | So across the bay?                        | <b>CHECK</b>     |
| G:      | Yeah, through the water.                  | <b>CLARIFY</b>   |

Similarly, in the University of Rochester TRAINS project (Allen 1991) a large number of dialogs involving joint planmaking under partial information were collected and annotated with dialog structure information (Heeman & Allen 1995). This preliminary work led to the creation of the Dialog Act Markup in Several Layers (or DAMSL) standard for dialog move annotation (Core & Allen 1997), which has subsequently been used to annotate the Switchboard telephone conversation corpus (Stolcke et al. 2000), and other corpora.

Elicited dialog corpora have become important resources for the analysis not only of discourse and dialog structure but also of the attentional and indexical aspects of spatial reference and of anaphoric and definite reference (Poesio & Vieira 1998; Eckert & Strube 2000; Coventry, Tenbrink & Bateman 2009). Particularly in the case of anaphoric reference, there is a longstanding research program in both computational linguistics and more traditional discourse analysis making use of corpora to investigate the factors that go into determining the antecedent of an anaphoric expression, as they relate to sentence structure, discourse structure, and a wide range of other factors (Hobbs 1978; Fox 1987; Biber 1992; Lappin & Leass 1994; McEnery 2000).

#### 4.2.4. Anaphora and definite reference

Large-scale annotation of anaphoric relations in corpora was pioneered by Fligelstone (1992) in the context of the Lancaster “grammar factory” (Garside, Leech & McEnery 1997). An annotation schema was developed for specifying referential dependency relations among expressions in texts, as in (14).

- (14) On Monday [the company]<sub>1</sub> reported higher fourth quarter earnings, raised its<sub>1</sub> dividend and announced plans for a 3-for-2 stock split.

The annotation scheme included specification for the annotation of VP anaphora, discourse deixis and ellipsis, as well as a range of other anaphoric phenomena (see also Tutin et al. 2000) for a discussion of the range of anaphoric phenomena).

Corpora annotated with information about anaphoric relations have played an important role in the development and evaluation of cognitive models of anaphoric processing cf. article 75 (Geurts) *Accessibility and anaphora*. Gundel, Hedberg & Zacharski (1993), for example, argue for a universal Givenness hierarchy (IN FOCUS > ACTIVATED > FAMILIAR > UNIQUELY IDENTIFIABLE > REFERENTIAL > TYPE IDENTIFIABLE) on the basis of the annotation of naturally occurring referring expressions in a number of small corpora. They show that each level in the hierarchy is preferentially signaled by a certain type of referring expression. For example, pronominal expressions are primarily used to refer to IN FOCUS elements, demonstratives to refer to FAMILIAR (but not IN FOCUS) elements. Tetreault (2001) used anaphorically-annotated corpus to evaluate a variety of algorithms for resolving anaphoric dependencies, demonstrating the effectiveness of his variant of centering theory. Bosch, Katz & Umbach (2007) show that the differences distribution of antecedents for demonstrative and personal pronouns in corpora reflects preferences in interpretation evident in comprehension experiments.

Corpus-based methodology has also been used to investigate constraints on the use of definite and indefinite expressions cf. article 41 (Heim) *Definiteness and indefiniteness*. Poesio & Vieira (1998) annotated sentences from the Wall Street Journal corpus, classifying definite expressions according to their use: anaphoric (*a car . . . the Chevy*), bridging (*a car . . . the tire*), discourse new (*the first person in line*), and broader context (*the king*). Confirming previous corpus work (Fraurud 1990), they found that about half of the definite expressions uses in the corpus were classified as anaphoric, with the other half unrelated to discourse entities mentioned in the text, raising interesting questions for uniqueness and familiarity theories of definiteness.

In order to better study relationships among various types of semantic processes and structures, in recent years there has been a move toward annotation integration. For example Kibrik & Krasavina (2005) integrate anaphoric annotation with annotation of rhetorical structure. Stede (2004) includes rhetorical structure, information structure and anaphoric reference. Particularly noteworthy is the OntoNotes project (Hovy et al. 2006) which combines word-sense annotation, semantic role annotation and anaphoric reference annotation for a variety of text genres. OntoNotes annotation also associates words with elements in a non-linguistic structured ontology of concepts. This is a step towards the kind of annotation we have termed “content oriented,” in which linguistic items are associated with non-linguistic elements. In the next section we briefly turn to this type of semantic annotation.

#### 4.3. Content-oriented annotation

Content-oriented corpus annotation originated with the Message Understanding Conferences (MUC-1 through MUC-7) of the early 1990s (Grishman & Sundheim 1996), designed to foster research on the automatic extraction of information from texts. While the early MUC challenges focussed on a few handpicked data-base templates related to specific pieces of information of interest (e.g. naval engagements or terrorist events), starting with MUC-6 more general domain-independent semantic tasks such as named-entity

identification and co-reference recognition were introduced. A set of content-annotated corpora were created in this context.

Content-oriented annotation involves the association of linguistic elements in a text with non-linguistic entities, as indicated in (15), for example, where the linguistic elements are “tagged” with referential information.

```
(15) <ENAMEX TYPE = "CORPORATION" ID = "APL"> Apple computer
      </ENAMEX>
      <TIMEX VAL = "1997-7-9"> today <TIMEX> hired
      <ENAMEX TYPE = "PERSON" ID = "Steven Paul Jobs"> Steve Jobs
      </ENAMEX>
```

An attribute on an XML tag marks the intended semantic interpretation of the expression tagged. Temporal expressions (TIMEXs) and numerical values are associated with a normalized value in a standardized notation, such as the ISO 8601 standard for temporal and calendrical expressions. Names (ENAMEXs) and other referential expressions are associated with entries in a databases such as a gazetteer (for places), a stock-exchange listing (for corporations) or a bibliographic listing (for authors and books).

For the past decade, the Automatic Content Extraction (ACE) initiative (Doddington et al. 2004) has been developing guidelines for general content-based annotation. The ACE guidelines are intended to support a wide variety of industrial-scale text-content analysis. The current ACE guidelines describe three main types of annotation: Entity Detection and Tracking, Relation Detection and Characterization, and Event Detection and Characterization. Entity detection, the primary task, involves identifying referring expressions in a text and classifying them, as one of the following seven classes: Person, Organization, Location, Facility, Weapon, Vehicle, Geo-Political Entity. As Zaenen (2006) has pointed out, although identifying referents appears to be a straightforward task, in fact significant subtlety is required. Annotators must determine whether there is a reference to the city of New York in the phrase *The New York Times* or to the country of Vietnam in the phrase *the Vietnam Memorial*. They must also determine when expressions such as *the White House* are used metonymically (to refer, for example, to the entire executive branch) and whether terms such as *president* and *teacher* are being used to refer to an individual or a role. These issues become pronounced – as Deemter & Kibble (2000) noted – when annotators are asked to determine coreference.

Co-reference annotation was introduced as part of the MUC-6 program, and has been an important part of content-oriented annotation efforts since then (Hirschman & Chinchor 1997; Passonneau 2004). COREF, as it has come to be known, involves partitioning the set of referring expressions in a text into sets, so called “co-reference chains,” which all refer to the same object. The referring elements in (16), might be partitioned into the following coreference chains: {A, D}, {B, E, F, K}, {C, H, I}, {G, J}.

```
(16) Committee approval of [Gov. Price Daniel]A's [abandoned property act]B seemed
      certain Thursday despite the protests of [Texas bankers]C. [Daniel]D personally
      led the fight for [the measure]E. Under committee rules, [it]F went automatically to
      a subcommittee for one week. But questions with which [committee members]G
      taunted [bankers]H appearing as [witnesses]I, left little doubt that [they]J will
      recommend passage of [it]K
```

Co-reference annotation raises a number of issues for evaluating inter-annotator agreement, since annotators might disagree with one another both on the number of coreference chains there are (the number of objects under discussion) and which elements belong in the same chain. In (16) for example, annotators might disagree on whether *C* is part of the  $\{H, I\}$  chain or forms a chain of its own. This question is made difficult because *H* might be a subset of *C* or of *I* (or of both). Deemter & Kibble (2000) cite this kind of partial co-reference as one of the limitations of annotation based only on an intuitive notion of shared reference, arguing for more sophisticated annotation based on the many ways in which terms can be referentially related.

The most complex of the content-oriented annotation tasks is that involving times and events. The most thoroughly worked-out annotation language for time and event annotation is TimeML (Pustejovsky et al. 2005). TimeML is based on the Davidsonian idea that sentences describe events, cf. article 34 (Maienborn) *Event semantics*, and TimeML is a way of describing event-relations in an annotation language. This is illustrated in (17).

```
(17) The Berlin wall <EVENT eid = "e1" class = "OCCURRENCE"> fell
      </EVENT> <TIMEX3 tid = "t1" val = "1989-11-8"> yesterday
      </TIMEX>.
      <TLINK relatedEventID = "e1" relatedTime = "t1" relType =
      "IsIncluded"/>
```

This annotation indicates that the text describes an event of the Berlin wall falling that took place within the temporal interval of November 8, 1989. TimeML contains two types of annotation tags. Referential tags such as EVENT and TIMEX3 are used to identify temporal expressions and event expressions and to associate them with values and identifiers. Relational tags such as TLINK are used to relate these entities.

In addition to temporal relations, TimeML encodes information about modal and aspectual dependencies using two other linking relations, SLINKs and ALINKs. SLINKs indicate modal relations between events, crucially distinguishing actual from possible events, as illustrated in (18).

```
(18) ...Boston center <EVENT eid = "e2" class = "I_ACTION">
      tries </EVENT>
      to <EVENT eid = "e24" class = "OCCURRENCE"> raise </EVENT>
      TWA 800.
      <SLINK relType = "MODAL" eventID = "e22" subordinatedEven-
      tid = "e24"/>
```

ALINKS encode the relationship between events and their aspectual parts, typically relating verbs such as *begin* and *end* to their complements. TimeML was used to annotate 183 news articles to create the 61,000 word TIMEBANK corpus (Pustejovsky et al. 2003b). A similar annotation language for encoding relational and referential information about events and places known as SpatialML has also been developed (Mani et al. 2010).

TimeML, SpatialML and other sophisticated semantic annotation schemes (such as ACE), which are used to represent complex semantic information, have come to resemble true semantic representation languages. This resemblance points toward a potential

convergence between research in formal semantics and corpus-based semantic annotation. In fact some have begun to treat semantic annotation as akin to formal semantic representation – Bunt (2007), for example, has argued that semantic annotation languages should be provided with a formal semantic interpretation, sketching such an analysis for TimeML. Formal analysis can play an important role in assuring the adequacy and consistency of the annotation language, assuring that the intuitive semantics associated with the description of the scheme and implicit in the annotation guidelines is reflected in the formal structures of the annotation language and it can underline any such shortcomings (Katz 2007).

## 5. Distributional semantic models

The DISTRIBUTIONAL HYPOTHESIS that words that appear in similar contexts have similar meanings has a long heritage, going back to Harris (1954) and Firth (1957) in linguistics and to Rubenstein & Goodenough (1965) in computational linguistics. The hypothesis is based on a simple intuition. We observe that *spaghetti* and *linguini* occur in close textual proximity to many of the same words in a corpus (*cook*, *sauce*, *Italian*, etc.) or in many of the same documents (*Pasta for Beginners*, *Eating Italian*, etc.) and this encourages us to conclude that the words are semantically similar. In recent years a very active research program has developed, which explores this hypothesis using modern computational techniques (Schütze 1993; Lund & Burgess 1996; Landauer & Dumais 1997; McDonald 1997; Sahlgren 2006; Padó & Lapata 2007; Erk 2009; Baroni et al. 2010; Baroni & Lenci 2010).

What distinguishes contemporary distributional semantic models (or DSMs) is the scale of the models and the sophisticated quantitative analysis of lexical distribution that is used. Marrying vector-based techniques from the field of information retrieval (Salton, Wong & Yang 1975) with a dimensional analysis of meaning (Osgood, Suci & Tannenbaum 1957), researchers have characterized semantic properties of lexical items in terms of the relationships among the textual contexts in which these items are used. In what have variously been known as “word-space semantics” (Schütze 1997), “vector-space models” (Turney & Pantel 2010), “latent semantic analysis” (Landauer, Foltz & Laham 1998), or, more generally, “distributional semantic models” (Baroni & Lenci 2010), lexical meaning is characterized as a point or a region in a high-dimensional semantic space constructed on the basis of lexical distribution. Semantic relations among words (such as synonymy, antonymy and similarity) are computed on the basis of the vectors characterizing the words in this space.

There are two classes of DSMs (Sahlgren 2006): **Syntagmatic** or document-based models (e.g., the *Latent Semantic Analysis* (LSA) model of Landauer & Dumais 1997), which base semantic similarity on document co-occurrence (e.g., *cook* appears frequently in the same documents as *spaghetti*, so they are similar); and **paradigmatic** or word-based models (e.g., the *Hyperspace Analogue of Language* (HAL) model of Lund & Burgess 1996), which base semantic similarity on similarity of contexts (e.g., *spaghetti* and *linguini* both appear with *cook* and *sauce*, so they are similar). What counts as a document (a news article; a paragraph; a sentence) or a context (a 10 word window; a sentence; a paragraph) is one of the many parameters that characterize a particular DSM model. Other parameters include how the co-occurrence counts are used to construct the semantic vectors and how semantic relations such as similarity are computed on the basis of these vectors.

As an illustration, consider the three document corpus in (19), with each line constituting a document and each sentence being a context domain.

- (19) a. He cooks spaghetti. It cooks quickly.  
b. He cooks linguini. It cooks slowly.  
c. Both linguini and spaghetti are tasty.

Counting how many times each word appears in each document yields the syntagmatic vector space in (20), for the content words in this corpus.

|                      | <i>a.</i> | <i>b.</i> | <i>c.</i> |
|----------------------|-----------|-----------|-----------|
| <i>cook</i>          | 2         | 2         | 0         |
| <i>spaghetti</i>     | 1         | 0         | 1         |
| (20) <i>linguini</i> | 0         | 1         | 1         |
| <i>quickly</i>       | 1         | 0         | 0         |
| <i>slowly</i>        | 0         | 1         | 0         |
| <i>tasty</i>         | 0         | 0         | 1         |

A common metric for similarity in DSMs is the **cosine** of the angle between the vectors, which normalizes for the number of occurrences of words. The words *cook* and *spaghetti* have a cosine similarity measure of 0.5, while *cook* and *tasty* have a cosine of 0.0, since they do not occur in any of the same documents.

A paradigmatic (word-based) model of the same corpus yields the semantic space in (21), which is generated by counting the number of word co-occurrences in one of the five “contexts” (sentences) that make up the corpus.

|                      | <i>cook</i> | <i>spaghetti</i> | <i>linguini</i> | <i>quickly</i> | <i>slowly</i> | <i>tasty</i> |
|----------------------|-------------|------------------|-----------------|----------------|---------------|--------------|
| <i>cook</i>          | 0           | 1                | 1               | 1              | 1             | 0            |
| <i>spaghetti</i>     | 1           | 0                | 1               | 0              | 0             | 1            |
| (21) <i>linguini</i> | 1           | 1                | 0               | 0              | 0             | 1            |
| <i>quickly</i>       | 1           | 0                | 0               | 0              | 0             | 0            |
| <i>slowly</i>        | 1           | 0                | 0               | 0              | 0             | 0            |
| <i>tasty</i>         | 0           | 1                | 1               | 0              | 0             | 0            |

In this semantic space *cook* and *spaghetti* have a cosine similarity of just under 0.3 – they only occur with the same word (*linguini*) once – while *cook* and *tasty* have a cosine of just over 0.7, since they both occur with *spaghetti* and *linguini*. Sahlgren (2006) compares syntagmatic and paradigmatic models over a range of tasks and finds that paradigmatic models are more effective for identifying such semantic relations as synonymy and antonymy, while syntagmatic models are more effective at identifying general semantic association (as between *milk* and *cow*).

Contemporary DSMs are also distinguished by the techniques used to reduce the dimensionality of the very large semantic spaces built out of word-word or word-document co-occurrence counts (ranging in the tens of thousands of dimensions) to lower-dimensionality “semantic” spaces (typically in the hundreds). The most common such technique is singular value decomposition (SVD). Landauer & Dumais (1997) demonstrated the effectiveness of dimensionality reduction by applying such a model to the TOEFL synonym test (for a given a word, which of the provided alternatives is a synonym). Building a paradigmatic model based on a 5-million-word encyclopedia corpus and reducing the high-dimensional word-word co-occurrence vectors to 300 “semantic” dimensions using SVD, they were able to achieve a performance of 64% on the TOEFL test, a score on par with average student performance, by simply having the model choose the answer with highest cosine similarity to the target word. Rapp (2003) improved this result to over 90% with a similar but more sophisticated DSM based on the much larger BNC.

In recent years DSMs have been applied to a number semantic tasks, from predicting semantic similarity judgements (Miller & Charles 1991; McDonald 1997), to distinguishing and disambiguating word-senses (Schütze 1993, 1998), to rating verb-argument plausibility (Erk, Padó & Padó 2010). While distributional semantic research has primarily focussed on modeling word meanings, there have been efforts to integrating compositional interpretation into such models (Kintsch 2001). Two recent treatments of adjectives-nouns composition are of particular interest (Baroni & Zamparelli 2010; Guevara 2010). Baroni & Zamparelli built a model that involves treating adjectives as as matrices – functions from vectors to vectors that combine with noun meanings to give modified nominal meanings. The adjective *red*, for example, was interpreted as the function that (best) computed the vector for *red box* from the vector for *box*. Guevara, on the other hand, built a model in which both the noun and the modifying adjective were interpreted as vectors, computing the combination *red box* via a general modifier function applied to each of the constituent vectors.

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Graham Katz, Washington, DC (USA)

## 110. Semantics in computational lexicons

1. Representation and computation
2. Building semantic lexicons
3. Multilingual and cross-lingual aspects
4. Interfaces and interoperability
5. Conclusion and outlook
6. References

### Abstract

*This chapter gives an overview of work on the representation of semantic information in lexicon resources for computational natural language processing (NLP). It starts with a broad overview of the history and state of the art of different types of semantic lexicons in Computational Linguistics, and discusses their main use cases. Section 2 is devoted to questions of how to construct semantic lexicons for Computational Linguistics. We discuss diverse modelling principles for semantic lexicons and methods for their construction, ranging from largely manual resource creation to automated methods for learning lexicons from text, semi-structured or unstructured. Section 3 addresses issues related to the cross-lingual and multi-lingual creation of broad-coverage semantic lexicon resources. Section 4 discusses interoperability, i.e., the combination of lexical (and other) resources describing different meaning aspects. Section 5 concludes with an outlook on future research directions.*

### 1. Representation and computation

#### 1.1. Lexicons in computational semantics

The development of semantic lexicons in and for computational semantic processing has been shaped by two complementary aspects of lexical meaning. Since words are combined to form complex phrases that express specific meanings, lexical meaning clearly relates to *structural aspects of meaning* in compositional meaning construction, with phenomena such as argument structure, quantifier or adverbial scope, presupposition projection, or anaphoric reference (cf. article 82 (von Stechow) *Syntax and semantics*). But more importantly, the lexicon plays its primary role in the representation of the *lexical meaning of individual words* that build the basis for constructing complex meanings, and that can serve as a basis for recognising and modelling paraphrases, lexically driven entailments, or creative meaning extensions such as metaphor.



Computational theories of grammar have been studied extensively in the course of the last decades, with a strong focus on formal modelling and efficient computational processing of compositional meaning construction. Particular focus was put on the design of expressive semantic formalisms, ranging from classical predicate logic to dynamic semantic formalisms, and the design of principled meaning construction methods for diverse grammar frameworks (for an overview see Müller 2010). Since all major computational grammar formalisms are *lexicalised*, it is the computational semantic lexicon in conjunction with compositional meaning construction principles that needs to account for structural semantic phenomena. Phenomena that have received particular attention are quantifier and adverbial scope, plural interpretation, temporal reference, or aspectual properties of events (e.g. Dalrymple et al. 1997, Kamp, van Genabith & Reyle 2011). On the level of representations, a rich body of work is concerned with the compact representation of structural and lexical semantic ambiguities (cf. article 24 (Egg) *Semantic underspecification*).

The meaning representations obtained from computational semantic grammars are typically interpreted using a model-theoretic setting. However, practical uses of computational semantics crucially rely on information about the *lexical meaning of predicates*. As an example, consider a Question Answering system that has to determine that *James Watt was the first to build a working steam engine* is a relevant answer to the query *Who invented the steam engine?*. There are various ways of representing the required lexical semantic knowledge, but none can be considered complete on its own.

In traditional formal semantics, lexical meaning is defined by way of meaning postulates, again interpreted against a model (Carnap 1947), or else by way of lexical meaning relations such as synonymy, antonymy, hyponymy, etc. (Lyons 1977). The semantics of predicate-argument structures describing events or situations has been characterised using semantic or thematic roles, or proto-roles (Fillmore 1976, Dowty 1991). Formal descriptions that define the lexical meaning of predicates have been attempted by way of decompositional analysis (Katz & Fodor 1964). However, agreement on a basic inventory of atomic meaning descriptions has been elusive (Winograd 1978). Most of these approaches to lexical meaning representation have been applied in work on semantic lexicon building for computational grammars at one time or another.

A few proposals also exist for richer semantic characterisations of lexical meaning. Examples include Pustejovsky's generative lexicon that can account for, i.a., the interpretation of metonymy (Pustejovsky 1995), Copestake and Briscoe's work on sense extension (Copestake & Briscoe 1995), or research on the integration of multi-word expressions (Sag et al. 2002). Sharing the concerns of ontological semantics (Nirenburg & Raskin 2004), Cimiano & Reyle (2005) include interfaces to ontological knowledge. Here, the role of ontological knowledge is to provide semantic criteria for ambiguity resolution, and to support inferences on the basis of the derived semantic representations. Finally, substantial research exists on the development of *linking theories* that capture regularities in the syntactic realisation of arguments with specific semantic properties (Bresnan & Zaenen 1990; Grimshaw 1992; Davis & Koenig 2000; Dang, Kipper & Palmer 2000).

All these approaches are mainly concerned with clarifying the formal and computational aspects of representing and processing lexical meaning in computational grammar formalisms, but have not been scaled to large semantic lexicons for broad-coverage, semantically informed NLP systems. Thus, today there exists a good understanding of the

mechanisms that are required for the treatment of structural and lexical semantic phenomena in computational grammars – if the information is actually present in the lexicons. The creation of such semantic lexicons – which may involve highly structured representations – is a tight and serious bottleneck.

## 1.2. Standalone semantic lexicons

The creation of semantic lexicons has been pursued largely independently of computational grammar research. Depending on theoretical assumptions and the intended usage, semantic lexicons are structured according to different aspects of meaning and thus differ considerably in their descriptive devices. Some lexicon accounts characterise the meaning of individual words (or often, their individual *word senses*) by grouping them into *semantic classes* and by defining lexical semantic relations between these classes. Other lexicons try to capture constitutive meaning aspects of lexical items by decomposing their meaning in terms of atomic meaning primitives and define semantic relations between words on the basis of such primitives. Some lexicons, finally, use a combination of these techniques. This section gives an overview of diverse types of semantic lexicons and their modelling principles. We start with lexicons describing the meaning of lexical items in terms of sense definitions, semantic classes, or lexical semantic relations. Argument-taking predicates require in addition semantic descriptions that capture the constitutive meaning relations holding between predicates and their arguments. A number of lexicons is devoted to specific aspects of the meaning of particular word classes (such as nominalisation, factivity, presupposition, or polarity of emotion). Other specialised lexicons focus on the description of the non-compositional semantics of idiomatic expressions, light verbs, or collocations, or relate different modalities. Finally, we address the relation between semantic lexicons and ontologies.

### Lexicons modelling inherent lexical meaning

Building on influential work in theoretical lexical semantics, in particular Dowty (1979), Jackendoff (1972), Jackendoff (1985) (cf. article 17 (Engelberg) *Frameworks of decomposition*), early attempts to computational lexicon building aimed at providing *inherent meaning descriptions* that can model lexical inferences, the semantic relations between diatheses and paraphrases, or resolve lexical ambiguities in context. Dowty's and Jackendoff's work both aim at inherent, decompositional meaning descriptions in terms of primitive semantic predicates. The aims and scope of decomposition, however, diverge considerably. Dowty's work focuses on explaining systematic meaning relations between diathesis alternations (e.g. inchoative and causative readings of *open* or *close* using primitives like CAUSE and BECOME), and on the ability of these semantic relations to predict the range of possible constructions for different types of predicates. Further aspects concern aspectual properties of verbs. Decomposition is restricted to modelling these grammaticalised categories of lexical meaning, leaving the core lexical semantics of verbs largely unanalysed.

In contrast, Jackendoff's work on Lexical Conceptual Structure (LCS) attempts to capture the lexical meaning of predicates in terms of a set of primitive predicates such as *cause*, *go* (inspired by physical motion) to define generalisations across predicates (cf. article 19 (Levin & Rappaport Hovav) *Lexical Conceptual Structure*).

Figure 110.1 shows an example for the causative use of *break* with an instrument expressed by a *with*-PP. The heart of the lexicon entry is the semantic description (:LCS) which uses figures to denote semantic categories. It defines the meaning of *break* as “an Agent [1] causes the identity of an Experiencer [2] to become a broken Experiencer [2], using an Instrument [20]” ([9] stands for “Predicate”, and [19] for “Instrumental Particle”). The lexicon entry also provides global semantic description of the verb’s valency in terms of theta roles (:THETA\_ROLES) and selectional restrictions (:VAR\_SPEC), as well as mappings to other lexical resources such as WordNet (:WN\_SENSE), PropBank (:PROPBANK), and Levin classes (:CLASS).

```
:DEF_WORD "break"

:CLASS "45.1.a"

:WN_SENSE ((("1.5" 00787971 00201902)
             ("1.6" 00938146 00231588))

:PROPBANK ("arg0 arg1 arg2(with)")

:THETA_ROLES ((1 "_ag_th,instr(with)")

:LCS (cause (* thing 1)
        (go ident (* thing 2)
          (toward ident (thing 2)
            (at ident (thing 2) (break+ed 9))))
      ((* with 19) instr (*head*) (thing 20)))

:VAR_SPEC ((1 (animate +)))
```

Fig. 110.1: LCS lexicon entry for transitive *break* with *with*-PP (Dorr et al. 2001)

Dorr (1997) presents automation techniques to develop LCS-based lexicons, linking LCS representations to Levin classes and WordNet, as seen above. This work proves the applicability of LCS descriptions for special aspects of verb meaning (cf. also VerbNet, below), yet the coverage of LCS-based meaning descriptions is restricted, as is their role in large-scale NLP applications. Pustejovsky (1995) describes the generative capacity of lexical meaning from an opposite viewpoint, assuming a minimal core description and a number of principled operations that allow for systematic sense extensions. The theory considers both verb and noun meanings (cf. article 17 (Engelberg) *Frameworks of decomposition*), but the treatment of nouns in terms of *Qualia Structure* is most widely known: it describes the *constitutive*, *formal*, *telic* and *agentive* functions of nouns that account for systematic meaning extensions. While there is no large resource providing qualia information, the CORELEX resource (Buitelaar 1998) models another part of the generative lexicon, namely the systematic polysemy of nouns.

## Lexicons modelling meaning relations

Another structuring principle for semantic lexicons consists in defining semantic classes, i.e. groups of words that are more or less strictly synonyms, and hierarchical semantic relations among them, in terms of super- and subconcepts. This is the inherent structuring principle underlying taxonomies, which allows us to generalise attributes of concepts at some level in the hierarchy to their subconcepts (cf. article 21 (Cann) *Sense relations*). To account for the pervasive phenomenon of lexical ambiguity, semantic classes need to be distinguished. This may be achieved by way of formal semantic descriptions of the inherent meaning of predicates (see above). Given the difficulty of this task, however, semantic classes are most often defined by way of glosses or textual sense descriptions, combined with linguistic examples.

Early instances of this type of semantic lexicons are machine-readable dictionaries (MRDs) such as the Longman Dictionary of Contemporary English, LDOCE (Procter 1978). LDOCE provides linguistic codes and classifications for word senses, including glosses that use a controlled vocabulary, thus approximating a decompositional analysis. However, MRDs are mostly aimed at human users and contain informal descriptions, inconsistencies, and implicit information. This makes the extraction of general-purpose lexicons from MRDs difficult (Carroll & Grover 1989).

The most widely used resource that adheres to the above-mentioned structuring principles is WordNet, a resource originally motivated by psycholinguistic considerations, and designed for computational as opposed to human usage (Fellbaum 1998). WordNet's semantic classes, called *synsets*, are defined as groups of *synonymous word senses*. WordNet consists of different hierarchies, one for each major part of speech (noun, verb, adjective, adverb); the main relation between synsets is the *is-a* relation (corresponding to the hyponymy relation between the lexical items in the synsets). Instead of assuming a single top concept, WordNet established 11 top concepts, corresponding to broad conceptual domains (such as entity, event, psychological feature, etc.). Figure 110.2 shows a small excerpt of the WordNet *is-a* hierarchy around the synset for the “automobile” reading of *car*. It shows how WordNet synsets are described with short natural language glosses which are not drawn from a controlled vocabulary, but can nevertheless be viewed as providing a (pre-formal) decompositional analysis. Formalisation of WordNet glosses has been attempted in Mihalcea & Moldovan (2001) by parsing them into logical forms. For many synsets, short example sentences are also available.

Next to hyponymy, WordNet encodes lexical meaning relations such as antonymy, meronymy (part-of relation), entailment, cause, attribute, derivation, etc. These relations provide additional meaning aspects for a given synset, while only indirectly, in terms of their semantic relations to “neighbourhood” concepts (cf. article 21 (Cann) *Sense relations*). The synset *car* from Figure 110.2, for example, is meronymically related to over twenty other synsets, such as *car door*, *air bag*, or *roof*.

Due to its size (it covers more than 200,000 word senses) and simple structure, WordNet has shown extremely useful in NLP. For example, a wide range of methods exploit its hierarchy to quantify the semantic similarity between words (Budanitsky & Hirst 2006). An unresolved issue, however, is the question of its *granularity*. WordNet uses comparatively fine-grained word senses, which have the potential to convey very specific information. Yet, vagueness and underspecification of lexical meaning in real-world use often make the assignment of a particular sense difficult or impossible (Kilgarriff 1997). Recent

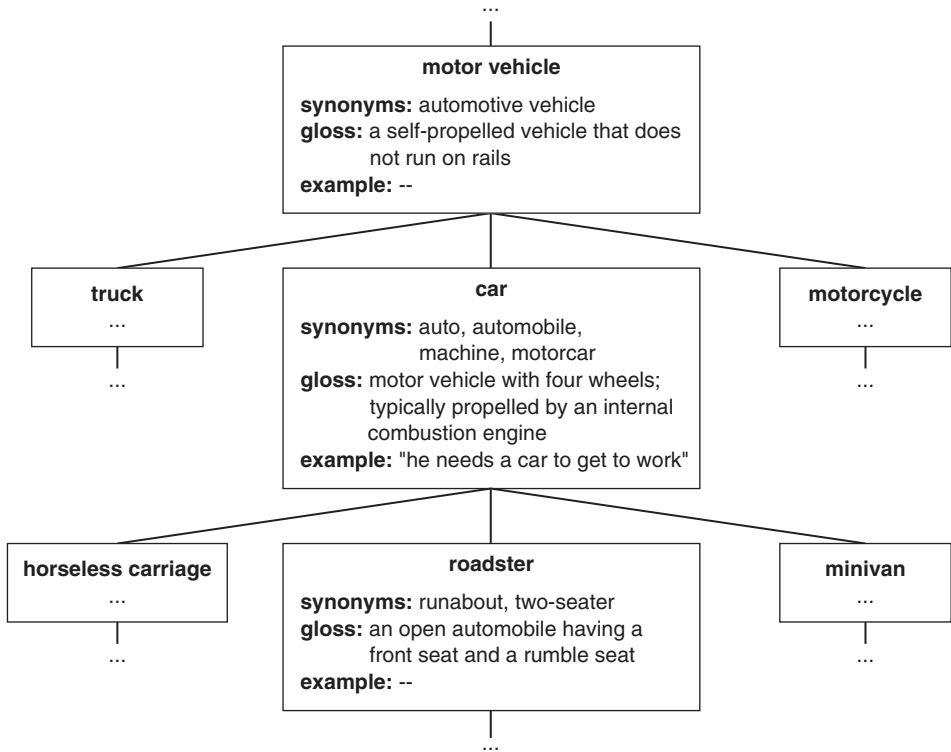


Fig. 110.2: WordNet *is-a* hierarchy centered around the primary sense of *car*

work explores strategies to dynamically “group” word senses to find an optimal level of granularity for a given task (Palmer, Dang & Fellbaum 2006; Hovy et al. 2006).

The increased interest in multimodal applications has lead to the development of multimodal lexicons. Borman, Mihalcea & Tarau (2005) have developed a WordNet-based resource, PicNet, that combines linguistic with pictorial representations for concepts. Such knowledge can be used for better video or image retrieval (Popescu & Grefenstette 2008).

### Lexicons modelling predicate-argument structure

The characterisation of meaning by way of synonymy, hyponymy and other meaning relations works particularly well for lexical items that refer to entities, as most nouns do. Predicates denoting events or states, such as verbs and deverbal nouns, have a more complex structure in at least two respects: Syntactically, they combine with *arguments*, which requires a semantic characterisation of the arguments in terms of their inherent relation to the event or state (their *semantic role*, such as *agent*, *patient* or *experiencer*) as well as their linking to surface positions. Also, events and states are often internally structured in terms of aspectual properties. This makes a simple *is-a* hierarchy insufficient to express semantically relevant relations between events and states, for example to draw inferences about the result states of events or the involvement of participants.

A variety of theories exist that characterise the arguments of predicates in terms of thematic or semantic roles, such as AGENT, THEME, LOCATION, etc. (e.g. Gruber 1965, Fillmore 1968, Jackendoff 1972, cf. article 18 (Davis) *Thematic roles*). Classifications were intended to capture syntactic and semantic characteristics of the respective arguments and verb classes. Fillmore (1968), for example, argued for a universal set of atomic thematic roles to capture mainly semantic generalisations, and used these to classify verbs according to the case-frames they allow. Jackendoff (1972) defined a small number of thematic roles in terms of primitive semantic predicates in LCS (see above), and established linking principles to map syntactic and semantic arguments (Jackendoff 1990). However, similar to the general problem of decomposition, no agreement could be reached on a complete and universal set of thematic roles. Dowty (1991) introduced a weaker definition of thematic roles, replacing the set of distinct thematic roles with two “proto-roles” (PROTO-AGENT, PROTO-PATIENT) whose semantics are determined through individual entailments holding for a given predicate and argument. Fillmore (1976) later established a radically different view in introducing Frame Semantics, which assumes concept-specific semantic roles of predicate classes, defined in terms of semantic frames and their frame-specific roles. A more syntax-oriented view on the semantics of argument structure emerges from the work of Levin (Levin 1993; Levin & Rappaport Hovav 2005). She establishes semantic verb classes (“Levin classes”) on the basis of syntactic argument realisations in diathesis alternations. The underlying assumption is that the ability of a verb to occur in certain syntactic alternations is grounded, or a reflex of underlying semantic properties of verbs.

Out of these traditions, a number of large-scale lexicons have emerged that are based on the syntactico-semantic properties of argument-taking predicates, mainly for verbs and mainly for English. Due to the differences between the underlying theories, they differ considerably in their design decisions and structuring mechanisms (Ellsworth et al. 2004; Merlo & van der Plas 2009). Figure 110.3 shows the entries for transitive *break* in the three most widely used predicate-argument structure based lexicons.

*PropBank* (Palmer, Gildea & Kingsbury 2005) is a verb lexicon specifying semantic predicate and role annotations on top of the Penn Treebank, a large English treebank with constituent structure annotation (Marcus, Santorini & Marcinkiewicz 1993); *NomBank* (Meyers et al. 2004) extends the approach to deverbal nouns. *PropBank* and *NomBank* annotate coarse-grained word senses called “rolesets” (like *break.01* in Figure 110.3). The semantic roles (“arguments”) are given verb-specific mnemonics (like *breaker*). Arg0 and Arg1 correspond to Dowty’s proto-agent and proto-patient and thus share meaning across predicates, while arguments with higher numbers are defined in syntactic terms, with limited generalisations. Resources that follow the model of *PropBank* have been developed for Chinese (Xue 2008) and Korean, although the syntactic nature of *PropBank*-style roles makes the re-use of English role definitions for other languages difficult.

*VerbNet* (Kipper-Schuler 2005) represents an extension and refinement of Levin verb classes (Levin 1993). It is thus located directly at the boundary between syntax and semantics. On the syntactic side, the lexicon contains syntactic frames (field *Syntax*) with selectional restrictions of verb arguments (field *Roles*). The semantic side is based on intersective Levin classes (Dang et al. 1998), a refinement of Levin’s original theory, and defines a hierarchy over verb classes, generally not exceeding a depth of three levels (field *Class*). It assumes a small set of abstract, semantically motivated thematic roles (field

| PropBank        |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Roleset         | break.01 "break, cause to not be whole"                                                                                                                                                                                                                                                                                                                                                                                 |
| Verbnet         | Class: 1                                                                                                                                                                                                                                                                                                                                                                                                                |
| Roles           | Arg0:breaker                      Arg1:thing broken<br>Arg2:instrument              Arg3:pieces                                                                                                                                                                                                                                                                                                                         |
| Example         | [Arg0 John] broke [Arg1 the window]<br>[Arg2 with a rock].                                                                                                                                                                                                                                                                                                                                                              |
| VerbNet         |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Class           | 45.1                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Roles           | Agent [+int_control], Patient [+solid], Instrument [+solid]                                                                                                                                                                                                                                                                                                                                                             |
| Syntax          | Agent V      Patient    (with) Instrument                                                                                                                                                                                                                                                                                                                                                                               |
| Example         | Tony broke the window with      a hammer.                                                                                                                                                                                                                                                                                                                                                                               |
| Semantics       | cause(Agent,E)<br><br>contact(during(E),Instrument,Patient)<br><br>degradation_material_integrity(result(E),Patient)<br><br>physical_form(result(E),Form,Patient)<br><br>use(during(E),Agent,Instrument)                                                                                                                                                                                                                |
| FrameNet        |                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Frame           | Cause_to_fragment                                                                                                                                                                                                                                                                                                                                                                                                       |
| Definition      | An Agent suddenly and often violently separates<br><br>the Whole into two or more smaller Pieces,<br><br>resulting in the Whole no longer existing.                                                                                                                                                                                                                                                                     |
| Roles           | Agent:    The conscious entity, generally a person,<br>that performs the intentional action that<br>results in the Whole being broken into Pieces.<br><br>Cause:    An event which leads to the<br>fragmentation of the Whole.<br><br>Pieces:    The fragments of the Whole that<br>result from the Agent's action.<br><br>Whole:    The entity which is destroyed by the Agent<br>and that ends up broken into Pieces. |
| Example         | [AGENT He] *ripped up* [WHOLE the letter].                                                                                                                                                                                                                                                                                                                                                                              |
| Semantic Types  | Agent=Sentient                                                                                                                                                                                                                                                                                                                                                                                                          |
| Inherits From   | Transitive_action                                                                                                                                                                                                                                                                                                                                                                                                       |
| Is Causative of | Fragmentation_scenario                                                                                                                                                                                                                                                                                                                                                                                                  |
| Lexical Units   | break.v, break_apart.v, break_down.v,<br>break_up.v, chip.v, cleave.v, ...                                                                                                                                                                                                                                                                                                                                              |

Fig. 110.3: Lexicon entries for transitive *break* in PropBank, FrameNet, and VerbNet

Roles). For selected meaning aspects, VerbNet provides fine-grained definitions in a decompositional style, using conjunctions of semantic predicates to characterise pre- and post-conditions of the event *E* as well as temporal and aspectual properties (field Semantics).

*FrameNet* (Fillmore, Johnson & Petruck 2003) is a lexicon in the Frame Semantics paradigm (Fillmore 1976) that groups verbs, nouns, and adjectives into semantic classes (frames) that correspond to abstract situations or events. While a variety of criteria is used in determining frames, most of them tend to be semantic. FrameNet defines semantic roles at the level of individual frames (cf. article 29 (Gawron) *Frame Semantics* for details). Figure 110.3 shows that *break* is analysed as belonging to the CAUSE\_TO\_FRAGMENT frame, with definitions of the frame and roles stated in natural language. Some of the semantic roles are further specified in terms of general semantic types such as *Sentient*. The frames are organised into a “frame hierarchy” defined by frame-to-frame relations (*inheritance*, *subframe*, *causative-of* etc.) that define hierarchical, but also paradigmatic semantic relations, such as successions of events and states in script-like situations. The frame hierarchy also provides mappings between frame-specific semantic roles. Due to its primarily semantics-oriented structuring principles (schematised situations and participant roles), the FrameNet classifications established for English have been successfully transferred to different languages, though not without need for language-specific adjustments in the inventory of frames and roles (Burchardt et al. 2009; Subirats 2009; Ohara et al. 2004).

Due to the differences in their underlying theories, these resources have put different emphases on syntactic vs. semantic structuring principles, and correspondingly achieve different degrees of generalisations in defining and relating semantic classes. PropBank does not specify relations across lexical items on a formal level, although informal characterisations can be read off the free-text descriptions provided for word senses and role labels. VerbNet achieves a higher degree of generalisation by introducing a certain degree of hierarchical structuring. In addition, it provides strong decompositional semantic definitions of verbs, including thematic roles with selectional preferences. In FrameNet, the coarse-grained semantic classes (frames) typically cover a number of predicates and provide only a limited definition in terms of their sets of semantic roles. Additional characterisations and constraints are only available in free text form. Similar to WordNet, it may be possible to gain considerable information from the hierarchical structure that is defined over frames, in terms of frame-to-frame relations, and in fact this network shows potential for use in NLP tasks (Narayanan & Harabagiu 2004). Nevertheless, the FrameNet resource is still far from complete and requires more rigorous formal definition of frames and frame relations.

A largely unexplored area of semantic lexicon building is the design and creation of lexicons for the difficult classes of non-compositional lexical semantic phenomena. Most computational lexicons assume compositionality in the sense that they specify semantic representations only for “atomic” structures (typically, words), as opposed to idiomatic expressions or multiword expressions. Fellbaum et al. (2006) proposes a model for large-scale lexical resource building focusing on idiomatic expressions coupled with textual data. The SALSA project (Burchardt et al. 2009) investigated special annotation schemes and lexicon entry creation for idiomatic expressions and figurative meanings in the Frame Semantics paradigm.



## Semantic lexicons, ontologies and world knowledge

There is a close relation between hierarchically structured semantic lexicons such as WordNet and ontologies in that both are organised along the lines of an *is-a* hierarchy. However, there are – at least in theory – two fundamental differences between semantic lexicons and ontologies.

The first distinction lies in the *nature of the objects* that are defined. In semantic lexicons, these are lexical units (words or word senses) of particular languages, while the classes defined in ontologies proper are *concepts* (Gruber 1995) that may or may not be language-independent. This difference becomes obvious once we contrast WordNets for different languages. A comparison of these resources shows that languages can have lexical gaps (cf. the absence of an exact English counterpart to German *Gemütlichkeit*). At the same time, they may lexicalise distinctions that other languages do not (cf. the English distinction between *isolation* and *insulation* both of which translate into German as *Isolation*). Multilingual semantic lexicons must handle such divergences explicitly. In EuroWordNet, this happens via an *inter-lingual index (ILI)* (Vossen 1998).

The second distinction is the *descriptive inventory*. Semantic lexicons categorise lexical items with respect to lexical relations, lexical properties, or predicate-argument structure. In contrast, ontologies provide rigidly defined knowledge-oriented (encyclopedic) relations, attributes and axioms for concepts. For example, the concept *politician* will need to provide typed attributes and relations such as *party*, *period of service*, or *elected by* which are clearly encyclopedic.

In practice, however, the distinction between linguistic meaning and world knowledge is notoriously difficult (Hirst (2004), cf. article 32 (Hobbs) *Word meaning and world knowledge*). Lexical meaning often closely corresponds to conceptual knowledge. Lexical relations like antonymy, synonymy and also entailment are crucially grounded in ontological categories and properties (such as *dead* vs. *alive*, *bachelor* and *unmarried*), which makes them difficult, if not impossible, to distinguish from ontological concepts and relations. Differences show up in cases of linguistic distinctions that do not have an immediate ontological counterpart, as in linguistically conveyed differences in perspectivisation of one and the same event (e.g. *buy* vs. *sell*). On the other hand, some lexical ontologies, such as WordNet, include semantic relations that are truly ontological, such as *part-of*, which adds to terminological confusion.

While linguistic knowledge is often easier to specify than the potentially open-ended field of ontological information, purely linguistic properties are insufficient for NLP applications that require deeper semantic analysis. On the other hand, the knowledge encoded in ontologies cannot be put to use in NLP applications without relating it to the linguistic realisation of the classes and relations. This may be provided in different ways: by constructing an explicit mapping between a semantic lexicon and an ontology (Niles & Pease 2003); by enriching a semantic lexicon with ontological information (Gangemi, Navigli & Velardi 2003), or through construction of hybrid lexicons that include a linguistic and an ontological level of description, such as OntoSem (Nirenburg & Raskin 2004), or HaGenLex (Hartrumpf, Helbig & Osswald 2003).

## Lexicons modelling specific meaning aspects

A number of lexicon resources concentrate on particular meaning aspects. Some focus on linguistic properties like the implicative behaviour of sentence embedding verbs (Nairn,

Karttunen & Condoravdi 2006), the evaluative function of lexical items (Esuli & Sebastian 2006; Pang & Lee 2008), or collocation patterns (Spohr & Heid 2006). Others describe the semantics of particular word classes such as prepositions (Saint-Dizier 2006) or nominalisations (Lapata 2002). Yet other lexicons provide information on generic semantic similarity (Lin 1998) or admissible sentence-level paraphrases (Lin & Pantel 2001). These resources vary widely in how structured they are. On one extreme, they may employ complex graph-based structures (Spohr & Heid 2006), or rest upon in-depth linguistic examination, as in the case of (Nairn, Karttunen & Condoravdi 2006). On the other end of the spectrum, they are sometimes little more than ranked lists of word pairs (Lin 1998).

### 1.3. Semantic lexicons in use

*From semantic resources to semantic processing.* The various types of knowledge that are represented in computational lexicons are potentially beneficial for a wide range of NLP tasks. We will motivate this claim on a small example from Question Answering, where questions and answer candidates can differ on a number of linguistic dimensions. For example, a potential answer to the question *Whom did Peter see?* may be *The man with the moustache was seen by Peter*, i.e., in passive voice. The relationship between active and passive sentences is best modelled by mapping syntactic (surface) argument positions onto their corresponding *semantic roles*, a process known as semantic role labelling or shallow semantic parsing and pioneered by Gildea & Jurafsky (2002). This is a prime application of predicate-argument structure-based lexicons.

A different problem is posed by *Peter saw the man with his binoculars*, a sentence with an attachment ambiguity where it is unclear whether the binoculars modify the object of the seeing event. Such problems can be addressed by forming semantic classes that describe *selectional preferences* for argument positions, such as the instrument of “see” (Resnik 1996). As illustrated above, some lexicons encode conceptual classes, or selectional restrictions for argument positions.

Next, a sentence like *Peter saw the point of Jack’s argument* should not be considered relevant even though it shares both predicate and subject with the question. The reason is polysemy: here, the sense of “see” can be paraphrased by “understand” while in the question it is closer to “observe”. Selection or assignment of the appropriate word sense in a given context is addressed in the task of *word sense disambiguation* (WSD, Navigli 2009). The by far most widely used sense inventory for this task are the WordNet classes, due to WordNet’s high coverage, and the ability to use the detailed hierarchy to guide generalisation. Finally, some answer candidates can only be recognised as relevant through *inference* (Norvig 1987), such as *The man was identified by the eye witness Peter*: Establishing a relation between this sentence and the question requires the knowledge that being an eye witness necessarily requires an act of observation. This relation might be defined in the inherent meaning of the expression in a lexicon, it might be established through a formal inference process, using knowledge from an ontology, or can be modelled through approximate inference methods (see below).

*Disambiguation in context.* The availability of semantic lexicons and their encoded representations is merely a first step towards their actual use in semantic processing tasks. A serious limitation for their use is that they list the range of possible semantic classes for lexical items, but do not provide specifications as to when these classes are appropriate

for a given instance of the lexical item in a specific context. In fact, all applications sketched above crucially depend on *automatic disambiguation* methods that can assign one or more appropriate classes to lexical items in context. Such disambiguation models can be based on a large variety of techniques ranging from knowledge-based or heuristic techniques to statistical models.

Over the last years, robust data-driven methods have been very successful. Such methods can make use of *quantitative information* gained from annotated corpus data which many semantic resource building efforts have produced in parallel with the lexicon resources. The FrameNet database, for example, comes with a large corpus of frame-annotated sentences that were successfully used for training semantic role labelling systems (Gildea & Jurafsky 2002). WordNet provides frequencies of senses through the sense-annotated Semcor corpus (Fellbaum 1998). Data-driven methods for word sense disambiguation are still confronted with serious problems (McCarthy 2009). Due to the highly skewed frequency distribution over senses, supervised models require massive amounts of manual annotations that cannot be achieved on a realistic scale. The performance of unsupervised models, by contrast, is still weak. An alternative to statistical models are knowledge-based methods. The Lesk algorithm (Lesk 1986) and its derivatives compute semantic overlap measures between words in the context of the target word and the words in the sense glosses listed in WordNet for each synset, resulting in a model that is still hard to beat. A promising recent development is the emergence of *knowledge-based* methods that link semantic classes to the vast common-sense knowledge repository Wikipedia, whose articles and link structure can serve as the basis for disambiguation models for the semantic classes without the need for manual annotation (Gabrilovich & Markovitch 2007; Ponzetto & Navigli 2010).

In contrast to independent models for disambiguation, Pustejovsky, Hanks & Rumshisky (2004) propose an integrated *contextual* lexicon model for word senses that associates target entries with syntagmatic patterns of words, so-called *selection contexts*, that determine the assignment of word senses in context.

*Approximate semantic processing.* Semantic analysis in current practical NLP applications is far from comprehensive. This is due to the scarcity of resources on the one hand, and the complexities of fine-grained semantic analysis on the other. Still, currently available resources have been put to use effectively for a variety of semantic analysis tasks that are known to be highly problematic for computational modelling. A commonly used technique is to approach complex phenomena by considering simplified, and thus more tractable, aspects that are accessible to current semantic processing tools and techniques. A crucial factor in the success of this approach is the large amount of *redundancy* in the text collections most NLP tasks are concerned with. Redundancy lowers the requirements on detail and precision, since relevant linguistic material will usually occur more than once. In consequence, even the simple notion of generic *semantic relatedness* is put to use in many applications. It underlies most Information Retrieval systems, and can inform the resolution of syntactic and semantic ambiguities (Dagan, Lee & Pereira 1999; Resnik 1999; Lapata 2002).

With regard to drawing inferences from text, the textual inference framework (Dagan et al. 2009) has risen to prominence. In textual inference, entailment relations between sentences are not defined through a theory of meaning, but rather established by annotator judgments, with the effect of decoupling phenomenon and processing paradigm. A number of approaches have been applied to textual inference, including full-fledged logical inference. However, most approaches are approximate, relying on the partial

information present in current semantic lexicons. WordNet, for example, can be used to add hyponym and hyperonym information to analyses; FrameNet and VerbNet can be used to retrieve similar predicates, and to some extent also information about result states (Burchardt et al. 2007).

*Limitations and prospects of current semantic lexicons.* The amount of semantic knowledge encoded in today's semantic lexicons is still limited. As a result, more involved inference problems still remain outside the reach of lexicon-driven approaches. This holds even for the currently most advanced "deep" semantic NLP systems that include large-scale meaning construction and inference machinery, such as Bos (2009). For example, the rejection of the standard interpretation of *Peter and Mary got married* in the context of *Peter married Susan, and Mary married John* requires knowledge about the incompatibility of multiple synchronous marriages. One direction of research towards richer semantic resources and processing is the acquisition of such knowledge from corpora, either unstructured text or pre-structured texts from Wikipedia (see Section 2.3.). Another one is the enrichment of semantic representations by building interfaces to manually crafted ontologies such as Cyc or SUMO (Niles & Pease 2003); however, the task of defining flexible interfaces between the lexical and the ontological level is still a challenge (see Section 4.).

## 2. Building semantic lexicons

Computational lexical semantics has achieved a major break-through in large-scale lexical resource building within the last decade, as evidenced by the resources presented in Section 1. At the same time, current methods are still insufficient to meet the need for deeper analysis, both for general and specialised domains, and, prominently, the need for multilingual resources.

### 2.1. Strategies for building semantic lexicons

The two main strategies for manual lexicon creation can be seen as opposing poles on a continuum. On one end of the spectrum lie manual resource creation efforts that do not use corpus data at all, relying exclusively on linguistic insight. Great care must be taken not to overlook relevant phenomena, and to achieve a good balance of lexical instances in terms of frequency of occurrence and representativeness of senses.

The other pole is formed by strict corpus-driven lexicon development. This method annotates a corpus from which the lexicon is later extracted. Advantages of this approach include the grounding of the lexicon data in naturally occurring instances, which ensures good coverage of phenomena, and the ability to read quantitative tendencies off the annotations. On the downside, corpus annotation often faces massive redundancy for frequent phenomena. Also, annotation introduces overhead, notably in the effort necessary to guarantee consistency and informativity. Particularly problematic are the ambiguity and vagueness inherent in many semantic phenomena such as word sense (Kilgarriff 1997). Finally, lexicon extraction is confronted with the problem of characterising phenomena across multiple linguistic levels, which requires well-designed interfaces (see Section 4.). In practice, the most feasible strategy for the manual creation of a semantic lexicon is often a compromise. This might involve direct manual creation of the resource that is nevertheless guided by systematic sighting and frequency analysis of the data to encourage high

coverage and representativeness. A variety of corpus analysis tools support empirically guided lexicon building through quantitative analysis and linguistically informed search on large corpora: the CQP workbench (Christ et al. 1999), Sketch Engine (Kilgarriff et al. 2004) or the Linguist's Search engine (Resnik & Elkins 2005). Exemplary corpus annotation can serve to validate analysis decisions and provide data for corpus-driven models.

## 2.2. Conservative methods for data-driven lexicon creation

Traditional lexicon construction, whether introspective or corpus-driven, proceeds manually and is a long and expensive process. The creation of many semantic lexicons that are in general use, such as WordNet, was only feasible because these resources concentrated on a small set of semantic relations. However, manual lexicon creation strategies can be complemented with semi-automatic methods aimed at extending the coverage of existing lexicon resources. These methods take advantage of corpus-based lexical semantic processing methods and range from simple to challenging.

A pressing need that is comparatively simple to address is an increase in coverage to previously unknown lexical items. In *supersense tagging* (Ciaramita & Johnson 2003; Curran 2005) unknown words (usually nouns) are sense-tagged according to a small number of broad WordNet classes. Pennacchiotti & Pantel (2006) build sense vectors characterising synsets that can be used to find the closest WordNet synset for unknown words, bringing together large-scale extraction and integration of semantic relations.

A more challenging goal is the structural extension of a semantic lexicon, which involves shaping new semantic classes or senses, their insertion into the existing lexical hierarchy, and the induction of semantic relations. Fully automated induction of semantic classes, semantic relations, and full ontologies (see below), is still in its infancy. Hence, practical resource creation often reverts to more controlled, semi-automatic methods. For VerbNet, e.g., Korhonen & Briscoe (2004) automatically acquire new Levin classes using corpus-based methods. The integration of this information into the VerbNet hierarchy still requires manual definition of novel semantic classes and predicates, as well as local modifications of the VerbNet hierarchy (Kipper et al. 2006).

## 2.3. Automatic acquisition of semantic lexicons and knowledge bases

Fully automatic methods try to reduce human effort as completely as possible. As is evident from the previous discussion, completely automatic acquisition is only possible either for coarse-grained classes or by tuning methods to individual relations.

Most such approaches rely on (unannotated) corpora, which are now available for many languages, domains, and genres, often by harvesting from the web. Semantic relations can be gathered from unanalysed corpora by collecting co-occurrence information about words or word pairs, following Harris' (1968) observation that semantically related words tend to occur in similar contexts. Variation in the specification of contexts gives rise to a range of approaches. *Pattern-based* methods use lexico-syntactic templates to identify contexts (typically a small number) that identify individual relations (Hearst 1992). The upper part of Figure 110.4 illustrates this idea for hyponymy relations. In contrast, *distributional* methods record the co-occurrence of individual words with their surrounding context words (e.g., all words within a context window or within a syntactic relationship). Pairwise similarities between the vector representations (e.g., cosine similarity) can then be interpreted as general semantic relatedness (Schütze 1993); see the lower part of Figure 110.4.

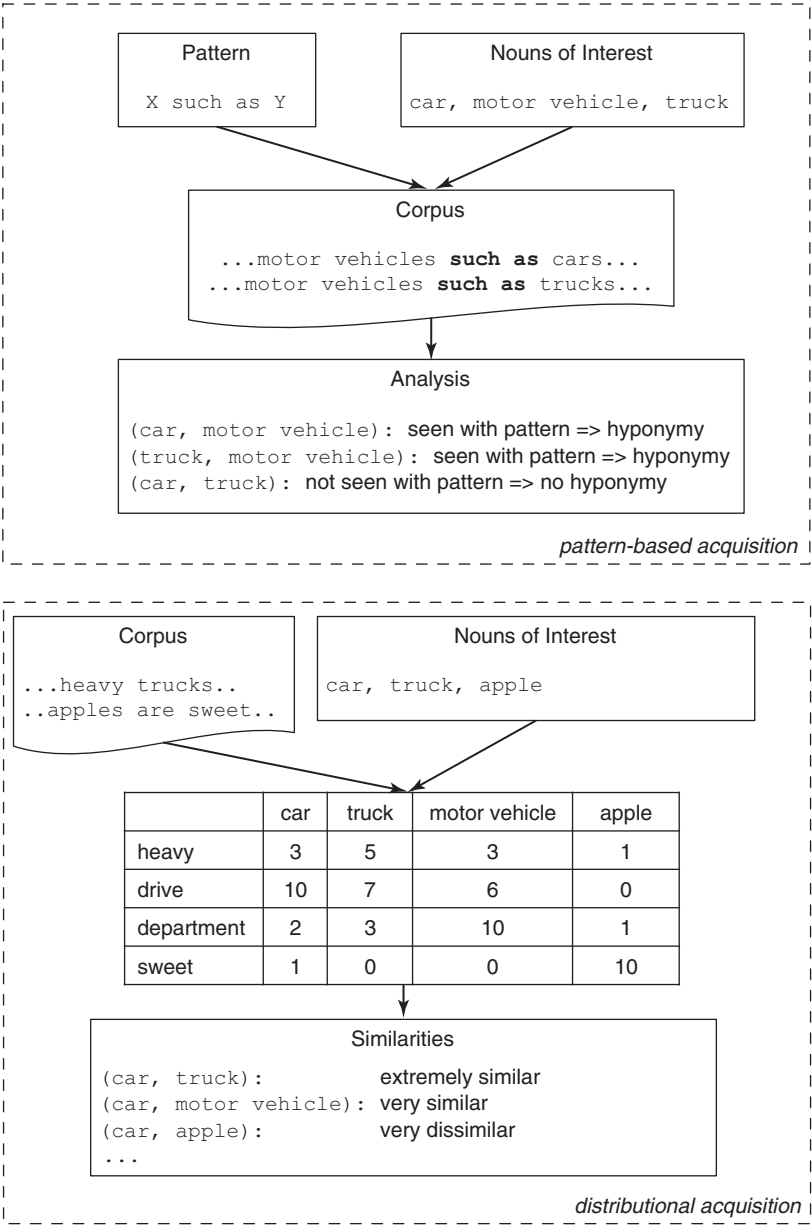


Fig. 110.4: Automatic acquisition of lexical information from corpora

Learning semantic classes

Automatic approaches typically start with the induction of semantic classes or senses, i.e., sets of words with similar semantic properties. Unsupervised approaches to this task almost invariably use *clustering* techniques that group words with similar distributional

representations into classes (Hindle 1990; Lin 1998; Pantel & Lin 2002). Further examples are Schulte im Walde (2006), who induces verb classes for German purely on the basis of distributional information, and Green, Dorr & Resnik (2004), who induce word classes that are similar in nature to frame-semantic classes by combining evidence from two dictionaries. Prescher, Riezler & Rooth (2000) cluster verb-object pairs to obtain semantic classes. Grenager & Manning (2006) use a structured probabilistic model to induce equivalence classes of arguments across diathesis alternations that resemble PropBank roles.

A major drawback of unsupervised learning methods is that they are incompatible with pre-structuring the domain of semantic classes. This problem is addressed by semi-supervised *bootstrapping approaches*. Here, a small number of initial “seeds” is used to bias the induction of classes towards a desired class structure. Riloff & Jones (1999), Thelen & Riloff (2002) run a pattern-based bootstrapping process to induce semantic classes such as *building*, *human*, *event*, or *weapon*. A major issue in bootstrapping is the acquisition of bad patterns or items, which can “poison” the bootstrapping process. This is usually avoided by confidence-based filtering. In the verbal domain, Miyao & Tsujii (2009) develop a probabilistic supervised model that classifies unseen verbs into the full inventory of VerbNet classes, relying on features extracted from unannotated corpora.

Beyond the level of individual words, surface-oriented acquisition methods may be used to acquire sets of phrases or sentences with similar meanings (“to work for”  $\Leftrightarrow$  “to be employed by”). This task is called *paraphrase acquisition* and can be based on comparable and parallel corpora (Barzilay & Lee 2003; Bannard & Callison-Burch 2005).

The main challenge in learning semantic classes is the large number of different criteria by which items can be grouped. This is indicated by the large number of classifications proposed in the literature (cf. Section 1.). Consequently, there is no unique “correct” classification, which exposes evaluation against any fixed gold standard to criticism.

### Learning semantic relations

We now consider the induction of (binary) semantic relations holding between words or semantic classes, the so-called *relation extraction* task. Traditionally, the focus is on nominal relations such as synonymy, hyponymy/hyperonymy (*is-a*) and meronymy (*part-of*) – the relations also found in WordNet. In the pattern-based tradition, Hearst (1992) has used simple surface patterns to induce *is-a* relations. Girju, Badulescu & Moldovan (2006) use a similar approach for meronymy induction. Ruiz-Casado, Alfonseca & Castells (2005) learn extraction patterns and acquire new lexical relations for enriching WordNet using Wikipedia. A recent development is a broader focus on other lexical relations, such as *causation* in work by Pantel & Pennacchiotti (2006). They also use the lexical relations they induce to extend WordNet. Fine-grained relation extraction (Agichtein & Gravano 2000) and classification (Girju et al. 2009) tends to target increasingly encyclopedic relations such as *content-container*, *part-whole*, and thus approaches the domain of ontology learning (see below).

A related task is the *acquisition of inference rules*, which identifies pairs of words where the second follows from the first (“to snore”  $\Rightarrow$  “to sleep”). Such inference rules can be acquired not only on the lexical level, but also for multi-word expressions and phrases (Lin & Pantel 2001; Pantel et al. 2007; Pekar 2008).

Turney & Littman (2005) go beyond the search for individual relations. They develop models to determine the semantic similarity holding between pairs of relation tuples,

e.g. *mason:stone – carpenter:wood*. This task extends identification of semantic relations to the task of recognising analogies; it requires representations not only of word meaning, but also of relations between words.

### Learning and populating ontologies

Techniques for inducing full-fledged ontologies integrate relation learning with class learning, the two tasks described above. It typically begins with the induction of concepts, which may be instantiated with lexical items. The classes are subsequently structured on the basis of semantic relations. These are initially taxonomic, but are subsequently extended by relational and encyclopedic knowledge.

One possibility is to extend the clustering-based methods for inducing semantic classes described above to induce hierarchical structure (Caraballo 1999). Cimiano, Hotho & Staab (2005) refine this technique by using formal concept analysis, employing predicate-argument relations as contexts. Unfortunately, the induction of hierarchies with clustering techniques multiplies the problems encountered in analysing and evaluating clustering-induced semantic classes. A promising new development is the injection of global consistency constraints into ontology learning, e.g. by enforcing the transitivity of hyponymy (Snow, Jurafsky & Ng 2006).

Knowledge can also be drawn from other sources. Traditionally, this meant machine-readable dictionaries (Nichols et al. 2006). In the last years, the huge growth of Wikipedia has led to a flurry of work on this resource. Ponzetto & Strube (2007) convert the category structure of Wikipedia into a large *is-a* hierarchy. Ruiz-Casado, Alfonseca & Castells (2005) use Wikipedia as a resource for learning patterns for semantic relations and extend WordNet with newly acquired relation instances. Suchanek, Kasneci & Weikum (2008) construct a large-scale ontology that combines WordNet and Wikipedia. Its taxonomy backbone is formed by WordNet and enriched with facts derived from Wikipedia. While these approaches are able to derive large-scale and high-quality ontological resources (when evaluated against other ontologies, or human judgements), they rely on the existence and correctness of such resources as well as the compatibility of their structuring principles with the target ontology.

Learning semantic knowledge from corpora or structured resources such as Wikipedia currently seems to be the most promising way to solve the acquisition bottleneck. It is, however, inherently restricted to the type of knowledge that is directly or indirectly recoverable from textual or semi-structured resources. General world knowledge remains difficult to acquire from text, as it is often too basic to be conveyed explicitly, even in encyclopedic sources such as Wikipedia.

## 3. Multilingual and cross-lingual aspects

The development of comprehensive criteria for semantic classification presents itself as a new challenge for each language. Therefore it seems attractive to start from a monolingual model developed for a given language when developing resources for a new language. However, the structure of a monolingual semantic lexicon is not guaranteed to fit other languages, due to conceptual and lexical differences (cf. article 13 (Matthewson) *Methods in cross-linguistic semantics*). In what follows, we discuss strategies for building semantic lexicons for a growing set of languages, and for dealing with cross-linguistic differences in practice.



### 3.1. Manual multilingual resource development

While some languages (notably English) are fairly well researched, few resources exist for many smaller languages. An important research question is therefore how existing resources in *source* languages (SL) like English can be re-used for efficient development of new *target* languages (TL). Ideally, criteria or even concrete annotation guidelines of the SL can be directly transferred to the TL. This presupposes that the criteria used to structure the SL resource are (at least largely) consistently applicable to other languages. For example, adopting Levin verb classes as structuring principle for a multilingual classification requires that all languages show similar verbal diathesis alternations.

Retaining a tight correspondence between categories and relations across different languages is desirable for another reason: If such correspondences are possible, the design principles evidently capture cross-lingual generalisations. In lexicography, such correspondences allow the study of cross-lingual similarities and differences of lexicalisation patterns (Boas 2005). In NLP, they can be directly exploited for cross-lingual processing, e.g. by translating queries through WordNet synsets or FrameNet classes that relate lexical items across several languages.

The best-known example of parallel lexicon development is WordNet, which has become available for a large number of languages through the EuroWordNet project (Vossen 1998) and the Global WordNet association. Another example is FrameNet, counterparts of which are available or under development for Spanish (Subirats 2009), German (Burchardt et al. 2006), and Japanese (Ohara et al. 2004). PropBank resources are available for Chinese and Korean.

However, the correspondences are rarely, if ever, perfect. There are two strategies how to deal with divergences. EuroWordNet exemplifies *flexible correspondence*. WordNet categories (synsets) are lexical, and therefore tied strongly to individual languages. In EuroWordNet, therefore, resource development in individual languages was largely independent. However, all languages map their synsets onto a so-called “inter-lingual index” (ILI), an unstructured set of language-independent synsets. Specifically, there is an ILI synset for each synset in any of the EuroWordNet languages. However, the links between ILI synsets and synsets of individual languages are not necessarily equivalence (synonymy) links (Peters et al. 1998). For example, the Dutch distinction between “hoofd” (human head) and “kop” (animal head) is mirrored in the existence of two distinct ILI synsets. These ILI synsets are linked to a single English “head” synset by way of a *hypernymy* link. In this manner, the ILI accommodates structural differences between the individual WordNets.

In contrast, work on FrameNets for new TLs attempts to retain *direct correspondence*, since the categories under consideration, schematised situations, lend themselves more readily to cross-lingual generalisation. Consequently, the structure of FrameNet was used as an initial starting point for most other projects, which restricts the work for new TLs to the assignment of lexical items to pre-defined frames and the collection of examples. Problems arise from FrameNet’s assumption that frames are evoked lexically. Figure 110.5 shows an example of a cross-lingual difference in the granularity of lexicalisation. In English FrameNet, the distinction between *driving* a vehicle (as a driver) and *riding* a vehicle (as passenger) was codified in the form of two frames: *Operate\_Vehicle* and *Ride\_Vehicle*. In German, however, this distinction is not clearly lexicalised: the verb *fahren* can express both situations and cannot be assigned straightforwardly to one of

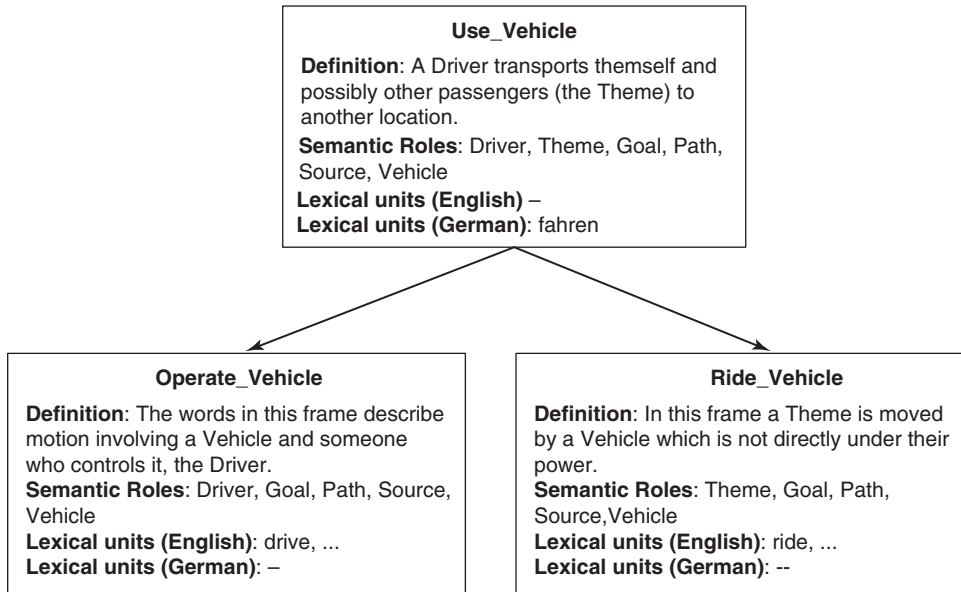


Fig. 110.5: Example for a cross-lingual divergence (German/English) in FrameNet

the two frames. This situation was resolved by introducing a common superframe, *Use\_Vehicle*.

More difficult to amend are general differences in argument realisation patterns between languages (such as differences in the argument incorporation of motion verbs between Romance and Germanic languages). Since in such cases establishing direct correspondence has undesirable consequences, the multilingual FrameNet initiative has decided to revert to an ILI-like flexible mapping when necessary.

### 3.2. Cross-lingual resource acquisition

For many languages, manual resource development is not an option at all. Thus, current research investigates techniques for cross-lingual resource induction to automate this process as completely as possible.

A first straightforward method is to use an existing *bilingual dictionary* to “translate” a SL resource into a TL resource. This method does not have any linguistic context at its disposal, other than the information encoded in the dictionary. Therefore, it requires (i) a high degree of correspondence on the lexical level between the two languages, and (ii) high-quality sense disambiguation for the selection of appropriate translation pairs from the dictionary. Fung & Chen (2004) construct a Chinese frame-semantic predicate classification by mapping English FrameNet entries onto Chinese using two bilingual dictionaries, with a subsequent monolingual disambiguation step, and obtain a high accuracy. While bilingual dictionaries developed for human users are often inconsistent and lack quantitative information, they can also be induced from corpora and used to induce selectional preference information for TLs (Peirsman & Padó 2010).

A second method is the use of *parallel corpora* in a three-step method called *annotation projection* (Yarowsky, Ngai & Wicentowski 2001). In Step 1, the SL side of a parallel corpus is labeled automatically, using the available SL resources. In Step 2, the SL annotations are transferred to the TL, on the basis of automatically induced word alignments. In Step 3, the TL annotations can serve as input either for lexicon creation, as described in Section 2.3., or as training data for new TL labelers. As Resnik (2004) observes, projection can be understood as reducing an unsupervised setting to a supervised setting, in which the TL labels are provided by the SL via word alignment. The validity of the TL labels relies on the so-called “direct correspondence assumption” (Hwa et al. 2002) – namely, that the semantic annotation of a source expression is also valid for its translation in the parallel corpus. This is an issue in particular for structural annotations, such as dependency relations or morphological information, but can be alleviated with filtering. A factor that can greatly affect the quality of target annotations are errors in the word alignments underlying projection. Here, a useful strategy is the exploitation of data redundancy and robust learning methods (Spreyer & Kuhn 2009). Annotation projection has been applied to various semantic phenomena, such as word sense (Bentivogli & Pianta 2005), frame-semantic information (Padó & Lapata 2009), temporal annotation (Spreyer & Frank 2008), or Information Extraction (Riloff, Schafer & Yarowsky 2002).

#### 4. Interfaces and interoperability

The most widely used semantic lexicons in computational semantics concentrate on some well-defined aspect of meaning. For practical purposes, it is therefore often necessary to combine information from several resources. The three most common scenarios are linking semantic lexicons to other levels of description such as syntax or ontologies; the combination of different semantic lexicons; and the combination of general-vocabulary lexicons with domain-specific ones. While these tasks share a number of concerns, such as the compatibility of design principles and granularity issues, each of them poses its own specific challenges.

*Interfaces to morphosyntax.* Using a semantic lexicon for tagging free text with classes or senses usually involves part-of-speech tagging and lemmatisation. Morphological analysis may be required for specific semantic properties, for example tense and aspect for temporal analysis. This step can exploit a large body of work on standardisation (e.g. of tagsets), and divergences between the encodings used in the underlying processors and the coding scheme of a given semantic lexicon are usually easy to resolve. More intricate is the definition of interfaces between syntactic structure and semantic roles in predicate-argument structures. Both symbolic (rule-based) and statistical (feature-driven) interfaces to semantic lexicons need to associate syntactic structures obtained from parsing with their corresponding semantic roles (i.e., linking properties). Currently available parsers deliver constituent- or dependency-based structures, using a wide spectrum of categories and structure-building principles. Therefore, explicit mappings need to be defined between parser output and the syntactic representation used in the lexicon. Here, omission or misclassification of syntactic properties can constitute a serious obstacle for the use of semantic lexicons. Problems of this kind have been addressed in the extraction of lexical resources from PropBank and German FrameNet lexicons from annotated corpora (Babko-Malaya et al. 2006; Burchardt et al. 2008).

*Interfaces to other semantic lexicons.* The coverage of lexical semantic resources that exist for English today is impressive, but when processing free text we are still likely to encounter gaps. This is particularly true for lexicons encoding predicate-argument structure, whose deeper descriptions usually suffer from limited coverage.

This situation has engendered considerable interest in combining and integrating semantic lexicons. Most of the work pursued fully automatic strategies. For example, Sem-Link (Loper, Yi & Palmer 2007) provides a mapping between VerbNet, PropBank and FrameNet. Often, interest in the mappings is motivated by a particular application: Crouch & King's (2005) Unified Lexicon maps natural language onto a knowledge representation; the goal of Giuglea & Moschitti (2006) and Shi & Mihalcea (2005) is more robust semantic role assignment.

Current approaches rely almost exclusively on simple heuristics to establish inter-resource mappings, such as overlap in verbs between classes, or agreement of verbs on selectional preferences. While the resulting mappings are beneficial for practical purposes, these heuristics cannot deal well with fundamental design differences between resources (such as granularity or the focus on syntactic vs. semantic criteria). Such design differences can be bridged by detailed analysis (Čulo et al. 2008), but appears to be outside the scope of automatic methods.

*Interfaces to ontologies.* As discussed earlier, semantic lexicons need to be distinguished from ontological resources. Many NLP tasks, however, can benefit from the inclusion of a formal ontology, e.g. as a basis for inference, or as a repository for automatically acquired factual knowledge, as in Information Extraction or Question Answering tasks (Huang et al. 2010).

An explicit mapping has been manually defined between the English WordNet and the SUMO ontology (Niles & Pease 2003). Mismatches in granularity are covered by explicitly marking non-isomorphic correspondences. A method developed in Spohr (2008) makes it possible to extend this mapping automatically to other languages in EuroWordNet.

Among the largest horizontally and vertically connected resources is the Omega ontology (Philpot, Hovy & Pantel 2010). It integrates the WordNet, VerbNet, FrameNet and LCS lexical resources with a number of upper model ontologies (Hovy et al. 2006). In view of the special needs of NLP applications and given the problems encountered in the alignment of independently developed resources, the OntoNotes project (Pradhan et al. 2007) now undertakes a large *integrated multi-level corpus annotation project* as a basis for corpus-based semantic processing: annotations cover word sense, predicate-argument structure, ontology linking and co-reference relations and are tailored to allow rapid but reliable annotation practice with semi-automatic support for validation.

*Interfaces between general and domain-specific resources.* The development of NLP applications (e.g., for the natural or social sciences) can involve the creation of domain-specific lexical semantic resources, such as lexicons of medical procedures (Fellbaum, Hahn & Smith 2006) or soccer terms (Schmidt 2006). A major challenge lies in the integration of these specific lexicons with existing generic linguistic resources. Particularly striking are changes in syntactic and semantic properties that can affect general vocabulary items when used in a special domain. Verbs, for example, can show exceptional subcategorisation properties and meanings (e.g. the German *verwandeln* (*to convert*) with exceptional intransitive use in a soccer context for the special meaning “to turn into a goal”). Similar problems arise at other levels: the use of ontologies requires techniques for interfacing general and domain-specific

ontologies. The problem of matching and aligning ontologies automatically is the subject of intensive research in Web Semantics (see article 111 (Buitelaar) *Web Semantics*).

Thus, domain-specific texts require adapted models for parsing, ambiguity resolution as well as special handling in semantic lexicons and their mapping to ontologies. On the other hand, closed domains can also facilitate tasks such as the heuristic selection of word sense (Koeling, McCarthy & Carroll 2005).

*Community efforts for standardisation and interoperability.* In response to such problems, techniques for supporting the standardisation of language resources have been discussed and developed for a considerable time, as in the EAGLES initiative. With developing W3C standards, advanced representation models are being proposed to achieve interoperability across different representation frameworks for language resources (Francopoulo et al. 2006). Recent community efforts work towards ISO-standards for language resources (e.g. in LIRICS). Large community projects are developing resource infrastructures to support interoperability and exchange of resources at a large scale (e.g. CLARIN, FLReNet; see Calzolari 2008). These projects provide a solid *formal* base for data exchange; agreement on standards for the represented *content* remains a more difficult endeavour.

## 5. Conclusion and outlook

Natural language processing has seen tremendous achievements in the last decade through the development of a range of large-scale lexical semantic resources. As we have shown, most theoretical frameworks for describing the meaning of words have found their way into lexicon resources, to different degrees and in various combinations.

The creation of WordNet, despite its limitations, can be considered a success story that has engendered stimulating research and advances in semantic processing, comparable to the effect that the Penn Treebank had in the area of syntactic processing. A key role for its feasibility and success was its concentration on a simple relational model of lexical meaning. This allowed rapid development to a sizable resource and offers flexible means for deployment in practical semantic NLP tasks. Its intuitive structure also prepared the ground for developing a multilingual EuroWordNet in a linguistically motivated and computationally transparent architecture. The practical use of such resources is greatly enhanced by the parallel creation of annotated corpora as a basis for induction of automatic annotation and disambiguation components.

Virtually all recent major resource creation efforts, such as FrameNet, PropBank and VerbNet, have adopted the methodological aspects of WordNet and its follow-up projects: (i) concentration on the encoding of a coherent, focused aspect of lexical meaning; (ii) empirical grounding, by using data-driven acquisition methods and providing annotated data for corpus-based learning, and (iii) horizontal multilingual extension, building on experiences gained in 'pilot' languages.

Still, the enormous efforts required for creating more complex lexicons such as VerbNet and FrameNet clearly show that the semantic resource acquisition bottleneck is far from being solved. And while some may still nourish hopes that one day 'the' ultimate, unified semantic theory of the lexicon will be reached, only the tip of the iceberg formed by semantic phenomena has been uncovered.

Largely unexplored is in particular the area of non-compositional lexical semantic phenomena (idioms and support constructions, metaphors) and to what extent they can

be integrated with existing semantic lexicons. The situation is similar for the acquisition and integration of lexicons for specific domains. Another issue are fine-grained meaning differences, which are especially important for language generation tasks. These are far from being covered by today's semantic descriptive inventories (Inkpen & Hirst 2006).

Today, we observe three major research directions: (i) the rapid creation of multilingual semantic resources using cross-lingual techniques, capitalising on carefully built existing monolingual resources, (ii) the automated induction of semantic knowledge in monolingual settings, through corpus-based induction methods, and (iii) the integration of complementary semantic lexicons and annotated corpora, both horizontally and vertically, into coherent and interoperable resources.

Statistical, data-driven induction of semantic knowledge is a promising step towards the automation of semantic knowledge acquisition. This area of research is novel and comparatively unexplored, and its methods are faced with the core problems of semantics, in particular the structuring of the semantic space into classes and relations and the identification of salient meaning components. These are challenging decisions even for humans; in addition, corpus-based methods reach their limits when it comes to uncovering deeper aspects of semantic knowledge that cannot be derived from surface phenomena and quantitative analysis. As a result, automatic resource induction is typically used in a semi-automatic fashion that integrates human judgements.

In view of these limitations, novel forms of semantic resource acquisition are being explored that build on collaboratively, human-built resources, folksonomies such as Wikipedia, or specially designed annotation tasks (cf. article 111 (Buitelaar) *Web Semantics*). Structured and unstructured information from Wikipedia can be used for harvesting semantic resources, from taxonomies to ontological attributes and relations. However, Wikipedia's focus is on encyclopedic information rather than lexical semantic information. A new trend builds non-expert contributions for targeted types of knowledge: translation, semantic tagging, etc., using game-like scenarios or Amazon's Mechanical Turk platform.

The move to corpus-based techniques has led to a big momentum and growth in lexical semantic resource building, and approximate methods for using them are well established in natural language processing. But the need for accurate semantic processing persists. More accurate semantic analysis will be needed for tasks that require high precision and that cannot exploit data redundancy. Examples are applications in the areas of knowledge-based natural language understanding and human-machine interaction.

*We thank Rainer Osswald and Alexander Koller for comments and Antonina Werthmann for editorial support.*

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Anette Frank, Heidelberg (Germany)  
Sebastian Padó, Heidelberg (Germany)

## 111. Web semantics

1. Introduction
2. The Semantic Web
3. Explicit web semantics
4. Implicit web semantics
5. Conclusions
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### Abstract

*This article presents an overview of web semantics, i.e., the use and study of semantics in the context of the Web. We differentiate between explicit web semantics, building on Semantic Web standards for web-based knowledge representation (ontologies) and reasoning, and implicit web semantics, building on text and link mining from web resources.*

### 1. Introduction

This article presents an overview of the emerging field of *web semantics*, divided into *explicit* and *implicit* web semantics.

*Explicit web semantics* is discussed in the context of the Semantic Web, which is fundamentally based on the formal interpretation of web objects (documents, databases, images, etc.) according to an ontology. Web objects are therefore provided with knowledge

markup, i.e., semantically annotated with formally defined ontology classes and/or relations, on the basis of which ontology instances can be extracted. Knowledge markup of textual data relies on information extraction based on shallow or deep linguistic analysis.

*Implicit web semantics* originates from the analysis of information that is available in web objects in combination with the connecting structures of these web objects. This work uses methods based on data mining (i.e., text and web mining) to explore the network of web links and natural language references between documents (and other web objects) and to derive some level of semantic interpretation from this, e.g., by grouping or otherwise relating documents, extracted terms, or named entities. Work on web mining has been boosted recently by the emerging infrastructure of user defined tags as developing in the context of blogs, wikis and web communities.

## 2. The Semantic Web

The Semantic Web is a vision of a future version of the World Wide Web, in which all web-based knowledge is encoded in an explicit, formal way to allow for increasingly intelligent and therefore autonomous artificial agents as discussed by Berners-Lee, Hendler & Lassila (2001).

The Semantic Web idea implies the definition of formal, web-based ontologies to express the knowledge that is understood by humans as well as agents, and knowledge markup of web documents and databases according to these ontologies.

It is to be expected that over the next decade the knowledge structures of many application domains will be formally encoded in web-based ontologies, which will have a considerable impact on the sharing and use of expert knowledge within a wider community.

### 2.1. Realizing the Semantic Web

The Semantic Web has its origins in the application of knowledge representation languages to the annotation of web documents with semantic metadata. One of the earliest approaches to this is SHOE (Simple HTML Ontology Extensions) as described by Heflin, Hendler & Luke (1999).

SHOE is a knowledge representation language designed specifically for the web, which means that it “exists in a distributed environment with little central control” and therefore “treats assertions as claims being made by specific instances instead of facts to gather and intern as generally-recognized truth”.

This is also an important aspect of the Semantic Web in general. In contrast to much of the previous work on Artificial Intelligence, the Semantic Web deals with an object of study that is very large, describes an ‘open world’ and is inherently dynamic.

Another aspect of the SHOE language that has been taken up in further development of the Semantic Web concerns syntax. As HTML and XML were already established languages on the Web, the syntax of SHOE was defined first in HTML and soon after in XML.

SHOE was a forerunner of the currently predominant Semantic Web representation languages RDF (Resource Description Framework – see <http://www.w3.org/RDF/>)

and OWL (Web Ontology Language – see <http://www.w3.org/TR/owl-ref/>). OWL in particular allows for the definition of full ontologies – formal representation of entity classes, relationships between them and rules and axioms that guide what kind of assertions can be made and inferences drawn – as well as ontology instances that can be defined over web objects according to indicated ontologies.

The standardization of RDF and OWL allows for an easy exchange of web-based ontologies and instance collections as a growing number of tools become available for analyzing, indexing and otherwise handling such data, which eventually may lead to a realization of the Semantic Web vision of full and automatic access to all available knowledge.

Ontologies and how they are used in representing the meaning of web objects will be explained in more detail in the next section. For now it is important to note that ontologies as well as instances, i.e., individual assertions, are web objects themselves and therefore have a unique identity according to the URI (Uniform Resource Identifier) protocol that guides the Internet as a whole and also the Semantic Web.

URIs are therefore also at the basis of the so-called *semantic web layer cake* of increasingly more powerful representation layers that need to be developed and installed in order to realize the Semantic Web – see Fig. 111.1 below.

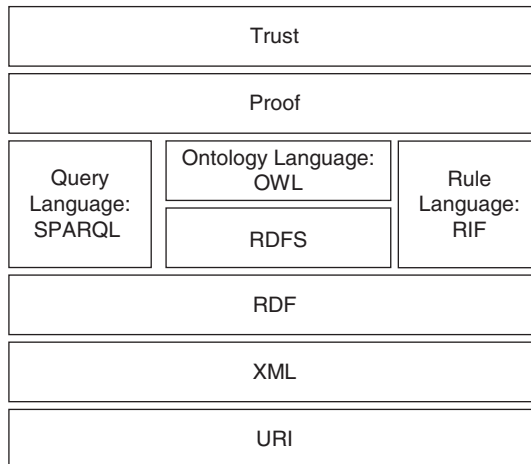


Fig. 111.1: Semantic web layer cake

These layers involve the definition of entity classes and relations using RDF or OWL (based on URIs and XML), of rules and axioms using the rule language RIF and of queries using the query language SPARQL.

On top of this the Semantic Web needs to have a layer of ‘proof’ and ‘trust’ by which assertions can be formally verified and traced to their originators.

## 2.2. Current status of the Semantic Web

The Semantic Web can be viewed from different directions: as a research project that aims at adding semantics to the web, as a set of Internet standards that implement the



layers of the Semantic web layer cake, or as the accumulation of actual Semantic Web objects, i.e., web-based ontologies and ontology instances.

In fact it is probably most instructive to look at the Semantic Web from the last point of view, i.e., in terms of its size. For this purpose we can for instance consult the semantic web search engine Swoogle, which keeps track of RDF and OWL web documents that are being published on the Internet – see Ding et al. (2004) and the Swoogle website at <http://swoogle.umbc.edu/>.

Currently (February 2008), Swoogle reports to have collected almost 2,5 million of such documents, out of which however about half were valid RDF or OWL documents. Perhaps more interestingly however, Swoogle also reports that from these 1 million documents a total number of about 580 million separate simple facts could be extracted, each of which takes the form of a so-called *triple* between a *subject*, a *predicate* and an *object* to which the subject is connected.

For instance, the fact that there is a web document with URL <http://www.dfki.de> that describes DFKI which is located in Saarbrücken can be defined by three triples over the abstract node resource-1 as *subject*:

- ‘URL’ as *predicate* with string ‘<http://www.dfki.de>’ as *object*
- ‘name’ as *predicate* with string ‘DFKI GmbH’ as *object*
- ‘location’ as *predicate* with string ‘Saarbrücken’ as *object*

Another source of information on the number of ontologies that have been published on and can be accessed from the Semantic Web is OntoSelect, an ontology library that collects, analyzes and organizes ontologies that have been published on the Internet – see Buitelaar, Eigner & Declerck (2004), Buitelaar & Eigner (2008) and the OntoSelect website at <http://olp.dfki.de/OntoSelect/>.

OntoSelect allows browsing of currently (February 2008) over 1600 ontologies according to size (number of classes, properties), representation format (DAML, RDFS,

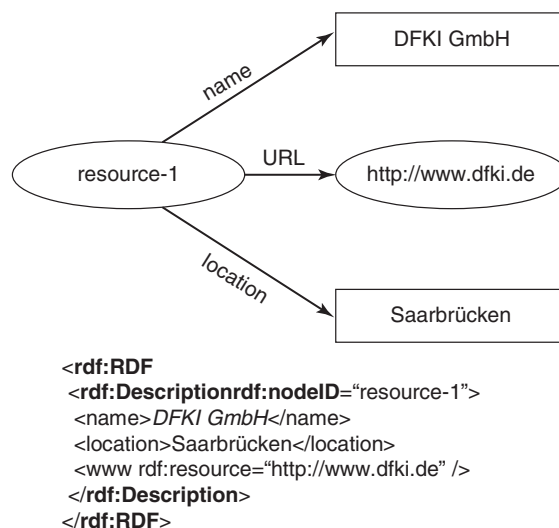


Fig. 111.2: Example of RDF triples

OWL-Lite/DL/Full), connectedness (score over the number of included and referring ontologies) and human languages used for class and property labels.

The distribution of human languages across ontologies on the web is given in Tab. 111.1 below. The advance of English over other languages is not surprising as most ontologies still originate from English speaking countries although some start to appear with labels also in other languages, primarily German, French, Spanish and Portuguese.

Tab. 111.1: Distribution of languages across ontologies on the web (based on OntoSelect)

| <i>Language</i> | <i>Percentage of Ontologies with Labels<br/>in this Language</i> |
|-----------------|------------------------------------------------------------------|
| English         | 71.0 %                                                           |
| German          | 11.5 %                                                           |
| French          | 6.0 %                                                            |
| Spanish         | 3.7 %                                                            |
| Portuguese      | 3.2 %                                                            |
| other           | 4.6 %                                                            |

In summary, the Semantic Web is still in an early stage but already a large number of formally defined facts (ontology instances) and models (ontologies) for interpreting these facts are available online.

### 3. Explicit web semantics

The vision of the Semantic Web is to turn the current Web of documents and data into a Web of formally defined knowledge – see for instance Berners-Lee, Hendler & Lassila (2001), Fensel et al. (2002). Ontologies play a central role in this vision and we will therefore consider them in more detail in this section. In particular, we will discuss the knowledge representation languages that have been proposed for defining web-based ontologies, the development and evolution of ontologies and the link between ontologies and the lexicon.

An ontology is an explicit, formal specification of a shared conceptualization of a domain of interest as defined by Gruber (1994), where “formal” implies that the ontology should be machine-readable and “shared” that it is accepted by a group or community. Further, it should be restricted to a given domain of interest and therefore model concepts and relations that are relevant to a particular task or application domain.

Ontologies formalize the intensional aspects of a domain, whereas the extensional part is provided by a knowledge base that contains assertions about instances of concepts and relations as defined by the ontology.

#### 3.1. Knowledge representation for ontologies

The history of web-based knowledge representation languages can be outlined as follows – based on Horrocks & Patel-Schneider (2003).

RDFS was first proposed as an XML-based knowledge representation language with which web-based ontologies could be defined. With RDFS one can define classes and

properties (binary relations), range and domain constraints (on properties), and subclass and sub-property (subsumption) relations. RDFS is, however, limited in expressive power. For example, with RDFS it is not possible to define if properties are functional or transitive or to describe classes in terms of the properties of their individuals.

Such limitations led to the development of further, more expressive web-based knowledge representation languages such as OIL (Fensel et al. 2000, 2001), and two languages based on the Darpa Agent Markup Language (DAML – see Hendler & McGuinness 2000): DAMLONT (McGuinness et al. 2002) and DAML+OIL (Horrocks 2002). DAML+OIL was subsequently used as a basis for the W3C web ontology language OWL.

OWL uses the same syntax as RDF (and RDFS), e.g., *rdfs:subClassOf* to assert subclass relationships. OWL-specific classes and properties, expressed as combinations of RDF syntactic constructs, are used to extend RDFS functionality, e.g., the *owl:complementOf* property is used to add class complementation.

The semantics of OWL is based on Description Logic (Baader et al. 2002; Horrocks, Patel-Schneider & van Harmelen 2003), whereas the semantics of RDFS are given by a non-standard model theory, where individuals, classes and properties are all elements in the domain, property elements have extensions which are binary relations on the domain, and class extensions are only implicitly defined by the extension of the *rdf:type* property.

OWL is a layered language with three versions: Lite, DL and Full.

OWL Full uses all of the OWL language primitives and is syntactically and semantically upward-compatible with RDF/S. It is however undecidable and therefore does not allow for complete (or efficient) reasoning support.

OWL DL (Description Logic) is a sublanguage of OWL Full that restricts application of the constructors from OWL and RDFS. Therefore it corresponds to a well studied description logic that permits efficient reasoning support. On the other hand we lose however full compatibility with RDF/S.

OWL Lite even further restricts OWL DL to a subset of language constructors, e.g., excluding enumerated classes, disjointness statements, and arbitrary cardinality. The

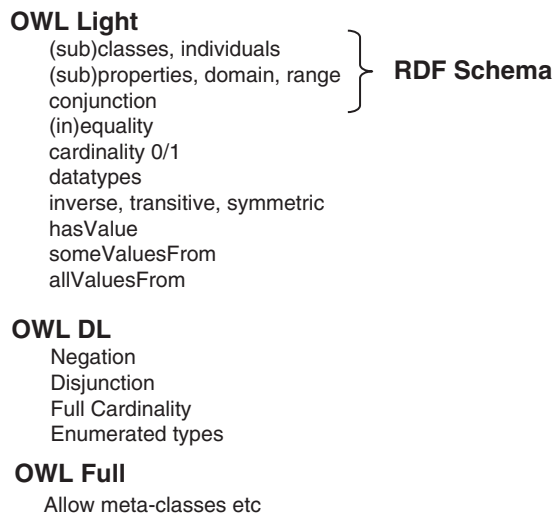


Fig. 111.3: Language constructs in RDFS and OWL

advantage would be that it is easier to understand and implement, although it is much less expressive than OWL Full or OWL DL.

An overview of knowledge representation constructs in RDFS and the three OWL versions can be summarized as follows:

### 3.2. Ontology development

Ontology development is primarily concerned with the definition of classes and class properties, which may include relations between classes. (In OWL this distinction can be expressed by use of *owl:dataProperty* for the former vs. *owl:objectProperty* for the latter.) An ontology thus consists of classes that are organized by way of a taxonomy backbone (is-a relation) and other, non-hierarchical relations. Constraints on classes and relations between classes can be expressed through general and domain-specific axioms. Finally, in order to derive facts that are not explicitly encoded by the ontology but could be derived from it, an ontology may include also (domain-specific) rules that allow for such derivations.

Ontology development can be supported by ontology editing tools, of which Protégé (<http://protege.stanford.edu/>) is the most well known – see for instance Noy et al. (2001). Protégé provides graphical support for the definition of classes, properties and instances and includes a number of so-called PlugIns for visualization, consistency checking and other applications. Importantly, Protégé also includes a Plug-In for the editing of OWL-based ontologies – see Knublauch et al (2004). Other tools for ontology development exist but most of these are commercial whereas Protégé is freely available for research purposes.

### 3.3. Ontology learning

Ontologies define the semantics of a particular domain at a particular point of time and in a particular context. However, as domains change over time and can be viewed differently depending on application, ontologies need to evolve as well, as for instance with ontologies that model the rapidly developing biomedical domain. For this purpose a number of researchers have started developing *ontology learning* methods for the automatic extraction of ontological knowledge from data, primarily from text – see for instance Maedche (2002), Gomez-Perez & Manzano-Macho (2003), Shamsfard & Barforoush (2003), Buitelaar, Cimiano & Magnini (2005), Buitelaar & Cimiano (2008).

A large collection of methods for ontology learning from text have developed over recent years as witnessed by the growing number of publications in this area. Unfortunately, there is not much consensus within the ontology learning community on the exact task they are concerned with, which makes a comparison of approaches difficult. In order to estimate the state-of-the-art in ontology learning Buitelaar, Cimiano & Magnini (2005), Cimiano (2006) established an overview of the subtasks that together constitute the complex task of ontology development (either manual or with any level of automatic support).

Ontology development is primarily concerned with the definition of concepts and relations between them, but connected to this also knowledge about the symbols that are used to refer to them. In our case this implies the acquisition of linguistic knowledge about the terms that are used to refer to a specific concept in text and possible synonyms of these terms.

An ontology further consists of a taxonomy backbone (is-a relation) and other, non-hierarchical relations. Finally, in order to derive also facts that are not explicitly encoded by the ontology but could be derived from it, also rules should be defined (and if possible acquired) that allow for such derivations.

All of these aspects of ontology development can be organized in a layer cake of increasingly complex subtasks, as illustrated in Fig. 111.4 below. The example shows the defined knowledge for the concept *disease* and related concepts, i.e., the terms that can be used to refer to or associated with *disease* – also for languages different than English, the taxonomic relation of the concept *doctor* with *person*, a non-hierarchical relation between *doctor* and *disease*, and a rule that can be defined over the *person* and *disease* concepts.

Tab. 111.2: Ontology learning layer cake

|                  |                                                                         |
|------------------|-------------------------------------------------------------------------|
| Axioms & Rules   | $\forall x, y \text{ (suffer From (x,y) } \rightarrow \text{ ill (x))}$ |
| Relations        | cure (domain:Doctor, range:Disease)                                     |
| Concept Taxonomy | is_a (Doctor, Person)                                                   |
| Concepts         | Disease:=<I, E, L>                                                      |
| Synonyms         | {disease, illness}                                                      |
| Terms            | disease, illness, hospital                                              |

### 3.4. Ontology selection

As the Semantic Web continues to grow in terms of developed and published ontologies, it will become much easier to *find* rather than *construct* an appropriate ontology for a particular application. On the other hand, as more and more ontologies become available to choose from it is correspondingly hard to find the best ontology.

Until very recently the solution to this problem was supposed to be handled by foundational ontology libraries as discussed by van Heijst, Schreiber & Wielinga (1997). However, in recent years web-based services like SWOOGLE and OntoSelect have been developed that enable a more data-driven approach to ontology search and retrieval. An important aspect of these services is the ranking of retrieved ontologies relative to a query keyword, or in the case of OntoSelect, a query document.

A web-based ontology, defined in RDFS or OWL, is in many respects just another web document that can be indexed, stored and retrieved. On the other hand, an ontology is a highly structured document with possibly explicit semantic links to other ontologies that are to be addressed by specific measures, e.g., Alani, Brewster & Shadbolt (2006) describe the following measures: “Class Match” (coverage of ontology class names occurring also as search terms in the ontology selection search query), “Density” (the number of links between classes, indicating the depth of knowledge represented by the ontology), “Semantic Similarity” (a measure of similarity between the link structures around classes) and “Betweenness” (a measure of the number of links that go through each class). These last two measures are based on the assumption that ontologies are well-structured with equal semantic balance throughout all constitutive parts, which unfortunately is only seldom the case.

Another set of measures or rather criteria for ontology ranking and selection has been proposed by Sabou, Lopez & Motta (2006). The focus here is more on the application of

ranked/selected ontologies and therefore includes such criteria as “Modularization” (Can retrieved ontologies be split up in useful modules?), “Returning ontology combinations” (Can retrieved ontologies be used in combination?) and “Dealing with instances” (Do retrieved ontologies include instances as well as classes/properties?) next to more standard measures such as coverage.

### 3.5. Ontologies and the lexicon

A lexicon represents different interpretations of words with senses. A sense represents the semantics of a word, very much like a class definition in an ontology. In fact, semantic lexicons such as WordNet are semi-formalized dictionaries that group words into classes (i.e., synsets or senses) for which we can give formal definitions. In this way, semantic lexicons are the reverse of ontologies in that they assign one or more classes (i.e., senses) to a given word, whereas ontologies assign labels (i.e., words or more complex terms) to a given class.

Given these assumptions we may thus view the collection of ontologies on the Semantic Web as a large, distributed semantic lexicon, in which we can look up the meaning of words, just as in a regular dictionary. Consider for instance the meaning of *director* as provided by the following two ontologies.

In the AgentCities ontology a *director* is of class “Role” that somebody can assume. Unfortunately, the ontology provides no additional information on what constitutes a “Role”, but simply assigns it as a super-class to the “Director” class as well as to the “Actor” and “Playwright” classes. From this information we may infer something about the meaning of *director*, namely that it is something similar to being an *actor* and a *playwright* but not much more.

```
(1)      <daml:Class rdf:ID = "Director">
          <rdfs:label>Director</rdfs:label>
          <rdfs:subClassOf>
            <daml:Class rdf:about = "#Role"/>
          </rdfs:subClassOf>
        </daml:Class>
```

A more informative definition for a different sense of *director* is provided by the University Benchmark ontology, which defines *director* of class “Director” with super-class “Person” that has the property “headOf” with a value of class “Program”. As the ontology further defines the class “Program” as a sub-class of “Organization”, we may infer that *director* in this sense of the word refers to a *person* who is the *head* of a specific type of *organization*, i.e., a *program*.

```
(2)      <owl:Class rdf:ID = "Director">
          <rdfs:label>director</rdfs:label>
          <owl:intersectionOf
            rdf:parseType = "Collection">
            <owl:Class rdf:about = "#Person"/>
          </owl:intersectionOf>
          <owl:Restriction>
            <owl:onProperty
              rdf:resource = "#headOf"/>
```

```

<owl:someValuesFrom>
  <owl:Class rdf:about = "#Program"/>
  </owl:someValuesFrom>
</owl:Restriction>
</owl:intersectionOf>
</owl:Class>

```

However, to allow for the application of ontologies in natural language processing (NLP) applications such as semantic annotation and ontology-based information extraction (see below), a richer linguistic representation is needed of domain terms, their synonyms and multilingual variants. Currently, such information is mostly missing, or represented only in an impoverished way (using RDFS Label).

To allow for a richer representation of linguistic information in a domain ontology, Buitelaar, Sintek & Kiesel (2006) developed a lexicon model for ontologies, LingInfo, which was further developed by Buitelaar, Cimiano, Haase & Sintek (2009) into LexInfo (see <http://lexinfo.net/>), a principled and formal model for associating linguistic information to ontology elements (classes, properties) with respect to any level of linguistic description and expressivity. The main characteristic of LexInfo is that it allows for a declarative representation of linguistic information on ontology elements, such that this information is reusable across ontology-based NLP systems.

The current situation is that one needs to establish this information anew for each ontology-based NLP system and for each ontology that such a system supports. This is clearly undesirable as it does not allow for a distribution of effort. Instead, a clear modularization of tasks, i.e., separating the creation of lexica from their usage in a particular ontology-based NLP system, would allow for the creation and sharing of lexicons independent of but usable with different ontologies. To realize this vision, LexInfo provides a declarative model for representing such an “ontology-lexicon”.

### 3.6. Ontology-based information extraction

Semantic annotation or ‘knowledge markup’ of textual data is based on the employment of task- and domain-specific ontologies, thesauri or other semantic resources for enriching this *data* with semantic *metadata* that annotate text segments (names, terms, sentences, paragraphs, images, etc.) with their semantic interpretation.

If knowledge markup is based on a formally defined ontology that describes a knowledge base model, the markup process in effect extracts information from available data to populate a knowledge base of facts (named entities, concepts, events) according to the ontology, a process that is also referred to as ‘ontology population’.

The current state-of-the-art in knowledge markup is still largely based on manual data processing, in which domain experts manually tag documents or sections of documents with ontology classes – for an overview see Handschuh & Staab (2003). Alternatively, a knowledge markup system may employ language technology and machine learning tools for the automatic mapping of text segments to ontology classes.

The knowledge markup process in effect will extract information from the textual data to generate a knowledge base of facts as defined by the corresponding ontology. Information extraction consists of a number of steps that will incrementally build on the recognition of basic semantic units and semantic relations between them.

An important first step is named-entity recognition, which is mostly restricted to a small set of non-interrelated and non-formally represented entity classes, e.g., “person”, “location”, “date”, “organization”. However, especially in technical domains much larger sets of entity classes are used based on domain ontologies, as used for instance by Reidsma et al. (2003) in sports video annotation, Rebholz-Schuhmann & Kirsch (2004) in the biomedical field, Saggion et al. (2007) in business intelligence.

A related step is the identification of relevant concepts in the text. For this purpose, terms that are indicators for such concepts need to be extracted and semantically classified, i.e., mapped to ontology classes that define the concepts. Semantic tagging has been mostly implemented by use of Wordnet for English or of wordnets for other languages. However, for knowledge markup in technical domains, terms are to be tagged primarily with ontology classes from relevant ontologies as indicated above.

A final step is the identification of events, which may involve several concepts and/or named-entities and which are expressed by relations between them. In traditional information extraction, events have been mostly defined by so-called ‘templates’: a small number of relations between relevant concepts and/or named-entities that are to be filled by analysis of available data (see Cowie & Wilks 2000).

Obviously, if such templates are expressed in a formally defined knowledge representation and markup language such as RDFS or OWL, they roughly correspond to an ontologically defined class with its properties. This brings together the information extraction tradition – see e.g., Cowie & Lehnert (1996) – with the knowledge representation and reasoning traditions – see e.g., Sowa (2000), both of which will play an increasingly important role in the future of web semantics and in the study of linguistic meaning in general.

## 4. Implicit web semantics

Ontologies and ontology-based information extraction as discussed in the previous sections are based on the formal and explicit definition of meaning, e.g., by use of RDFS or OWL.

Other routes in web semantics are however taken as well, i.e., by:

- User-defined semantics: annotation of data with keywords without formal definition
- Emergent semantics: induction of recurring patterns across large data sets of linked web data

### 4.1. User-defined semantics

With the advent of so-called ‘Web 2.0’ sites, allowing web users to publish their pictures, videos, stories, etc. on the web, these users started to annotate their published items with keywords, mostly by free association. Over time, such keywords were referred to as tags and the process as ‘collaborative tagging’, ‘social tagging’ or ‘folksonomy’ (coined by van der Wal 2004) to highlight the connection of this non-expert or ‘folk-based’ indexing with taxonomies as used by indexing experts.

Another route in user defined semantics is the collaborative compilation of dictionary and encyclopedia entries as done in the context of Wikipedia (<http://www.wikipedia.org/>), Wiktionary (<http://www.wiktionary.org/>) and similar initiatives. Such resources provide a



wealth of open-access (lexical) semantic information that can be exploited in NLP applications – see for instance Strube & Ponzetto (2006) who derive a large-scale taxonomy from Wikipedia that they then use to compute semantic similarities between words, e.g., for use in word sense disambiguation and co-reference resolution.

## 4.2. Emergent semantics

Probably the furthest removed from traditional study of linguistic meaning is the idea of *emergent semantics*, which is based on the induction of recurring patterns across large data sets. An example of such patterns is the analysis of so-called ‘social networks’ between (web) users based on the data they produce and access (see for instance Wassermann & Faust 1994).

Social network analysis is based on web mining, i.e., the analysis of which web document is connected to which others, assigning weights to heavily used connections and thereby bringing in the web user. Web mining in turn is based on the use of data mining methods as developed originally for finding regularly occurring patterns in databases.

Through a combination of web mining with NLP, in particular text classification and information extraction, social network analysis systems are now able to derive not only networks of web users but also of concepts as used in web documents.

This opens the way to so-called ‘emergent semantics’, i.e., the definition of meaning based on (web) use, i.e., words and expressions in general deriving their meaning from the way they are actually used instead of their meaning being defined a priori, e.g., through senses in a lexicon – see for instance Mika (2007) who gives this example: “The term ontology is associated [in Web forums], among others, with HTML, XML and databases, concepts not directly related to the understanding of ontologies in the Semantic Web community.”

Finally, a combination of explicit and implicit web semantics can be found in work on Semantic Web mining, which explores the connecting structures of formally interpreted web objects – see for instance Berendt et al. 2002.

## 5. Conclusions

In this article we presented an overview of the use and study of semantics in the context of the Web. Web semantics is a growing field that will have important implications for the study of semantics in general and linguistic semantics in particular, as more and more parts of our lives (work, study, entertainment, etc.), and therefore also our use of language, are taking place on the Web. It will therefore be of importance to start a serious integration of web semantic research into mainstream linguistic semantic study.

*This work has been supported by the European Union FP7 program under grant number 248458 for the Monnet project and by the Science Foundation Ireland under Grant No. SFI/08/CE/I1380 for the project Lion-2.*

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*Paul Buitelaar, Galway (Ireland)*

## 112. Semantic issues in machine translation

1. Introduction
2. Machine Translation architectures
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### Abstract

*There has been research in Machine Translation for half a century. In this article we sketch the role that semantic knowledge and semantic analysis of words, sentences and texts have played in the different architectures that have been suggested for translating texts automatically. We sketch the reasons for making use of semantics in Machine Translation, the problems that arise from using it, the shape tradeoffs could take for minimizing the cost of semantic analysis and maximizing its impact on translation quality and how linguistic analysis and semantic representation could be combined with data-driven approaches and why this should be done.*

### 1. Introduction

The challenge of Machine Translation (MT) is to translate texts written in a source language A into texts written in a target language B such that the result is a syntactically and semantically well-formed, pragmatically coherent text of the target language and such that the meaning of the target text equals the meaning of the source text. Normally it is assumed that the most natural translation unit be the sentence – or, when required, another expression that the text structure presents as a unit by means of markup information and punctuation, as, for example, a headline, an item in a table, an enumeration, a caption etc.

We neglect the corresponding task of segmenting the text into such units, we skip also other preprocessing tasks like reformatting and spell checking etc. and concentrate on the task of translating unformatted sentences or otherwise syntactically coherent expressions. Also we will not talk about speech and the problems connected to speech translation and the solutions suggested to solve them.

#### 1.1. Ambiguity

Most sentences, expressions and words are ambiguous when taken in isolation (cf. article 23 (Kennedy) *Ambiguity and vagueness*: ‘Most linguistic utterances display “interpretive uncertainty”,’) and, because of this, can obtain different translations in different contexts.

Nearly since the beginnings of Machine Translation, it has become clear that ambiguity of words and structures is one of the hardest problems for translating texts automatically: German *Engländer* means *Brit* or *Englishman* or otherwise *monkey wrench* and we know what is meant and know how to correctly translate the word only if we have additional

information, like *ein fünfzigjähriger verheirateter Engländer* / *a fifty years old married Brit* or *ein Engländer für 5-Zoll-Rohre* / *a monkey wrench for 5 inch tubes* which allows to *disambiguate* the contribution of the word.

Correspondingly, when translating a structurally ambiguous expression one usually must know from context which reading is meant, as when translating *nice mice and cats* into French where one has to know whether the adjectival modification refers to the left conjunct of the coordination or to the coordination as a whole (*des souris gentilles et des chats* / *des souris et des chats gentils*)

Normally the reader isn't aware of such ambiguities (lexical or structural) because he or she resolves them unconsciously using background knowledge about the topic or new knowledge from the text. For Machine Translation disambiguation is a big challenge.

## 1.2. Disambiguation

Many cases of ambiguity can be resolved by exploiting diverging syntagmatic properties of the associated readings.

### 1.2.1. Syntactic analysis filter

The importance of syntactic filtering is often illustrated by a paraphrase of Zenon's paradox:

- (1) *Time flies like an arrow.*

The words *time*, *flies* and *like* are multiply ambiguous. There are  $2 \times 2 \times 2 = 8$  possibilities of assigning part of speech tags to them (*time<sub>N</sub>* or *time<sub>v</sub>*, *fly<sub>N</sub>* or *fly<sub>v</sub>*, *like<sub>prep</sub>* or *like<sub>v</sub>*). When translating into languages that represent the different readings with respect to gender, number, tense and mode by different forms more than English does there are even up to 128 possibilities of assigning forms (for example in German there are 6 word forms for *time*: *Zeit*, *messe*, *misst*, *miss*, *messen*, *messt* etc.). However when the sentence undergoes syntactic analysis there are only three readings left, the Zenon meaning, a reading where a number of representatives of the species *time flies* have a feeling of *liking an arrow*, and an imperative reading where *flies* are *timed like an arrow*. Further filtering is left to pragmatics or semantics.

### 1.2.2. Semantic analysis filter

Local semantic information can help to disambiguate further, as in the following:

- (2) *Mary Stuart heiratete einen Engländer.*  
*Mary Stuart married an Englishman.*

The verb *heiraten* / *to marry* represents an event type which relates to persons. Therefore in (2) *Engländer* obviously designates a person, not a tool (and must be translated by *Englishman* therefore, not by *monkey wrench* or *wrench* - it will not be translated by *British* or *Brit* neither in this case, but this is for detailed historical knowledge which is far beyond linguistic knowledge).

Formally, this type of knowledge can be exploited by assigning semantic *selectional restrictions* to the arguments of the subcategorization frames of the words in the lexicon and by relating the different translations of the arguments to corresponding different semantic specifications (for ‘*selectional*’ or ‘*selection restriction*’ see also article 16 (Bierwisch) *Semantic features and primes*). For example, we may assume that the verb *heiraten* is assigned the subcategorization [subj(n):PERSON, obj(n):PERSON] that the noun *Engländer* is assigned the semantic type disjunction PERSON | INSTR plus transfer information stipulating, among other things, that *Engländer* is translated by *Englishman*, if it can be inferred from context that the word designates a PERSON. Given this knowledge we learn from (2) that *Engländer* is a PERSON and must be translated correspondingly.

Disambiguating semantic information may also flow in reversed order in predicate-argument-structures: from argument to syntactic head. German *einstellen* has several meanings. If the direct object is a person it is used in the sense of *to hire*, if it is a payment, it obtains a temporal meaning in the sense of *to suspend* (and must be translated correspondingly in both cases). Of course, several such semantic restrictions may interact.

### 1.2.3. Selectional restrictions and preferences

Semantic selectional constraints aren’t always that precise as in the case of *heiraten* and *einstellen* and its roles. Consider the ‘age measuring’ adjective *fünfzigjährig* / *fifty years old* of the introductory example. When applied to *Engländer* it prefers the corresponding reading as HUMAN being, but doesn’t reject the TOOL reading completely. Given the attributed age, there is a bias towards the person reading only, probably because it is more natural to characterize persons by age than tools. However, in order to be able to characterize persons the adjective must relate to an appropriate value (a *150 Jahre alter Engländer* is much less likely to refer to a person than an *Engländer* that has 40, 50 or 60 years). This means that not every lexical item that has arguments requires clear-cut restrictions for them or a subset of them, sometimes such restrictions only result from further modifications and sometimes they give hints about preferences only.

### 1.2.4. Metaphoric use and metonymic variation

It complicates matters that metaphoric use and metonymy aren’t rare phenomena, at least when considering literary and newspaper texts (see also article 26 (Tyler & Takahashi) *Metaphors and metonymies*: ‘*Metaphor and metonymy are now understood to be ubiquitous aspects of language*’). In a farce or cartoon, for example, there might be machines and tools playing the role of persons such that a sentence like *Der gute Engländer lag traurig auf seinem Lager in der Werkstatt* would have to be translated by something like *Good monkey wrench lied sadly on his bed in the workshop* and would sound quite natural in this context. This means that, given an appropriate global context, semantic relations may change such that semantic conclusions may be suspended that otherwise could be drawn from local constraints as provided by selectional restrictions. (The ontological incompatibility between tools and persons may be suspended for example, such that in a corresponding story about anthropomorphic animated objects the tool reading doesn’t provide a clash).

Computing parameters from a text that can reliably guide the interpretation of the text and its passages (informing about the domain an assertion is about and whether it is used literally or as a metaphor etc.) is obviously a rather ambitious task.

### 1.3. Ambiguity-preserving translation

Machine Translation is not identical to text understanding. It presupposes text understanding to some extent, but there are cases where it can do without resolving ambiguities which from the standpoint of the recipient's interest should be resolved. This is no contradiction. It only says that Machine Translation may trust the assumption that similar ambiguities in source and target text (which correspond to each other) can be disambiguated by similar means and in a similar way if the context of these ambiguities is translated without loss of information.

For example, *Drucker* in German is ambiguous. It may refer to a *print worker* or a *printing device*. Generally, this difference is relevant and the context must be such that it provides information that enables the reader to resolve the ambiguity. Otherwise the text containing the word is not *felicitous* in the sense of the Gricean maxims (cf. article 92 (Simons) *Implicature* 2.2; also 95 (Potts) *Conventional implicature and expressive content*). English *printer* is ambiguous in exactly the same way and it will be disambiguated in the same way as its source counterpart, provided there is corresponding disambiguating information in the source text and provided this information is translated adequately. In this case *printer* is a perfect translation and better than *print device* or *printing worker* which may obtain a flavor of overspecification in the presence of the described context information.

Ambiguity-preserving translation has been advocated for in Kay (1980, 1997), Kay, Gawron & Norwig (1994) among others.

Note that even text understanding doesn't presuppose for a text to be felicitous that every ambiguity must be resolved (and that the context contains enough disambiguating information for this purpose). If the corresponding term or structure doesn't refer to a central topic, message or referent of the text the unresolved information may be completely sufficient. Often, sentences with scope ambiguities are examples of this. In *all politicians talked to a number of experts* the subject may take scope over the object – so that every politician talked to his own group of experts – or the other way around – where there is just one (specific) group of experts the politicians all talk to. For many purposes of using such sentences however, it doesn't matter which scope relation holds; cf. also articles 43 (Keenan) *Quantifiers* and 62 (Szabolcsi) *Scope and binding*.

Ambiguity-preserving translation presupposes that the target language provides lexical or structural forms that are similarly ambiguous as the forms of the source language that are to be translated. With respect to corresponding transfer systems it additionally suggests that the representation formalisms used provide means for *underspecification* of information (cf. article 24 (Egg) *Semantic underspecification*).

Availability of ambiguity-preserving transfer equivalents doesn't mean that the corresponding term or structure remains undisambiguated throughout the entire process of translating the sentence or text. It might be disambiguated implicitly by contextual constraints like the mentioned selection restrictions mentioned above. However, disambiguation might have to be carried out explicitly also (where 'explicitly' means that there have to be applied inference rules beyond unification in semantic composition), in order to assure necessary information flow and consistency with regard to other elements in the

text (see also article 86 (Kay & Michaelis) *Constructional meaning*). It is important to realize that expressions presenting corresponding translation tasks neither necessarily precede the considered term nor are located in close vicinity of it. Good examples are presented by texts with pronouns as in the following. A simple example:

- (3) *Joan bemerkte den Drucker. Sie ging auf ihn zu.*  
*Joan noticed the printer. She approached it / him.*

In the German sentence of (3), the correct translation of *ihn* into English (by *it* or *him*) depends on knowing what *Drucker* stands for, a person or a machine: *Drucker* is the *antecedent* of the pronoun and therefore it should provide the ontological information needed for translating the pronoun correctly. However, here, the noun is ambiguous, it doesn't provide sufficient justification for any of the alternative translations. At best, it can be said that things are interleaved: If *Drucker* is a person, *ihn* must be translated by *him*, otherwise by *it*. But that's not all: If *ihn* is translated by *him*, *Drucker* should be understood as a person and correspondingly with *it*. This means that deciding about the translation of the pronoun causes a decision about the reading of the antecedent even if this decision could be omitted when considering the task of translating the antecedent sentence taken in isolation. In some contexts this 'backwards'-dependency can be exploited for further disambiguation as in the following:

- (4) *Kürzlich erst hatte sie den Drucker eingestellt.*  
 a. *Jetzt kündigte er schon wieder.*  
 b. *Jetzt war er schon wieder defekt.*

*It was only recently that she had hired/adjusted the printer.*  
 a. *Now he already dismissed.*  
 b. *Now it already was defective again.*

In (4a) the selectional restriction provided by *kündigen* / *dismiss* to its subject indicates that *er* must designate a person. Because of the anaphoric link, *Drucker* must designate the same person. Therefore, *einstellen* must be translated by *to hire*, not by *to adjust*. In (4b) the same flow of information requires *einstellen* to be translated by *to adjust*. Note that in this example it is information from later sentences which is needed to disambiguate terms in previous sentences and to translate them correctly.

We keep from this that an answer to the question asking for the depth of semantic analysis of terms and structures that is appropriate in order to translate a text correctly depends on the language into which it is to be translated and the structural and lexical properties of this language in comparison with the source language, in particular on whether it provides similarly ambiguous terms and structures for the items in question. However, it depends also on whether such disambiguation is needed by separate translation tasks given by terms and structures figuring somewhere else in the text, before or after the item considered. This means that high quality translation in principle cannot be carried out by sequentially running through the text and translating simultaneously. From an epistemological point of view translation presupposes understanding the purpose of the text, understanding the situation at which the text aims, having the necessary background knowledge available, and, on the basis of this, being able to understand the



text to a certain degree and having the competence to decide if a (local) ambiguity in the text may remain unresolved in translation or not.

High quality translation in this sense is provided by none of the systems that have been developed so far.

## Topics

In the next section, we will give a brief tour d'horizon about what types of architecture have been developed since the beginnings of MT and what kinds of solutions have been presented to the problems mentioned.

During the last decades it has become a common insight that computing detailed semantic representations is very costly and tends to be a kind of overkill, as we have tried to illustrate above. Therefore, shallow semantic representations of various shapes have been suggested as the domain (and range) of translation, seen as a function from representations onto representations. We have tried to illustrate also that such representations must allow gradual disambiguation in order to provide the knowledge needed for the resolution of translation difficulties (which may be *long distance* -transfer- dependencies) on a case-by-case basis.

In section 3 we show how a formalism of this type fits in a typical transfer architecture and what the advantages are when compared to other approaches.

In section 4 we will report about current approaches to *hybrid* architectures mixing different translation methods and we will try to show how promising it is in particular to incorporate statistically gained information to semantics-based transfer systems which use underspecified representations.

The overview will end with a short concluding summary and outlook in section 5.

## 2. Machine Translation architectures

### 2.1. A brief history of the classical MT architectures

#### 2.1.1. The beginnings

Typically, the beginnings of MT are identified with Warren Weavers initiatives in 1947 and 1949 stimulating renowned thinkers and scientists of that time to think about the possibilities of translating texts automatically. Significantly enough, in his famous memorandum entitled *translation* (cf. Weaver 2003), Weaver (Claude Shannon's co-founder of information theory) addressed ambiguity as the main problem of MT and suggested to use recent knowledge about decryption and about formal languages together with knowledge from context for solving this problem and as an architectural basis for MT as such. Immediate cause of Weaver's initiatives was the increased need for translations that institutions like UNESCO showed and the growing number of such international institutions and also current and foreseeable international conflicts with foreseeable translation needs.

Weaver's credo was to understand translation as a process of decoding an encrypted message. It had a lot of influence on the discussions at those days. There had been recent success in decryption. An outstanding result was the deciphering of the code of the German *enigma* cipher machine in the Second World War.

The first phase of MT guided by this philosophy lead to a first demonstration of a prototype at IBM headquarters in 1954, where 49 simple Russian sentences could be

processed. This demonstration was a big success and triggered comfortable funding during the following years (cf. Hutchins 1995).

### 2.1.2. The knowledge bottleneck

The Georgetown demonstrator translated word by word. In order to deal with ambiguities it was augmented by morphological and very sparse syntactic analysis taking into account a small number of neighbors of the word to be translated: altogether it made use of a totality of 6 syntactic rules!

This somehow naive, over-enthusiastic attitude of the beginnings was at the basis of uncautiously trying to solve the translation problem by brute-force methods in the following. The trend was to trust more in calculating capacity than on linguistic research. (Note Loomis' characteristic statement *I instinctively trust the electronics boys more than I do the semanticists*, cf. Hutchins 1997).

In the early and mid sixties the disappointment of the investors, having spent about 20 Mio \$ in the *first generation* systems of the Georgetown type without commercially usable results replaced enthusiasm. The famous Alpac report (of the **A**utomatic **L**anguage **P**rocessing **A**dvisory **C**ommittee installed in 1964) by the US National Academy of Sciences came to the conclusion, in 1966, that *we do not have useful machine translation* and that MT is and will be commercially unattractive. With respect to funding: *linguistics should be supported as science, and should not be judged by any immediate or foreseeable contribution to practical translation* (cf. Pierce et al. 1966).

This statement stopped research on MT for a number of years. It is responsible however also for that MT could try a more realistic second start with a much more adult attitude, being aware that much more linguistics would be needed in order to tackle the problem seriously. The first person to see this and the first who did full-time work from a linguistic perspective on MT was Yehoshua Bar-Hillel at MIT who, in 1952, organized the first International Conference on Machine Translation. In the late fifties/early sixties he came to the conclusion that FAHQT, i.e. *fully automatic high quality translation* could not be possible for principle reasons. He argued that position (in Bar-Hillel 1960) with an example which became famous in the sequel, the following:

- (5) *Little John was looking for his toy box. Finally, he found it.*  
*The box was in the pen. John was very happy.*

*Pen* is either an enclosure, typically in the context of agriculture, or a writing utensil. In (5) it is used in the first sense with a more specific interpretation as *playpen*. In order therefore to translate *pen* into a language which brings out the difference (as in German *Laufstall* vs. *Schreiber*), the pronouns have to be resolved correctly, the box has to be identified as the toy box of the first sentence and what is more: a lot of *world knowledge* must be available according to which we know that in situations with toy boxes playpens are often found also (and less often enclosures for animals) and that boxes normally fit better into enclosures than into writing tools. Since, in principle, we need inferences like these in all domains texts can be about, MT necessitates complete knowledge about the world in order to disambiguate the terms and structures.

This is a very strong argument and at the basis of the criticism expressed against MT architectures with explicit, predefined rules governing text analysis and translation (so-called *rule-based* Machine Translation (RBMT)).

### 2.1.3. The Vauquois triangle

Bernard Vauquois, renowned pioneer of MT research integrated the architectural suggestions that have been suggested as responses to the challenges in the seventies and eighties, after ALPAC and a period of meditation, in a graphical illustration (cf. Vauquois 1975). Because it compares the architectures by a triangular structure, it is called the *Vauquois triangle*. Meanwhile, it is used in nearly every introduction to MT.

Fig. 112.1 adds some detailing illustrations to Vauquois' comparison. In essence it compares the relevant features of *direct translation* to those of *transfer systems* and *interlingua systems*, where *direct translation* means word-to-word translation as realizable via transducers. It characterizes the so-called *first generation* systems which have been developed in the sequel of the Georgetown demonstration. *Transfer systems* analyze the input into some abstract representation, *transfer* it to some representation of the target and generate a target translation from this latter representation. *Interlingua systems* analyze the input into a representation which is universal in the sense that all sentences that are translations from each other share this representation as common content abstracting away from all language specific elements and as 'blueprint' they are generated from. The development of transfer and interlingua systems mark the so-called *second generation* of MT.

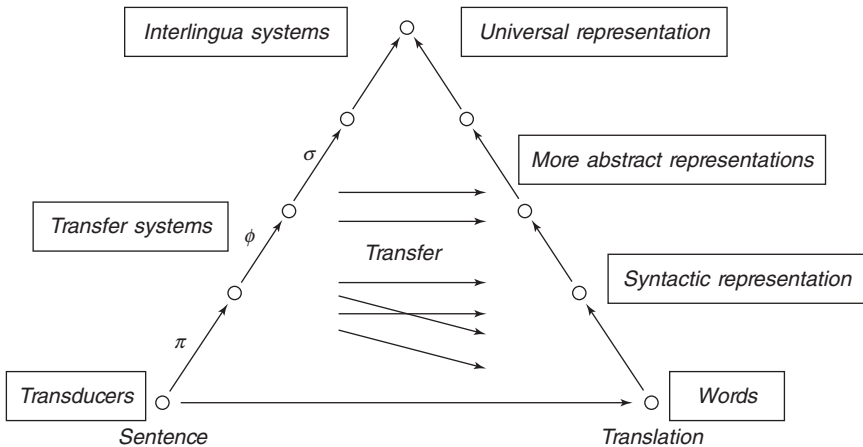


Fig. 112.1: Conventional RBMT architectures

The first and second generation systems of the Vauquois triangle do not yet address statistical methods of the so-called *third generation* of MT.

### 2.1.4. Direct translation

Most commercial initiatives stuck to the direct translation option, whereas most academic research centers investigated the transfer and interlingua option, which caused communication between commercial development and academic research to run dry step by step in the following time (there have been exceptions of course). This trend held for many years and it is only by the late eighties and the nineties that communication began to reincrease. Since the growing success of statistical MT it has become even intense (viz. Google translation).

Commercial systems which developed from first generation prototypes or architectures and survived are *SYSTRAN* (which offers the free online service *Babelfish*) and *LOGOS* (cf. Stoll 1986, Trabulsi 1989, Drouin 1989).

A striking feature of direct translation systems is that they are generally fast and robust, at least when compared to (rule-based) systems of later generations. This is due to the fact that, grosso modo, there is no time-consuming computation of abstract representations and complicated disambiguation operations; analysis settles for some sparse mapping to morphological base forms (*lemmatizing*) such that the translation process nearly exclusively consists of looking up words and expressions and their translations in bilingual dictionaries and combining the results into the target sentence, according to target surface rules. Since there is nearly no information available from compositional processes and generalizations the dictionaries carry most of the translation information and contain huge sets of descriptions of particular cases, considering a lot of syntagmas as a kind of multiwords.

### 2.1.5. Transfer systems

The arrows added to the Vauquois triangle in Fig. 112.1 indicate that there are many different subtypes of the transfer architecture. A system might use one or more levels of analysis. Analysis might mean syntactic, semantic, syntactico-semantic analysis or something else. Transfer can relate source representations to target representations of the same representation level. It can relate representations of different levels also and it can generate target strings from source representations avoiding construction of intermediate structures which could be interpreted as analyses of the target grammar.

*EUROTRA*, for example, used 4 layers of analysis: morphological structure (tokens), configurational structure (syntax), relational structure (dependency/predicate-argument structure) and interface structure (predicate-argument-structure with interlingual elements). *Translators* and *generators* mapped the representations of these layers to each other. Transfer was defined for the level of interface structure. *EUROTRA* was initiated by the European Community and aimed at modular translation systems for all EC languages (cf. Durand et al. 1991, Copeland et al. 1991). The project was very influential throughout the eighties and triggered a lot of research in neighboring domains also. (With respect to its basic settings *EUROTRA* owes a lot to the earlier *ARIANE* system (cf. Vauquois & Boitet 1985) of the *Groupe d'Etudes pour la Traduction Automatique* (GETA), which was established by Bernard Vauquois.)

Similarly symmetric with respect to source and target representations are the systems of the *ParTrans* project of the Palo Alto Research Center (Parc – a Xerox institution). *ParTrans* uses the results of the *ParGram* project which spells out grammars for many languages in the framework of *Lexical Functional Grammar* (LFG) (cf. Kaplan & Bresnan 1982 to LFG, Butt et al. 2002 to *ParGram*, Riezler & Maxwell 2006, Frank 1999 to *ParTrans*). *ParTrans* can be seen as a successor of the *EUROTRA* approach. Its representation formalisms are much more general (*syntactic c-*, *functional f-* und *semantic s-structure*), with more principle-based mappings. It uses elegant unification principles in order to compute composition and the values of the mapping functions. (In fig. 112.1  $\pi$ ,  $\varphi$  and  $\sigma$  relate to the corresponding projections of the LFG approach). Often, such symmetrical approaches aim at reversibility of the components as well (as LFG does).

In contrast, there are systems which compute the target string from the source representation without computing target language specific representations first and then generating the target string from them. (This transition is mostly realized via language pair-specific rewriting rules). Examples of commercial systems that follow this asymmetric architecture are METAL (*MEchanical Translation and Analysis of Language*, mainly developed by Siemens in the eighties) and IBM's LMT *logic based Machine Translation* (cf. Bennett & Slocum 1988, McCord 1989a, 1989b). (This is true for at least some periods of their development history; both systems or successors of them respectively are still on the market under different names – a successor of METAL among others as Langenscheidt's *T1* and successors of LMT in IBM's *web sphere translation server*, linguattec's *Personal Translator* and Lingenio's *translate*).

### 2.1.6. Interlingua systems

Interlingua approaches are similarly multi-faceted. There are approaches that aim at universal conceptual structure. An example is the *UNITRAN* system (cf. Dorr 1993, 1994) which translates on the basis of *lexical conceptual structures* (LCS) (cf. Jackendoff 1983, 1990 and article 30 (Jackendoff) *Conceptual Semantics*, also articles 19 (Levin & Rappaport Hovav) *Lexical Conceptual Structure*, 27 (Talmy) *Cognitive Semantics*, and 31 (Lang & Maienborn) *Two-level Semantics*).

However, the term *interlingua* doesn't exclusively label universal semantic representations or *logical form*. There are weaker interpretations which settle for representations of source and target sentences only which are not necessarily identical but use isomorphic predicate-argument structures only, with language-specific lexemes. In this case, a minimal step of transfer replacing source lemmas by corresponding target lemmas remains. The academic prototype of the *Linguistic Research Center* (LRC) at the university of Texas in Austin that METAL had been developed from later used this type of structurally isomorphic transfer. It was developed during the seventies. Other examples of this specific variant of interlingua are presented by early translation architectures of GETA in Grenoble (cf. Bennett & Slocum 1988, Vauquois 1975, Slocum 1988).

Finally, there are suggestions which are not interested in the option of logical inference at all, but only in reducing the combinatory complexity which is connected to the transfer setting: Whereas a transfer approach for translating  $n$  languages into each other needs  $n \times (n-1)$  transfer components (which are completely different in the worst case), a corresponding system that does all translations via the same interlingua does not need specific transfer components at all. Instead it needs  $n$  components for mapping the input to interlingua representations and another  $n$  components to generate the target sentences from such representations. If the interlingua used is not an expressive semantic representation language but just a representative of the  $n$  languages considered, analysis doesn't need to be more detailed and generation not more complex than in the transfer case. The approach can even be optimized by designing a kind of translation *esperanto* which approximates the words and structures of the languages considered in order to minimize the differences. In later GETA suggestions this language, called *pivot* language, is a kind of simplified and generalized English, called *unified networking language* (cf. Sérasset & Boitet 2000). (UNL is at the basis of the large international UNL-initiative (put forward among others by

Vauquois's successor at GETA, Christian Boitet), aiming at translation between many languages and different languages (including Asian languages), cf. Hong & Steirer 1999. There have been other such approaches also, with other pivots (for example the DLT system (*Distributed Language Translation*) developed at the BSO software company, Utrecht in the late eighties, which used a variant of ESPERANTO, cf. Sadler 1989).

### 2.1.7. Translation mismatches

Structural differences between source and target representation can be classified into different types of *translation mismatches* (cf. Kameyama, Ochitani & Peters 1991 for the notion, also Dorr 1994). Mismatches help to justify the usefulness of different layers of analysis further.

Typically, next to lexical divergences and gaps there are structural mismatches which, grosso modo, can be classified by three types of changes:

- *Thematic divergence and scrambling*  
Thematic roles are exchanged for each other (cf. Dorr 1990, Hutchins & Somers 1992); the order of constituents changes.
- *Deletion and insertion of structure*  
Words and structures aren't translated (*deletion*) or there are elements in the target without immediate equivalent in the source (*insertion*).
- *Head switching*  
Syntactic head and argument(s) are exchanged for each other.

For example, translation with morphological *contraction* is a phenomenon of deletion of structure (and the retranslation an example of insertion). It is easily resolved at the level of (morpho-)syntactic analysis:

- (6) *Er schreibt [an die Angestellten]pp ↔ Il écrit [aux employés]pp*  
 ↔ *He writes [to the employees]pp.*

At the level of syntactic analysis, the three-token PP-complement in German and English and the corresponding two-token complement in French are identically represented as instances of the type [Prep [DET<sub>def</sub> N]<sub>NP</sub>].

Similarly, (non-lexicalized) *compounds* may obtain isomorphic analyses.

- (7) *Zufallswort ↔ random word*  
 [NCOMPOUND N]<sub>N</sub>

Differences in constituent order disappear at the level of functional analysis (e.g. at the level of LFG's *f-structure*) and consequently for all more abstract representations which are assigned to this level (e.g. semantic representations). Also, structural differences which are due to idiosyncratic tense, modal or negation information disappear if the corresponding information is represented via specific feature values (as in LFG's *f-structure*) or interpretations of such values in terms of modal and temporal statements of a uniform semantic

representation language (as in *Discourse Representation Theory* or *Situation Semantics* etc.; cf. articles 35 (Ginzburg) *Situation Semantics and NL ontology*, 36 (Ginzburg) *Situation Semantics*, 37 (Kamp & Reyle) *Discourse Representation Theory*, 38 (Dekker) *Dynamic semantics*, and 39 (Zeevat) *Rhetorical relations*). Thematic divergence is just a matter of renaming attributes or thematic roles.

(8) gives an illustrating example, (9) presents the corresponding structurally isomorphic f-structures (modulo lexical material and attribute labeling):

- (8) *Peter würde der Wein nicht gefallen*  
*Peter n'aimerait pas le vin.*  
*Peter wouldn't like the wine.*

- (9) 
$$\left[ \begin{array}{l} \text{PRED: } \text{"gefallen"}(\uparrow \text{SUBJ})(\uparrow \text{OBJ}) \\ \text{SUBJ: } [\text{PRED: "wein"}] \\ \text{OBJ: } [\text{PRED: "peter"}] \\ \text{NEG: } + \\ \text{TENSE: COND} \end{array} \right] \left[ \begin{array}{l} \text{PRED: } \text{"aimer"}(\uparrow \text{SUBJ})(\uparrow \text{OBJ}) \\ \text{SUBJ: } [\text{PRED: "peter"}] \\ \text{OBJ: } [\text{PRED: "vin"}] \\ \text{NEG: } + \\ \text{TENSE: COND} \end{array} \right]$$
- $$\left[ \begin{array}{l} \text{PRED: } \text{"like"}(\uparrow \text{SUBJ})(\uparrow \text{OBJ}) \\ \text{SUBJ: } [\text{PRED: "peter"}] \\ \text{OBJ: } [\text{PRED: "wine"}] \\ \text{NEG: } + \\ \text{TENSE: COND} \end{array} \right]$$

*Head switching* is a type of translation mismatch which is often taken as an argument for spelling out transfer at the level of semantic representation. Head switching means that a syntactic head and (some of) its arguments or an adjunct exchange their positions for each other in the target. Example:

- (10) *Peter raucht gerne.*  
*Peter likes to smoke.*

In (10) the head of the German sentence, *raucht*, is translated as a complement of the head of the English sentence which in turn is the translation of *gerne* which is an adjunct of *raucht* in the source sentence. Conceptually, both, the adverb *gerne* and the verb *like* are modal operators (which take a property as argument and relate a second, individual, argument to it). Therefore it is very natural to assign both sentences structurally isomorphic semantic representations as in the following:

- (11) 
$$\text{gerne}(\text{peter}, \lambda x. (\text{rauchen}(x)))$$
  

$$\text{like}(\text{peter}, \lambda x. (\text{smoke}(x)))$$

However, it depends on the depth of analysis which is aimed at by the semantic formalism and its representations whether the divergence is abstracted away at the semantic level or not. Different perspectives have been taken to that in the past when defining transfer and interlingua architectures using semantic representations.

## 2.2. The role of semantic representation in different traditional MT architecture types

Throughout second generation MT a number of transfer and interlingua systems have been developed which use semantic representations. We mentioned EUROTRA (using a fourth representation layer called *interface structure*) and ParTrans' LFG translation where it is possible to assign semantic representations to f-structures by means of a projection  $\sigma$ . These *s-structures* can be used as an additional level of transfer on the one hand, or as a means for providing semantic information on the other, which can guide the construction of f-structures (by semantic selectional restrictions for example).

In the LFG-type transfer architecture semantic information is *co-described* to lexical items and grammar rules in the same way as functional and transfer information is. This is an advantage over EUROTRA-type approaches with specific (directional rewriting) *translators* between the representation layers, as all types of information (configurational, functional, semantic, transfer information) can flow together in the LFG typical path equations which constrain the possibilities of understanding and simultaneously translating a sentence. Instead, in the EUROTRA-type architecture, information from earlier processing stages (lower layers in analysis and higher layers in generation) aren't available anymore. Both approaches are similar however in that they do not require representations of particular semantic theories.

At least in principle, such architectures accept representations of any compositional language for semantic representation. Different semantic frameworks have been proposed and used: *Montague semantics* (cf. Dowty, Walland & Peters 1981) has been used in Philipps' Rosetta system (cf. Landsbergen 1982, 1987a, 1987b). *Situation semantics* has been proposed for MT in Kameyama, Ochitani & Peters (1991). *Quasi logical forms* (QLF) are used in the *Bilingual Conversation Interpreter* (BCI) (cf. Alshawi 1992). Discourse representation structure and underspecified versions of DRT have been used in various systems designed in the nineties (Barnett et al. 1991, Emele et al. 2000, Eberle 2002).

There is an important difference between transfer and interlingua architectures with regard to semantic representation: In transfer approaches semantic representations may use language specific predicates and structuring principles; in interlingua approaches (in the narrow sense), semantic representations should be neutral in this respect. They must express the semantic information that sentences of at least two languages that are translated into each other have in common. In principle, they must represent the semantic features that all sentences which are translations of each other have in common, including translations from structurally very different languages. Epistemologically this presupposes the assumption of a universal conceptual structure of the human way of thought that can be found beyond any language specific encoding. The mentioned *Lexical Conceptual Structure* (LCS) is an approach to spell out a corresponding conceptual language and UNIFORM is a MT system that uses it. In LCS (and corresponding conceptual approaches) events and states are broken down into basic action and state types. For example, for both sentences of (10) one might obtain something like (12) as a common representation:

$$(12) \left[ \begin{array}{c} \text{State BE} \left( \left[ \begin{array}{c} \text{Thing } x \\ \text{Position AT} \left( \left[ \begin{array}{c} \text{Thing } x \\ \text{Event SMOKE} ([\text{Thing } x]) \end{array} \right] \right) \\ \text{Manner LIKINGLY} \end{array} \right] \right) \end{array} \right]$$



It is of course much more difficult to generate translations from such representations than from representations which are closer to surface structure. In UNITRAN, the problem is alleviated by parameters assigned to the representations which inform about whether a specific argument or structure has to be realized syntactically and how.

Typically, conceptual representations do not model ambiguities, but stand for readings of the sentences. This means that analyzing sentences into such representations presupposes more effort with respect to disambiguation. Generally, the more representations use deep (fundamental) semantic predicates and relations the more the system is faced with disambiguation – or the more features for underspecification are needed if unmotivated disambiguation shall be avoided.

The first option (of disambiguated deep representations) is taken by so-called *Knowledge based Machine Translation* (KBMT, cf. Nirenburg et al. 1992). The basic idea is to provide a large amount of *world knowledge* and to use it for disambiguation when computing the deep interlingua representations of the sentences and texts, in order to be able to solve ambiguity problems as posed by Bar Hillel's problem (example (5), where *event frame knowledge* must be available and used to conclude that *pen* must be interpreted as a *playpen* in the reported situation; cf. also article 29 (Gawron) *Frame Semantics*). Because of this perspective, the main topics of KBMT are knowledge representation, design and properties of corresponding languages, tractability, and inference algorithms. Typically, information is represented in *frames* using languages which develop from AI languages like KL-One and from feature logic research. In order to be usable in practice, it is obvious that representation and translation must be restricted to specific domains. *Kant* and the later *Mikrokosmos* are renowned KBMT-systems (cf. Carbonell, Mitamura & Nyberg 1992, Onyshkevych & Nirenburg 1995, Nirenburg et al. 1996).

The second option (shallow representation) was a main focus of the *Verbmobil project* (which started in 1994 and ended in 2002, cf. Wahlster 2000). Verbmobil produced a number of (transfer) systems which made use of underspecified structures: different versions of systems on the basis of *minimal recursion semantics* and *underspecified DRT* (cf. Flickinger, Copestake & Sag 2000, Emele et al. 2000). We do not go into detail with them here. Instead, we will sketch the analysis and lexicon formalism of a transfer system that incorporates many features of these systems on the basis of a specific underspecification formalism in the next section. We will discuss the different pros and cons of the differences there.

There are a number of varieties of the more classical interlingua and transfer architectures using semantic representations which we also cannot go into here: *Lexicalist MT* (*LexMT*) focuses on minimizing problems from structural mismatches by defining transfer as a relation between sets of source and target lexeme representations, including representations of multiwords and idioms, where the set of source representations covers the source sentence and where the target sentence is generated from the corresponding set of target lexeme representations using syntagmatic constraints assigned to the representations (constraints with regard to logical type, semantic selectional restrictions, agreement etc.; cf. Whitelock 1992). Kuhn & Heid (1994) combine the codescription approach of LFG (which defines target structures by sets of equations) with semantic interlingua and spell it out in a HPSG setting. There are numerous other combinations. We come back to some of them sporadically in the following sections.

### 2.3. Trends in current MT research and development

Since the late eighties there have been suggestions for *Statistical Machine Translation* (SMT). The name of one of the first systems, *CANDIDE*, alludes to the underlying epistemological attitude: No a priori knowledge about language and translation is used. The IBM approach which led to the *CANDIDE* system (which has become classical meanwhile) draws heavily on the experiences made with statistical speech processing and applied corresponding methods to translation. It stipulates the translation of a sentence  $f_1^J$  (consisting of words  $f_1, \dots, f_J$ ) to be that sentence of the target language  $\hat{e}_1^I$  (consisting of words  $e_1, \dots, e_J$ ) that has the highest probability given  $f_1^J$ . The corresponding maximization uses Bayes's theorem:

$$\hat{e}_1^I = \operatorname{argmax}_{e_1^I} \{P(e_1^I) \times P(f_1^J | e_1^I)\}$$

This approach is referred to as *noisy channel* or *source-channel* approach (cf. Brown et al. 1990, Brown et al. 1992, Brown et al. 1993). (The use of *e* and *f* for sentences and words in the formula alludes to the language pair English-French which was -and still is- a popular field of examination, as the *Hansard corpus* makes large amounts of corresponding parallel texts available electronically; the *Hansard corpus* consists of the transcripts of the Canadian parliament debates with translations into English or French, depending on the original contribution.) It bases upon two probability models: the *language model* of the target language,  $P(e_1^I)$ , and the *translation model*,  $P(f_1^J | e_1^I)$ . Often, the translation model uses information from two further submodels: the (bilingual) *lexicon model* (which determines the probability of a source word *sw* to be translated into a target word *tw* in a context *c* – which, generally, is a *n*-gram) and the (word) *alignment model* which weights the positioning of translations of words (or expressions) in the target sentence. The models are trained using mono- and bilingual corpora.

In order to give a better account of various types of information which constrain translation and generation, it has been suggested in the sequel to use maximum entropy models instead, which provide the possibility to add weighted random variables or *feature functions* to the probability model as seems appropriate to the researcher with regard to modeling the data (cf. Och & Ney 2002). According to the maximum entropy approach search of the best translation  $e_1^I$  of a sentence  $f_1^J$  is steered by the following maximization (where  $h_m$  are feature functions and  $\lambda_m$  their weights):

$$\hat{e}_1^I = \operatorname{argmax}_{e_1^I} \left\{ \sum_{m=1}^M \lambda_m h_m(e_1^I, f_1^J) \right\}$$

This model, which subsumes the source channel model as a specific case, dominates the current discussion in SMT. There are various suggestions for feature functions, in particular suggestions which relate to linguistic knowledge. Another issue for improving the quality of SMT is to modify the data the models apply to. If knowledge about multiwords, collocational expressions and idioms is available, the model is better based upon sets of words instead of single words. If morphological knowledge is available it can be based on

basic forms, instead of inflected words, etc. There are suggestions for computing the corresponding knowledge automatically from (monolingual) corpora using statistical methods.

There is a third strand of approaching the translation problem: *example-based Machine Translation* (EBMT). EBMT has its roots in so-called *Machine aided human translation* (MAHT) and is a sophistication of the *translation memory* technique. Translation memories store translations of sentences of the human translator in easily searchable databases such that he or she can very efficiently access and use them for later translation tasks.

Most commercially available translation memories investigate texts to be translated and prepare them in such a way that the human translator is prompted for translations of sentences only if they haven't been found in the memory. If there are relatively similar sentences in the memory he or she will be provided with the corresponding translations as templates for the new translation. This idea has been put forward by going below the sentence level and storing translations of parts of sentences and their translations – *examples* – and understanding sentence translation as the task of finding an optimal cover of the source sentence by source parts of examples and to put together the target parts in a reasonable way. (Generally, a cover is *optimal* if the parts have to be cut only minimally in order to provide a partition of the sentence). EBMT was pioneered by Nagao and colleagues in the Japanese government project for MT in the late eighties, by Furuse and Iida, and by IBM's Japanese MT group among others (cf. Nagao, Tsujii & Nakamura 1988, Furuse & Iida 1994, Maruyama & Watanabe 1992, Watanabe & Takeda 1998). Today there are a number of groups investigating EBMT, among others a very productive one at DCU (cf. Gough & Way 2004).

Of course, similarities between the different approaches have been noticed. They are exploited in *hybrid* approaches to Machine Translation, which dominate the current discussion in the literature, independently of the specific emphasis the contributions take. For instance, EBMT's *examples* may obtain more structural interpretations which relate them closer to *expressions* in the conventional sense of the term and which allow a more compositional picture of the construction of translations from examples (cf. Chiang (2005). *Phrasal SMT* uses syntactic knowledge in SMT (cf. Quirk, Menezes & Cherry 2006). Of course, this easily combines with the structured understanding of EBMT examples mentioned before.

The notorious *sparse data problem* of SMT is tried to be weakened by generalizing the data using abstractions of the specific form the sentences take, as sketched further above, and by using similarity knowledge from monolingual corpora in order to improve the bilingual lexicon models (cf. Callison-Burch, Koehn & Osborne 2006 for an example).

SMT, EBMT and the search for hybrid improvements mark the *third generation* of MT development. There is not yet a fourth. (For a general overview to MT history and architectures, compare Hutchins 1986, 2001, Hutchins & Somers 1992, Trujillo 1992 to an early concise comparison of the interlingua and transfer approaches cf. Boitet 1988, to an overview giving a more detailed account of third generation MT cf. Jurafski & Martin 2000, Manning & Schütze.)

### 3. Transfer of underspecified representations

Many traditional academic transfer systems use large transfer components which specify most of the difficult translation mismatches such that the bilingual lexicon proper (if there

is one) contains relatively simple word-to-word statements only. From a commercial point of view this is disadvantageous. It means that relatively complicated programming code has to be maintained and extended continuously by programmers who are also lexicographers or conversely. This is expensive. Therefore many commercial systems have relatively simple transfer components and use huge dictionaries which enumerate many individual translation cases instead of configuring them by using generally applicable mapping rules.

Optimizing on both approaches means to provide a lean transfer component which ignores language specific and language pair specific knowledge and which is hence easy to maintain – and it means to provide a simple but expressive lexicon formalism which allows the lexicographer to define complex declarative transfer relations and to use and define corresponding templates without programming.

A prerequisite is that the representations that transfer applies to firstly abstract away from all types of information which can be inferred by language specific generation rules and, secondly, avoid detailing the meaning beyond the lexical and structural interpretation that is justified by the knowledge of the syntax-semantics interface, at least, as long as there are no requirements from transfer for more precise interpretations. We mean that the level of underspecified semantic representation fits best with these requirements.

### 3.1. Underspecified source and target representations

In order to illustrate what can be dealt with on the basis of underspecified semantic transfer and how and at which cost this happens, we make use of *flat underspecified discourse representation theory* (FUDRT and its representation structures (FUDRSs). FUDRT developed from an implementation of Reyle's *underspecified discourse representation theory* (UDRT; cf. Reyle 1993) which aimed at extending the theory from representation and interpretation of scope ambiguities to various other ambiguities in order to allow representations of a broad language fragment for practical purposes (cf. Eberle 1997, 2004). It has been used outside research for semantic representation in the MT products *Personal Translator* and *translate* (cf. Eberle 2002).

We concentrate on the structural ambiguity illustrated in sentence (13). It is expressed by different translation alternatives which relate to the different possibilities of disambiguation.

- (13) *Lucie zeigte den Film ihrer Familie.*  
 a. *Lucie showed the film of her family.*  
 b. *Lucie showed the film to her family.*

The function of the NP in (13) *ihrer Familie* and the argument it relates to are not clear from the context the sentence provides. It can be understood as a genitive NP modifying *den Film* *the film* (*the film of her family*) or as a dative NP providing an (optional) dative argument of *zeigen* *to show* (*to show to her family*). (13) is an example of an *attachment ambiguity* combined to a *functional ambiguity* (also called *label ambiguity*, cf. article 24 (Egg) *Semantic underspecification*).

In FUDRT, when compositionally building up the semantic representation of the sentence, complements and adjuncts aren't applied to their arguments. Instead they are written to the *functor set* of the basic representation (of the noun, verb, etc.). Additionally,

there is a *set of conditions* (possibly empty) which captures constraints about the type and order of application as provided by syntactic or other contextual constraints. For (13) a corresponding analysis system computes the following:

$$(14) \quad l_{e_t, akt(het), mrv(-, PAST, a)} : \boxed{\begin{array}{l} e \\ \text{zeigen}(e) \\ \text{agent}(e, x) \\ \text{patient}(e, y) \\ t \subseteq e \end{array}} : \left\{ \begin{array}{l} \text{subj: } l_{x@HUM} : \text{Lucie}(x), \text{ obj: } l_{x@ARTEFACT} : \text{der}(\text{film}(y)), \\ \text{Func: } l_{z@HUMCOLL} : \text{ihr}(\text{familie}(z)) \\ \{(\text{Func}=\text{gen} \wedge \text{first}(l_2, l_3)) \vee \text{Func}=\text{dat}\} \end{array} \right\}$$

(14) consists of a verb representation and three functors originating from the three NPs. The function of two of them is clear: They are subject and object of the verb and fill the corresponding thematic roles of the verb representation. The contribution of the third is not yet determined: Either its functional type, *Func*, is dative and it is to be applied as such to the verb representation (simultaneously carrying out the corresponding thematic linking) or it is *genitive* and it is to be applied to the direct object. This alternative is captured by the disjunctive statement in the set of constraints.

FUDRSs use *labels* for structures. The constraint *first*( $l_2, l_3$ ) uses this. It means that the representation labeled by  $l_3$  is to be applied to the one labeled by  $l_2$ . (The convention is that  $l_i$  refers to representation  $L_i$ ). In contrast to ordering statements like  $l_n \leq l_m$  which mean that  $L_n$  is to be applied to an argument representation before  $L_m$  is, *first*( $l_n, l_m$ )-statements, type-theoretically, mean that the type of  $L_m$  is raised such that it can apply to  $L_n$  and that this application precedes applications involving  $L_n$ . Practically, this is executed by moving the functor  $L_m$  to the functor set of  $L_n$  (and from this position into functor sets of more deeply embedded functors in later steps of specification, where moving is guided by restrictions from the syntax-semantics interface). Using *first*-statements, attachment ambiguities can be represented satisfactorily.

With respect to  $L_1$  and  $L_2$ , there is no order of application given yet in (14). Note that in this representation corresponding specifications are superfluous, as applying subject before object gives the same result as object before subject in this case. However, if subject and object introduce quantified representations, the alternatives that  $\{l_i \leq 1/8\}$  and  $\{l_2 \leq l_1\}$  express, represent the two scope readings one gets in this case. This means: FUDRT representations can capture scope ambiguities also. ‘ $\leq$ ’-statements have been used since the very first outlining of UDRT.

Functors are functions from basic representations into FUDRSs (i.e. the results of applying them to representations show in essence the same tripartite structure as the depicted sentence representation – consisting of a basic representation, a functor set and a set of application conditions). Complex sentences can also be represented this way. Representations allow for (partial) disambiguation by (partial) application of functors in accordance with the constraints of the respective set of conditions.

Underlining as in *Lucie* marks an underspecified lexical structure (which stands for a function onto more precise interpretations the evaluation of which is connected to constraints specified in the lexicon).

Decorations are used to inform about the referential *discourse referent(s)* (DRF) provided by the corresponding structures and their type properties. In (14) it says among

other things that the sentence event is of *heterogeneous Aktionsart* and that its location time  $t$  has to be located in the contextual *past*. Decorations can also be used for adding pragmatic information to the representations: annotations about the type of speech act, about style and register used. (If recognizable by the system from text information!). In current LMT-implementations, information structure is represented in terms of relations between labels (identifying corresponding substructures of the sentence). We skip explanations about the details of the representations and the complete inventory of the formalism.

Using modern parsing and construction methods (chunk parsing, semantic construction from parse forests etc. cf. Abney 1991, Schiehlen 1996, Schmid & Schulte im Walde 2000), such underspecified semantic representations can be computed efficiently.

### 3.2. Transfer module

The transfer module constructs a target FUDRS from a source FUDRS. It is guided by the recursive translation function  $\tau$ . By default,  $\tau$  defines the translation of a structured representation to be a structured representation consisting of the translation of the basic representation and of the set of translations of the elements of the functor set. The set of application conditions is preserved, modulo renaming of application relations. This default translation is based on default translations of the grammatical relations,  $\tau_r$ , and on the translations of the basic representations which stem from lexical entries,  $\tau_n$  ( $n$  for lexical *node*).  $\tau$  normally takes the following shape therefore (AC for *application constraints*):

$$\tau(\text{BasicRep}_{\text{AC}} \left\{ \begin{array}{c} \text{rel}_1 : \text{Functor}_1, \\ \vdots \\ \text{rel}_n : \text{Functor}_n \end{array} \right\}) := \tau_n(\text{BasicRep}) \left\{ \begin{array}{c} \tau_r(\text{rel}_1) : \tau(\text{Functor}_1), \\ \vdots \\ \tau_r(\text{rel}_n) : \tau(\text{Functor}_n) \end{array} \right\}$$

Recursive transfer strategies like this have been suggested by Zajac (1989, 1990), Dorna et al. (1994) and others, typically for different kinds of typed feature structures (expressing syntactic, functional, semantic knowledge or mixtures of such knowledge, as in HPSG).

Note that  $\tau_r$ , just like the lexical  $\tau_n$ , is language pair specific: It translates German dass-sentences into English that-clauses (and French and Spanish que-sentences); ob-sentences into whether- (and si-)sentences; prepositional complements and adjuncts into prepositional phrases headed by the typical translations of the source prepositions etc.

Given this algorithm, (14) is translated into an FUDRS with isomorphic structure modulo adjustments as described. These default translations can be specified or overridden however by specific definitions from the lexicon. We sketch examples in the next section.

### 3.3. Features of a lexicon formalism

The bilingual lexicon provides translations of the words. It defines the contextual circumstances under which specific translations of words are to be preferred. According to the

stipulations above, it treats all kinds of translation mismatches mentioned in the introduction, except for those which are a matter of source analysis and target generation: In the FUDR transfer setting these are mismatches relating to different word order, different tense systems, different pragmatic conventions etc. (This means computing target tense forms and corresponding auxiliary structures from compact tense information (mtv-terms), putting pragmatic information into words, ordering words at surface etc. are tasks of generation and have nothing to do with transfer in this architecture). The transfer setting is *lexicallist* in the sense that it stores all knowledge which is specific to the language pair in the bilingual lexicon.

The lexicon formalism described in the following adapts a suggestion of Bernth (1992), McCord & Bernth (1998) for *Logic based Machine Translation* to the case of flat underspecified semantic representation and extends it by a number of instructions. (Both formalisms are used in commercial Machine translation systems, in *Personal Translator* and in *translate*, cf. Eberle 2001). It provides a number of  $\tau$ -instructions which can be combined in order to describe amendments to the default translation. There are *local* and *global*  $\tau$ -instructions. Local  $\tau$ -instructions describe specific requirements with respect to the functor set of a representation (they are about the *local domain* of a word or structure). Global  $\tau$ -instructions are about elements in the wider context of the representation, i.e. about representations which use it as a functor or as a substructure of a functor.

Local  $\tau$ -instructions define changes of three types: The role a functor plays with regard to the basic representation can be changed (instruction type  $T_1$ ); a functor can be suppressed (type  $T_2$ ) or a new one introduced (type  $T_3$ ).  $T_1$ ,  $T_2$  and  $T_3$  allow to specify all cases of incorporation and thematic divergence, as have been illustrated in section 2.1.7. For instance, (8) (*Peter würde der Wein nicht gefallen.* – *Peter wouldn't like the wine.*) is sufficiently described in the lexicon by the following entry of *gefallen* using a  $T_1$ -instruction:

- (15) • gefallen [<sub>subj(n), iobj1(n)</sub>]  
 $\tau$ : like [<sub>obj(n), subj(n)</sub>]

(15) relates to uses of *gefallen* that have an indirect object (the affix '1' makes the grammatical role it is assigned to obligatory).  $T_1$  makes use of the convention of the lexicon formalism that the arguments of the source and target frame relate to each other from right to left.

According to (15) therefore, the indirect object of the source representation is required to be the subject of the target representation and the source subject the target object.

A position 'e' in the target frame means that the corresponding functor of the source representation is suppressed; that is, a  $T_2$  statement.  $T_3$  introduces new arguments by adding *item(NEW-REL, DESCRIPTION)-terms* to the target frame, where *NEW-REL* describes the new relation and where *DESCRIPTION* is a recursively defined expression built from target words, semantic types, pointers to the lexicon etc., describing the new argument (for example *item(comp(p([in – str acc])), [flasche, det(e, pl)])*, with respect to a translation *to bottle – in Flaschen abfüllen*).

Global  $\tau$ -instructions can erase, modify or replace adjunct representations and also substructures of the wider context of the word representation such that, in principle, each part of the sentence representation can be addressed and manipulated from the perspective of each word (which is assigned a labeled structure). These global  $\tau$ -instructions do

this by identifying substructures via corresponding paths in the source representation and defining what is to be done with these structures in the target.

Transfer by  $\tau$ -instructions is very similar to LFG's *correspondence-based transfer* (cf. Kaplan et al. 1989). Basically, in both approaches, transfer is described by path equations which are assigned (*co-described*) to the entries of the monolingual source lexicon. (The stipulations of (15) correspond to the set of constraints  $\{\uparrow \text{PRED} = \text{"gefallen"}(\uparrow \text{SUBJ})(\uparrow \text{sc OBJ2})\}$ ,  $(\tau \uparrow) = \text{"like"}(\tau \uparrow \text{SUBJ})\tau \uparrow \text{OBJ}\}$ ,  $\tau(\uparrow \text{SUBJ}) = (\tau \uparrow \text{OBJ})$ ,  $\tau(\uparrow \text{OBJ2}) = (\tau \uparrow \text{SUBJ})\}$  in LFG notation).

However, here, in contrast to the setting of Kaplan et al. (1989) for LFG transfer, descriptions relate to flat semantics representations, not to f-structures, and statements can be made about substructures from outside the local domain of the word in the sentence representation. (For example, restructuring of the sentence can be triggered and controlled from the position of verb arguments and adjuncts). This is made possible as the internal representation of the FUDRS is not recursive but is realized as flat lists of information items (This is similar to transfer architectures used in the Verbmobil project mentioned in section 2.2.).

In Eberle (2001) it is shown that the  $\tau$ -instruction mechanism is powerful enough to treat head switching in the lexicon, even cases of embedded head switching. As this is a notoriously difficult problem discussed at various places in the literature, which to our opinion cannot be treated satisfactorily in the lexicon for the level of syntactic or functional structure, this is a strong argument in favor of the described semantics based transfer architecture (compare Sadler & Thompson 1991, Butt 1994, Dorna et al. 1998). We come back to this problem in the next section.

### 3.4. Dynamic evaluation

Frequently, lexical transfer statements are connected to specific contextual conditions. Assume that the VP of example (13) *einen Film zeigen* is translated into *passer un film* in French if there is no indirect object and into *présenter un film* if there is one. This can be represented in the MT lexicon as follows:

- zeigen [subj(n),obj(n),iobj(n)]
  - c: d(obj):FILM &  $\vdash_d$  d(iobj):e
- (16)  $\tau$ : passer
- c: d(obj):FILM &  $\vdash_d$  d(iobj):f
- $\tau$ : présenter

Here, c stands for *condition*. *d* means *down* and relates a structured representation to one of its functors; *d(obj)* to a functor whose role is *obj*, etc. *e* means that the corresponding structure is *empty*, i.e. that the corresponding path does not exist. *f* means *filled*. FILM says that the corresponding structure is of type FILM. On the basis of the representation (14) neither *d(iobj):e* nor *d(iobj):f* can be entailed. However, in a model of the representation one of both holds. Transfer forces a decision in this case. Which one of the two solutions is more appropriate or more likely depends on default or statistics knowledge available to the system. The operator  $\vdash_d$  distinguishes weaker default assumptions from 'hard' inferences. Of course, in order to keep things consistent there must be bookkeeping



of these decisions. A minimal account of that is that the source representation is specified according to the assumption chosen by transfer. For (14) this means to specify the representation to (14.dat) or (14.gen).

As the translation of (13) into English makes use of different prepositions, there must be a corresponding evaluation trigger in the German-English transfer component, even if there is no difference concerning the translation of the verb, as in (13). This could also be integrated in the lexicon similarly to the case of the French verb. However, as the different translations are instances of general regularities in this case (per default German genitive is translated by an English of-phrase and dative by a *to*-phrase, independently of the structures modified), it is more efficient to handle this case in the general transfer component. Note that this doesn't mean to specify particular translations there, but to integrate a corresponding disambiguation trigger, as it is clear that transfer into English always must disambiguate the type of structural ambiguity represented by (13) because of the case representation mismatch between German and English.

Other such disambiguation triggers must be provided for the resolution of (certain) pronouns (see examples (3 and 4)). In the system that we sketch here the algorithm of Lappin & McCord (1990) and Lappin & Leass (1994) is used. This is a classical resolution algorithm (and a kind of standard for all successors). It is tailored for slot grammar analyses but can be used for other syntactic analyses also. It ignores semantic knowledge and is based on syntactic constraints using (handcrafted) weighting of structural configurations for computing rankings. It has been improved significantly by exploiting semantic knowledge from selectional restrictions – mainly with respect to possessive pronouns- and accessibility constraints (compare Eberle 2003). There are other analytic procedures and there are purely statistical methods also (for an overview compare Mitkov 1999, 2002, for a statistical approach Ge, Hale & Charniak 1998). We do not go into detail with this topic here.

As many disambiguations of ambiguous words are interrelated – where the resolution of referential terms is an important example, but not the only one –, maintaining overall consistency is a hard problem for Machine Translation. If, less ambitiously, one aims at more local consistency only (of paragraphs, instead of texts) and if one uses weak definitions of consistency only, the problem is significantly reduced however. This is what one is forced to do in practice. This means, keeping translation consistent is a matter of approximation.

#### 4. Flat, underspecified rule-based MT and current empirical MT trends

During the last decade there has been significantly growing interest to combine features from different types of Machine Translation. In (2.3.) we basically saw three trends towards hybrid systems. Combining EBMT and SMT enables going (far) beyond the word level with defining statistical translation models. Monolingual collocational information helps to circumvent the sparse data problem. Incorporating analytic (linguistic) knowledge into SMT serves the same goal (because statistics can be defined at the level of basic forms instead of inflected forms; in general for more abstract and therefore more frequent elements as are available by linguistic classification and abstraction).

Provided cautious syntactic and semantic representations as advocated for in this overview, a fourth issue seems viable and promising: a rule-based core system with

declarative analysis grammar and semantic construction, with transfer on the basis of flat semantic representations and with decision procedures where the ‘difficult’ decisions are founded on statistically gained knowledge from corpora.

Essentially, we see three types of knowledge which can help to make more justified decisions: selectional restrictions, preferences in the presence of structural ambiguities, operational criteria for lexical disambiguation and choice of transfer equivalents. A prerequisite for extracting reliable information of these types from corpora is that the available corpora are sufficiently *balanced* and sufficiently large.

#### 4.1. Learning selectional restrictions

There are two ways in which knowledge about (semantic) selectional restrictions of sub-categorized complements contribute to translation quality: Firstly, it can help to disambiguate ambiguous complements (which may be pronouns) and, conversely, it can help to disambiguate ambiguous syntactic heads by using the semantic relation they define in the opposite direction (compare section 1.2.2.). Secondly, it can contribute to structural disambiguation – if there are different possibilities for identifying the argument of a syntactic head (in the presence of coordinations for example). However, as has been discussed in section 1.2.3., there are a number of phenomena which suggest to model semantic selectional restrictions not as hard rules, but as default rules or to assign them context dependent weights. A prerequisite of learning selectional restrictions from corpora is to have a hierarchy of semantic types available and a corresponding classification of the lexicon. If there is an analysis system available which disposes of correspondingly structured lexical information, a maximum-likelihood approach is natural. An example is the suggestion of Bernth & McCord (2003) for slot grammar analysis: corpus sentences are parsed and the results are used to estimate the distribution of semantic types with respect to the frames as assigned to the words in the lexicon. If there is no a priori information about semantic classes such information can be built – and typically is built – from freely available lexical knowledge resources like WordNet (Fellbaum 1998; for an overview compare Schulte im Walde 2008). Provided a semantic typing of (part of) the lexicon a number of data driven extensions of the semantic knowledge (which can support disambiguation for Machine Translation) suggest themselves: Frame distribution patterns can be used to compute semantic typing of syntactic heads, in particular of verbs from corpora (cf. e.g. Schulte im Walde et al. 2008), and, more generally, to extract semantic collocations and contribute to *word sense disambiguation* in general (cf. Yarowsky 2000, Manning & Schütze 1999). Integrating bootstrapping methods, available knowledge about semantic classes as such and classification can be used to complete the lexical knowledge in this respect.

#### 4.2. Learning structural preferences

A lot of erroneous translations are caused by structural misinterpretations; either directly, because the target language provides different structures for the alternatives, or indirectly, because effects from selectional constraints may change. A notorious structural problem is PP attachment. Hindle & Rooth (1993) is an early attempt to improve analysis in this respect by statistical information. It has become very influential in the sequel and is at the basis of a number of extensions and improvements (cf. Volk 2001). As with other phenomena results become more meaningful and reliable if semantic types are considered

instead of words when computing probabilities for structural alternatives (cf. Stetina & Nagao 1997). As sketched in the previous paragraph, using (partly) informed systems for analysis in a bootstrapping approach seems very promising to compile preference knowledge for many kinds of structural ambiguities.

### 4.3. Learning contextual restrictions of transfer equivalents

A third strand of bootstrapping the translation system relates to translation proper. It is known that the use of *cognates* improves statistical word alignment significantly (cf. Simard, Foster & Isabelle 1992). This finding is widely used in modern hybrid systems, mixing EBMT and SMT, in order to learn new reliable equivalences – between simple words or between multi word expressions or structures (cf. Kondrak, Marcu & Knight 2003, Ma et al. 2008). From the perspective of human readable dictionaries it is not sufficient however to have probabilities available for transfer equivalences (as such or connected to word n-grams). The human user wishes operational conditions describing the structural circumstances under which a particular translation is preferred. This is identical to the needs of a RBMT system. A hybrid system built from a RBMT system needs both: exact structural conditions (as in example (16) above) labelled by a probability value which makes the system much more flexible and robust, in the presence of stylistic variation, metonymy, etc. Eberle & Rapp (2008) describes an approach for extracting such knowledge for a LMT system with underspecified semantic representation. Such approaches use the analyses of both source and target sentence in sentence aligned parallel corpora and the existing knowledge about transfer equivalents to extract new transfer relations with conditions to be abstracted from the given context (using semantic types) by testing significance against the sentences in the corpus.

## 5. Conclusion

Ambiguity is the hardest problem for high quality Machine Translation. Most ambiguities are semantic ambiguities. Classical rule-based systems are overcharged with taking into account all relevant meanings in the lexicon and disambiguating the correct meaning of words and structures in the sentence in order to compute correct translations. Statistics based systems and, more generally, data driven systems are confronted with sparse parallel data for many phenomena and language pairs and with insufficiently balanced corpora. Hybrid systems are promising as they may minimize the disadvantages of the contrasting approaches and optimize the advantages. Doing translation at the level of underspecified semantic representation with semantically typed lexical elements seems promising too. It avoids expensive disambiguation as far as possible. It widely abstracts away from syntactic and other formal language specific idiosyncrasies, in particular with regard to defining and using contextual clues for choosing translation equivalents. A direct consequence of this is that the remaining need for disambiguation in analysis and transfer relates to a wide extent to relations between semantic classes, not to relations between words. Such knowledge can be extracted from corpora by statistical methods if these corpora are annotated by corresponding classifications before. This can be carried out using the system and its resources. Such abstract relational knowledge is much more reliable in principle than knowledge on the basis of words, because corresponding

evaluations refer to types of sentences and words, not to tokens and reduce the sparse data problem significantly therefore.

We venture therefore the statement that rule-based Machine Translation will survive and semantics will be a prospective feature of it, provided there is used a modular architecture with lean declarative analysis and transfer components and interfaces for integration of statistics information as obtainable from corpora which are annotated by categorial and semantic evaluations of the sentences, where annotation is carried out with the help of the MT system itself.

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Kurt Eberle, Heidelberg (Germany)

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