

The Cambridge Handbook of

Morphology

edited by **Andrew Hippisley**
and **Gregory Stump**

The Cambridge Handbook of Morphology

This book describes the diversity of morphological phenomena in the world's languages, surveying the methodologies by which these phenomena are investigated and the theoretical interpretations that have been proposed to explain them. The *Handbook* provides morphologists with a comprehensive account of the interlocking issues and hypotheses that drive research in morphology; for linguists generally, it presents current thought on the interface of morphology with other grammatical components and on the significance of morphology for understanding language change and the psychology of language; for students of linguistics, it is a guide to the present-day landscape of morphological science and to the advances that have brought it to its current state; and for readers in other fields (psychology, philosophy, computer science, and others), it reveals just how much we know about systematic relations of form to content in a language's words – and how much we have yet to learn.

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Andrew Hippisley
Gregory Stump

Abbreviations

1	first person
2	second person
3	third person
ABL	ablative
ABS	absolutive
ACC	accusative
ACT	active
ADESS	adessive
ADJ	adjective
ADV	adverb
AGR	agreement
AGT	agent
APPL	applicative
ART	article
ASP	aspect
BEN	benefactive
CAT	category
CAUS	causative
CISLOC	cislocative
CLF	classifier
COM	comitative
COMP	complementizer
CONJ	conjugation
CONJN	conjunction
CONS.ADJ	consequent adjunctive
CONT	continuous
DAT	dative
DEF	definite
DEM	demonstrative
DESID	desiderative
DET	determiner
DIR	direct

DISTR	distributive
DU	dual
ELAT	elative
ERG	ergative
EXCL	exclusive
F	feminine
FUT	future
FV	final vowel
GEN	genitive
GEND	gender
HAB	habitual
ILL	illative
IMM	immediate
IMP	imperative
IMPF	imperfect
INCOMPL	incompletive
IND	indicative
INESS	inessive
INF	infinitive
INFL	inflection
INS	instrumental
INTR	intransitive
INV	inverse
IPFV	imperfective
IRR	irrealis
ITR	iterative
LEX	lexical
LOC	locative
M	masculine
MID	middle
MOR	morphological
N	neuter
NEG	negative
NMLZ	nominalizer
NOM	nominative
NON.EXP	non-experiencer
NUM	number
OBJ	object agreement
OBL	oblique
P	patient
PASS	passive
PAT	patient
PER	person
PFV	perfective

PL	plural
POSS	possessor
POT	potential
PREP	prepositional
PRET	preterite
PREVB	preverb
PRF	perfect
PROG	progressive
PRS	present
PSE	participant in speech event
PST	past
PTCP	participle
REFL	reflexive
REV	reversive
SEM	semantic
SBJ	subject agreement
SBJV	subjunctive
SG	singular
SMI	semeliterative
ST	stative
SUF	suffix
SYN	syntactic
TAM	tense, aspect, mood
THEME	theme vowel
THM	thematic
TNS	tense
TR	transitive
TRANS	transitivizing suffix
VOC	vocative
WK	weak verb, German

1

Introduction

Andrew Hippisley and Gregory Stump

1 Canonical Morphology

To many people, the term “morphology” immediately evokes certain canonical properties of word structure in natural language. These include the following:

- morphology involves assembling complex word-forms from stems and affixes (i.e., morphology is **concatenative**);
- rules of morphology apply to whole classes of stems in an extremely general way, if not exceptionlessly (i.e., morphology is both **regular** and **productive**);
- the semantic and grammatical content of a complex word-form is calculable from the stem and affix(es) from which it is assembled (i.e., a word-form’s morphological structure is semantically and grammatically **compositional**); and
- the semantic and grammatical units that word-forms express stand in a one-to-one correspondence to the particular stems and affixes from which those forms are assembled (i.e., morphological form and morphological content are **isomorphic**).

Introductory linguistics textbooks suggest that the traditional notion of the morpheme is ideally suited to the representation of morphological systems possessing these canonical properties.

The term “morphology” does, however, evoke a rather different picture in the minds of a good many linguists (certainly in the minds of most morphologists, if we may take ourselves as representative), for whom a language’s morphology is not simply a collection of canonical patterns, but rather a system involving varying degrees of adherence to and deviation from such canonical patterns. Some deviations can be dismissed as instances of gross irregularity; for instance, the suppletive portmanteau *worse* shares the combined content of the adjective *bad* and the comparative

suffix *-er*, but does not share any aspect of their form. But there are also highly methodical deviations from canonical morphology, and, cross-linguistically, these are both surprisingly common and surprisingly varied in their characteristics.

The canonical correspondence between content and form, for example, is overridden by a range of widely observable phenomena:

- In instances of **cumulative exponence**, a word exhibits a one-to-many relation between units of morphological form and units of content (as in the case of the *-s* in *sings*, which is an exponent person, number, tense and mood).
- In instances of **overlapping exponence**, a word has distinct morphological markings that express overlapping content (as in the case of Sanskrit *yuñj-yā-m* ‘I would join,’ in which *-yā* realizes the optative active and *-m* realizes the first-person singular active).
- In instances of **extended exponence**, a single semantic property receives more than one morphological expression in the same word (as in the case of the word *a-n-lokk-a-c^hi-n* ‘we did not run’ in Chhatthare Limbu [Kiranti; Nepal], whose morphology [1.INCL-NEG-RUN-PST-DU.SBJ-NEG] includes two expressions of negation; Tumbahang 2007: 228).
- In instances of **allomorphy**, the same content is realized by distinct morphological markings in distinct contexts (as the past tense is expressed by /d/ in *leaned* /lind/ but by /t/ plus stem ablaut in *meant* /ment/).
- In instances of **homophony**, the same morphological marking expresses different content in different contexts (as the /d/ in *leaned* expresses past tense in *They leaned on it* but past participial content in *They’ve leaned on it*).
- In instances of **homomorphy**, distinct lexemes not only share the same stem(s), but are alike in every detail of their inflection (as in the case of *WEAR₁* ‘have [clothing] on’ and *WEAR₂* ‘abrade’).
- In instances of **underdetermination**, a word’s morphology does not fully determine its content (as in the Sanskrit injunctive *gacchat* [mā *gacchat*! ‘s/he must not go!'], whose morphology has no overt expression of injunctive mood: *gaccha-* is a present-system stem and *-t* is the default exponent of the third-person singular active, both of which also appear in the third-person singular imperfect indicative active form *a-gaccha-t* ‘s/he went’).
- One use of the label **morphomic** (Aronoff 1994) is to categorize formal patterns that are incoherent in their grammatical content (as in Hua [Trans-New-Guinea], where the second-person singular and the first-person plural recurrently employ the same verb agreement marking, despite the fact that they are alike in neither person nor number; Haiman 1980).
- Similarly, **syncretism** is the systematic identity of word-forms expressing distinct content (as in the inflection of English *put*, whose infinitive, default present indicative, past, irrealis [*if he put it away*

tomorrow], subjunctive [*require that he put it away tomorrow*], and past participial forms are all alike).

- In instances of **deponency**, the same morphological marking has a default content in the inflection of one class of stems but a contrasting content in the inflection of some complementary class of stems (as the default passive morphology of Latin *parātur* ‘is being prepared’ doubles as the active morphology of the deponent verb form *cōnātur* ‘is trying’).
- In instances of **defectiveness**, the morphological expression of some specific content is unexpectedly lacking (as in the inflection of French *frīre* ‘fry,’ which simply lacks plural forms in the present indicative).
- In instances of “**empty**” **morphology**, a morphological marking expresses no semantic or grammatical content (as in Sanskrit, where the empty “linking vowel” *-i-* appears in the infinitive form of some verbs but not others, e.g. *car-i-tum* ‘to move’ but *kar-tum* ‘to do’).

Such deviations from canonical morphology uncover a variety of apparent dichotomies, and these are the loci of theoretical dispute: morphological theories vary according to the importance they place on particular dichotomies, and indeed according to whether they treat a particular dichotomy as real or false.

2 Morphological Dichotomies

Morphological dichotomies fall into a range of cross-cutting domains. These include dichotomies of form (§2.1), expressiveness (§2.2), and function (§2.3); typological dichotomies (§2.4); and dichotomous differences of theoretical architecture (§2.5). Theorizing about morphology makes it necessary to commit oneself with respect to a variety of dichotomous questions. Is a given opposition theoretically essential; real but theoretically insignificant; or simply illusory? Should a theory be guided by one assumption, or by its opposite?

2.1 Dichotomies of Morphological Form

At the level of morphological form, there is debate about basic units. Should morphemes be taken as the fundamental units of morphological analysis, or are words the fundamental units? In principle, both are units that might enter into the definition of a language’s morphology, and the centrality of one by no means excludes the centrality of the other from a conceptual point of view. But the debate is tangled by the history behind the morpheme. What is a morpheme? A minimal pairing of form and content (according to which *foxes* and *oxen* do not share any morphemes; Bloomfield 1933) or a minimal contentive unit of morpholexical

factorization (according to which *foxes* and *oxen* share the plural morpheme; Harris 1942; Hockett 1947)? However one chooses to define it, the morpheme has, over the years, accumulated a good deal of theoretical baggage, including the controversial hypotheses (1) and (2).

- (1) A word-form's content is fully determined by its component morphemes.
- (2) Morphemes are the only source of a word-form's content.

According to hypothesis (1), morphemes have a central role in both the formation and the interpretation of word-forms: just as a word's form can be exhaustively factored into a sequence of morphemes, so its content is a function of that of its component morphemes. The phenomenon of underdetermination (see again the Sanskrit injunctive *gacchat* in §1) constitutes *prima facie* counterevidence to this hypothesis; advocates of the morpheme have therefore sometimes resorted to postulating empty morphemes, which contribute to a word-form's content without contributing to its form. Skeptics object that this way of buttressing (1) simply renders it unfalsifiable.

According to hypothesis (2), a word-form gets its content purely from the morphemes into which it is segmented. On this view, the status of *written* as a past participle stems primarily from the morpheme *-en*, which triggers the ablaut modification */ai/* → */i/* as a secondary effect. This hypothesis seems to run afoul of instances like *sung*, whose status as a past participle is signaled by ablaut alone; one can counter this kind of evidence by appealing to zero morphemes that trigger ablaut, again raising the issue of falsifiability.

Those who regard the morpheme as the central unit of morphological analysis tend to view the dichotomy of concatenative and nonconcatenative morphology as a stark one: on this view, morphology is primarily concatenative, and nonconcatenative effects are associated with (overt or zero) morphemes purely as a secondary phenomenon. Seen in this way, morphology is very much like syntax in that it primarily involves complex combinations of discrete segmentable units.

But not all morphologists place this kind of importance on the distinction between concatenative and nonconcatenative morphology. Many see the concatenative/nonconcatenative dichotomy as trivial, assuming that affixes and ablaut are but two of the many functionally equivalent means by which a particular piece of content might be expressed. Under this point of view, the notion "morpheme" has less theoretical importance than the notion "exponent," which covers any sort of minimal morphological expression of content, including instances of ablaut, accentual or tonal modification, consonant gradation, metathesis, subtraction, and reduplication as well as affixation. Once the morpheme is deprived of its theoretical centrality, hypotheses (1) and (2) give way to other options, such as (3).

- (3) A word-form's content determines its morphological form.

The realizational view of morphology implied by this hypothesis has been energetically pursued in recent years (Matthews 1972; Anderson 1992; Stump 2001, 2016).

If the notion “morpheme” is contentious, so is the notion “word.” Morphologists differ widely on how to represent the internal morphological structure of a complex word-form. Some (Selkirk 1982; Lieber 1992; Halle and Marantz 1993) hold that the internal morphological structure of a word-form is a constituent structure having morphemes as its terminal nodes; others (Crysmann and Bonami 2016) hold that it is an ordered sequence of discrete morphs; and still others (Janda 1983; Anderson 1992; Stump 2001) maintain that a complex word-form has no internal morphological structure distinct from its internal phonological structure.

Not surprisingly, this diversity of viewpoints engenders related disagreement on how complex word-forms are defined. Some hold that a complex word-form is assembled from its component morphemes by ordinary principles of syntax (e.g. by phrase structure rules and head movement); others, that a complex word-form is defined through the application of morphological rules to a more basic stem; and still others, that a complex word-form arises by analogy to existing lexical patterns. Assumptions about the structure and definition of word-forms naturally flow from more global assumptions about the position of morphology in the architecture of grammar (§2.5).

2.2 Dichotomies of Morphological Expressiveness

Some morphological dichotomies pertain to the expressiveness of a language’s morphology. While morphology is canonically productive, a lot of morphology is unproductive. What is the status of unproductive morphology? Some maintain that it is purely vestigial, present in fossilized form in a language’s lexicon but not part of the domain of its synchronic morphological system. But empirical measures (Baayen 1993, 2009; Baayen and Renouf 1996) show that productivity is in fact a cline which presents no sharp borderline between synchronic and vestigial morphology. Moreover, morphology serves both to define new words and to analyze redundancies among existing words, and even unproductive morphology such as the *-th* of *length*, *width*, *strength* is associated with analyzable redundancies in the lexicon. For this reason, many view differences in productivity as differences of degree rather than of kind in the definition of a language’s morphology.

The regular/irregular dichotomy is similarly problematic. One can surely point to extreme cases (the canonical regularity of present-participial morphology in English vs. the utter irregularity of the suppletive portmanteau *worse*), but like productivity, regularity is a cline. The syncretism of past- and present-tense forms in the inflection of English verbs such as *shut* is irregular to the extent that it fails to conform to the regularity of the

default pattern of *gut/gutted*, but it is regular to the extent that the verbs exhibiting this pattern of syncretism are phonologically alike, ending in oral alveolar stops (*beat, bet, burst, cast, cost, cut, hit, hurt, let, put, quit, rid, set, shed, slit, split, spread, thrust*). Such facts again suggest a difference of degree rather than of kind in the definition of a language's morphology. Yet, experimental evidence has led many psycholinguists to conclude that regular morphology and irregular morphology are stored and processed differently by the human brain (Pinker and Prince 1988, 1991; Pinker 1991; Jaeger et al. 1996).

2.3 Dichotomies of Morphological Function

Dichotomies of morphological function are also central to motivating fundamental features of a language's grammatical architecture. Traditionally, morphology is assumed to serve two different kinds of functions in language. On one hand, some morphology serves to define the stems of newly created lexemes; such morphology is traditionally labeled "word formation" (a somewhat regrettable choice of terminology, given the ambiguity of "word"; Matthews 1991: 24ff.). On the other hand, some morphology serves to define the various word-forms by which a given lexeme may be realized in different syntactic contexts; such morphology is traditionally labeled "inflection." Morphologists disagree about the theoretical significance of this traditional dichotomy. Some hold that it has no real importance—that the characteristics ascribed to word formation and those attributed to inflection do not define a clearly delineated boundary in a language's morphology, but instead exist on a continuum. Others maintain the opposite view, that inflection and word formation are defined by distinct grammatical components. It is clear that at the level of morphological markings, there is no essential difference between word formation and inflection; for instance, *-en* can serve a derivational function (*ripen, woolen*) or an inflectional function (*oxen, eaten*); thus, if there is a distinction between word formation and inflection, it is a distinction not between kinds of markings, but between the kinds of uses to which those markings may be put.

Another important dichotomy in morphological function has attracted a good deal of interest in recent years: this is the distinction between morphosyntactic properties and morphomic properties. Morphosyntactic properties are grammatical properties to which morphology, syntax, and semantics are all potentially sensitive; in English, for instance, the association of *dogs* with the morphosyntactic property "plural" is expressed by its morphology (the suffix *-s*), determines its capacity to enter into particular syntactic combinations (*dogs were/*was awake, all/*each dogs*), and determines its plural semantics (which distinguishes the meaning of *I saw the dogs* from that of *I saw the dog*). By contrast, morphomic properties are grammatical properties to which morphology alone is sensitive (Aronoff 1994);

in modern English, for instance, the association of *helped* with the morphomic property “weak” is expressed by its morphology (the weak past-tense suffix *-ed*) but has no consequences whatever for either its syntax or its semantics. Inflection-class properties such as “weak” or “first declension” are familiar examples of morphomic properties, but, as Aronoff suggests, they only begin to hint at the much more extensive role that morphomic properties may play in the definition of a language’s morphology; thus, Round 2013 demonstrates the need for extensive reference to morphomic properties in his analysis of Kayardild morphosyntax. Moreover, Maiden 2005 argues that such properties play a significant role in the evolution of inflectional systems. Many morphologists have come to regard the distinction between morphosyntactic and morphomic properties as clear evidence of an autonomous morphological component in the architecture of a language’s grammar.

2.4 Typological Dichotomies

The extreme diversity of morphological systems reflects a variety of typological contrasts, for which a number of different classificatory schemes have been proposed. Most familiar is the scheme (developed progressively by Schlegel 1808, Humboldt 1836, and Sapir 1921) in which individual word-forms are classified according to their degree of synthesis (with analyticity and polysynthesis as extremes) and their degree of segmentability (with agglutination and fusion as extremes).

More recently, canonical typology (Corbett 2005; Brown et al. 2013) has been applied in all kinds of classificatory dimensions, focusing on the logical extreme implied by the definition of a given phenomenon and on the degrees and directions of deviations from this extreme. Corbett (2009), for example, proposes a cluster of canonical characteristics for inflection-class systems; few languages actually embody the canonical ideal, but languages in general can be classified according to the manner and extent to which they approximate this ideal.

Currently, there is also a burgeoning interest in ways of classifying morphological systems according to their relative complexity (as part of a larger concern with the nature of linguistic complexity; Hawkins 2004, Miestamo et al. 2008; Sinnemäki 2011). Because the notion of complexity is itself complex, a number of complementary approaches to the measurement of morphological complexity have been investigated; some are enumerative (equating complexity with numerousness), and others integrative (assessing the complexity of the relations among a system’s parts). The extent to which morphological systems vary within all of these typological dimensions is quite striking, but there are also apparent limits; for example, Ackerman and Malouf (2013) show that despite considerable cross-linguistic variability in enumerative complexity, morphological systems tend to vary much less widely with respect to

such measures of integrative complexity as that of an inflectional paradigm's average conditional entropy.

2.5 Theoretical Dichotomies

At the most general level, morphological theories must choose between a number of mutually exclusive premises. Incremental theories hold that a word-form's content is cumulative, arising through a kind of summing of the content of its parts; on this view, the past-tense form *walk-ed* acquires its content through the combination of the stem *walk-* (which contributes the lexical meaning "walk") with the suffix *-ed* (which contributes the property "past tense"). Realizational theories, by contrast, hold that a word-form's content logically precedes its form, which it in fact determines; on this view, it is the association of *walk* with the property "past tense" that licenses the affixation of *-ed*. Though the latter approach might seem to be the "top-down" equivalent of the former, the two approaches make different predictions. For instance, the realizational approach leaves open the possibility that a word-form may have content that simply goes unexpressed by its morphology, as in the case of the past-tense form *put*; it likewise leaves open the possibility that some part of a word-form's content may license more than one marking, as the property "plural" licenses both the stem choice and the suffix in *knife-s*.

Cross-cutting the choice between incremental and realizational approaches is the choice between lexical theories and inferential theories: the former presume that the word-form *walk-ed* is assembled from two lexical items, very much like the phrase *walk home*; inferential theories, by contrast, assume that the past-tense forms *sang* and *danced* are inferred from the stems *sing-* and *dance-* by rules that associate a particular morphological marking (e.g., $i \rightarrow a$ ablaut or *-ed* suffixation) with the property "past tense" (either as realizations of this property or as formal concomitants of its introduction into a word's property set).

Theories that are both inferential and realizational often attribute special importance to inflectional paradigms: if a paradigm is seen as a set of cells each of which pairs a stem or lexeme with a morphosyntactic property set, then a language's inflectional morphology may be seen as a system of rules for inferring the realization of cells: $\langle \text{WALK}, \{\text{past tense}\} \rangle \rightarrow \text{walk-ed}$. By contrast, theories that are both lexical and incremental often dispense with paradigms on the assumption that a word's form and content are an effect of the same principles of lexical insertion and feature percolation relevant for the formation and interpretation of phrases.

In inferential-realizational theories, the rules that infer the realization of a paradigm's cells may be of two kinds. On the one hand, a rule may deduce the realization of a cell $\langle L, \sigma \rangle$ directly, by reference to the lexical properties of the lexeme *L* and to the morphosyntactic property set σ ; this might be termed an exponence-based approach. In this approach, the cell

$\langle \text{CAPERE}, \{1\text{sg fut ipfv ind act}\} \rangle$ might be realized as *capiam* ‘I will take’ by means of a rule realizing the lexeme *CAPERE* and the property set $\{1\text{sg fut ipfv ind act}\}$ as the stem *capi-* suffixed with *-am*. On the other hand, a rule may deduce the realization of a cell $\langle L, \sigma \rangle$ indirectly, by reference to the realization of one or more other cells; this might be termed an implicative approach. In this approach, the cell $\langle \text{CAPERE}, \{1\text{sg fut ipfv ind act}\} \rangle$ might be realized as *capiam* by means of a rule specifying that if $\langle L, \{1\text{sg prs ipfv ind act}\} \rangle$ is realized as *Xiō*, then $\langle L, \{1\text{sg fut ipfv ind act}\} \rangle$ is realized as *Xiam*; this rule would in effect deduce the form of *capiam* from that of *capiō* ‘I take.’ The exponence-based and implicative approaches have different strengths; Blevins (2006), who distinguishes these approaches as “constructive” and “abstractive,” portrays the choice between them as dichotomous, but in fact nothing prevents a morphological theory from employing both approaches side by side, and there are indeed good reasons for favoring such a theory (Stump 2016; Chapter 14).

The fundamental point of contrast among current theories of morphology concerns the relation of morphology to syntax. The issue is whether these constitute a single system defined by the same set of principles, or two distinct grammatical subsystems, defined by distinct sets of principles and interfacing in a restricted way. In other words, the issue is whether morphology constitutes an autonomous grammatical component or is instead reducible to syntax. At present, the competition among these contrasting perspectives is vigorous, and shows no sign of abating soon.

3 Outline of the Handbook

The chapters that follow elaborate on the complex of dichotomies described above as well as on numerous debates surrounding them.

3.1 Foundations of Morphological Theory

The first part of the book lays the foundations on which the balance of the book rests. It serves as an exposition of the basic issues that relate dichotomies of morphological function, morphological form, and morphological expressiveness, aspects of which reverberate throughout the book.

In Chapter 2 (“Two Morphologies or One? Inflection versus Word-formation”), Andrew Spencer examines the evidence for two distinct roles of morphology, the derivational role of creating new words and the inflectional role of defining the inventory of forms that a word may assume according to its syntactic context. He turns the question into an investigation into possible types of *lexical relatedness*, where prototypical inflection and derivation share the space of lexical relatedness possibilities with types that blur the distinction and threaten to dissolve the dichotomy. In instances of transposition, for example, the derived word, though different

from its base with respect to part of speech, nevertheless retains its fundamental meaning and very often its form. If the minimal sign is the lexeme rather than the morpheme, then relatedness among words may be manifested at several levels, a complication that raises potential doubts about the derivation-inflection distinction. Spencer poses the question: can you always determine whether two word-forms realize the same lexeme or different lexemes? His answer lies in the nature of morphological rules: rules that introduce a new lexeme index (derivation) and those that don't (inflection), where a lexeme's index is a crucial component of its representation on multiple levels. On this view, the boundary between inflection and derivation is real, if not always easily discerned.

In Chapter 3 ("The Minimal Sign"), James Blevins addresses a fundamental formal dichotomy: if language is a system of signs, is the morpheme or the lexeme the smallest unit in the grammar where form and function get associated? Which one of these should morphologists consider their basic unit of analysis? The answer, he argues, depends on one's analytical goal. A morpheme-based approach has greater a chance of wringing out all redundancy in the form-meaning association: the nominative singular for several classes of Latin nouns involves a formative /s/, so it should be isolated as a recurrent unit of form mapping onto a discrete unit of meaning. But morpheme-based analyses are sometimes too granular, failing to accommodate such familiar phenomena as underdetermination (§1); lexeme-based approaches afford a simpler and more explanatory account of such phenomena. Blevins distinguishes among lexeme-based approaches according to whether their definitions are exponence-based or implicative in character. The implicative approach is discussed at greater length in Chapter 12; two exponence-based theories are examined in Chapters 17 and 18.

In Chapter 4 ("Productivity"), Georgette Dal and Fiammetta Namer discuss the nature of morphological productivity. They distinguish qualitative conceptions of productivity from quantitative measures, which have the advantage of being both more objective and more replicable. Because the more productive parts of a morphological system inevitably enjoy more prominence in the analysis of a language's grammar, productivity is seen as a key variable in morphological theory and description. Quantitative measures, however, show that productivity is a scalar notion—that any attempt to bifurcate a language's morphology into productive and unproductive parts is bound to prove artificial. Dal and Namer discuss the ways in which studies on productivity have influenced morphological research. Such studies are partly responsible for a methodological shift from introspection to empirical investigation, as researchers have made increasing use of corpora, search tools, and statistical techniques. Productivity studies have also pointed the way to a more usage-based approach to word formation, through the preference of corpus investigation over dictionaries.

3.2 Issues in Morphological Theory

Morphological theories are quite disparate in their assumptions and methods, but they are bound by a shared concern with certain perennial issues of form and content. What is the nature of morphological alternations? Where a word's definition involves a combination of morphological markings, how is this combination constrained? How does morphology express meaning? Is morphology like or unlike syntax? Are paradigms important to the definition of a language's morphology?

In Chapter 5 ("Alternations: Stems and Allomorphy"), Mary Paster looks at how a word's stem may vary depending on morphological context, despite the canonical expectation that it should remain constant. She distinguishes *non-suppletive allomorphy* (stem variation that is due solely to phonological processes) from *suppletive allomorphy* involving variation that implicates morpholexical conditions of one or another sort. Focusing on allomorphy of the latter kind, she distinguishes cases where the morphological context is the chief conditioning factor, from cases where the lexical entry itself determines stem choice and from cases where the morphological context involved may be characterized in phonological terms. Paster evaluates four frameworks with respect to a set of allomorphy "problem sets": lexical sub-categorization which assumes morphemes as minimal signs, Distributed Morphology, Optimality Theory and inferential-realizational approaches that make use of indexed stems. She concludes that one's preferred approach to allomorphy is largely determined by one's assumptions about where morphology resides in a language's grammar.

In Chapter 6 ("Morphological Semantics"), Paolo Acquaviva examines the morphological sign's *signifié*. Is morphological semantics special? Is the interpretation of morphology defined differently from that of phrase-level signs? How one addresses these questions depends directly on whether one assumes that the basic sign in morphology is the morpheme or the lexeme, and on whether one assumes that a language's morphology is defined by an autonomous component or by its syntax. While the semantics of lexemes can often be construed in referential terms, many morphological distinctions seem to express content whose semantic grounding is more plausibly seen as cognitive than as strictly referential. Moreover, unlike sentence-level interpretation, word-level interpretation is only indirectly related to articulated form. Acquaviva discusses a range of form-meaning mismatches demonstrating the lack of isomorphism between morphological structure and semantic structure. Even where there seems to be a direct link, the relation between what precisely is being expressed in the morphology and a concept is fuzzy. The chapter ends with a discussion about the universality of semantic-based morphological categories.

If form is not the sole basis for interpretation, what role if any does the ordering of affixes play? Marianne Mithun addresses this question in Chapter 7 ("Affix Ordering: Motivation and Interpretation") with reference mainly to polysynthetic words in various native American

languages – words a prominent feature of whose structure is the ordering of affixes. The chapter distinguishes approaches that attempt to insinuate insights from syntactic combinatorics – for example head movement, scope relations, and head ordering – from those that invoke purely morphological ordering principles, which may or may not be universal. For the latter, Mithun compares templatic descriptions of affix ordering with layered or hierarchical descriptions, where headedness and scope play a role in interpretation. Whatever descriptive device is used, it is argued that explanation should take full account of the kinds of synchronic ordering patterns to which particular diachronic developments tend to give rise – for example, as an effect of grammaticalization. Seen in this light, affix ordering, unlike constituent order, is an epiphenomenon. Speakers do not seem to parse exhaustively but interpret in chunks. The importance of affix ordering is really the light it sheds on the directions a morphological system can and cannot take.

Mark Aronoff's chapter ("A Fox Knows Many Things but a Hedgehog One Big Thing") takes Isaiah Berlin's famous division of thinkers and maps these categories onto the basic dichotomies in morphological theory: hedgehogs seek a single unifying theory, with the possible cost of deferring a full account of the data; foxes seek all the facts and, in their attempt to account for them, do not invariably insist on deriving their properties from a single set of interlocking principles. In this view, the choice between lexeme and morpheme (Chapter 3) is a choice between a fox concept and a hedgehog concept: hedgehogs fit the facts to the theory, even if this means sometimes resorting to such gambits as the zero morpheme. Aronoff contrasts the single-engine hypothesis behind the Distributed Morphology enterprise with lexicalism and the enriched conception of morphological machinery that it entails, in which the definition of a language's morphology makes essential reference to paradigms, stems, and morphemes. The roots of the hedgehog/fox dichotomy in morphology are traced back to Chomsky's recognition (in "Remarks on nominalization") that the relation between a verb and its nominalization cannot be plausibly attributed to a meaning-preserving transformation – that a different kind of machinery is needed to get the facts right. Morphology resists single-engine explanations because it is by nature contingent on a range of interacting factors, such as frequency effects and history, essentially the conclusion reached on affix ordering in Chapter 7. The chapter strongly implies that progress in morphology is bound to be driven by foxes, because the ecosystem of morphology involves cross-cutting principles and pressures whose interaction is far from interlocking, but often involves a reconciliation of conflicting demands.

Paradigms are the focus of the last chapter in Part II. In Chapter 9 ("The Status of Paradigms"), Gilles Boyé and Gauthier Schalchli present paradigms as an analytical device that can account for the form-function conflicts discussed in Section 1. Paradigms regulate the mapping of a "form

set” to a “feature set,” by allowing for variation in both. Making a distinction between content paradigm, where the cells express the feature sets needed by syntax, and form paradigms, the products of distinctly morphological rules, provides a path to accounting for such morphological mismatches as syncretism, deponency, defectiveness, suppletion, and overabundance (see again §1 and Chapter 17). A third kind of paradigm, the morphomic paradigm, catalogs the kinds of stem distribution that have no semantic basis (see Chapters 5 and 8). Boyé and Schalchli survey the role paradigms play in a range of morphological theories, from syntax-driven theories like Distributed Morphology and Word-Syntax to theories in which morphology possesses greater autonomy, such as A-morphous Morphology, Paradigm Function Morphology, Network Morphology, and Natural Morphology. (These receive fuller discussion in Part IV of the handbook.) The chapter includes a discussion of the value of positing paradigms for derivational morphology (see Chapter 2) and of the centrality of paradigms in implicative morphology (Chapter 3 and 12).

3.3 Morphological Principles

The issues raised in Part II inform principles that are the themes of the three chapters in Part III. Two of these are principles pertaining to the interface of syntax and morphology. According to lexicalism (the Principle of Morphology-free Syntax), no rule of syntax makes reference to the internal structure of a word or to purely morphological features. The complementary principle, the Principle of Syntax-free Morphology, concerns the nature of morphological rules; according to this principle, the morphological rules defining a word’s form are insensitive to that word’s syntactic context. Together, these principles entail that the shared vocabulary of syntax and morphology is highly restricted, essentially requiring a purely featural interface.

These principles embody a controversial theoretical dichotomy (§2.5), entailing a clear separation between syntax and morphology in the architecture of a language’s grammar. A third principle relates to complex interactions among rules and lexical entries; according to this principle, such interactions may be nonmonotonic, embodying default-override relations whose properties conform to universal inheritance principles. The final chapter in Part III elucidates an implicative principle according to which an inflected word’s form is defined not by rules relating particular morphosyntactic property sets to particular exponents, but by comparison to other forms in the same paradigm. None of the principles discussed in these three chapters is universally accepted; accordingly, each chapter details the evidence for and against the principle under discussion.

In Chapter 10 (“Lexicalism, the Principle of Morphology-free Syntax and the Principle of Syntax-free Morphology”), Paul O’Neill sets out the

history of lexicalism, a hypothesis about the separateness of syntax and morphology in a language's grammar; the ultimate basis for this hypothesis is the observational fact that phrase structure and word structure follow different patterns. O'Neill details the (ongoing) debates about where the border lies and about the relative merits of the strong and weak versions of the lexicalist hypothesis. He further discusses the development of the related "border control" principles, the principle of *lexical integrity*, and the *no phrase constraint*, and presents evidence for such controls as well as apparent counterevidence, such as clitics and compounding. While most theories accept the weaker or stronger version of lexicalism, Distributed Morphology rejects the border entirely. O'Neill argues that such a move denies purely morphological phenomena such as syncretism and morphomic distributions, illustrating with paradigms from Romance and Slavic.

In Chapter 11 ("Defaults and Overrides in Morphological Description"), Dunstan Brown presents the ways in which defaults have been used to shed light on the core part of the morphological system by explicating the dichotomies of morphological expressiveness—those of regularity and productivity (§2.2). Focusing on the allomorphy of affixal exponents more so than on stem allomorphy (Chapter 5), the chapter points to Generative Phonology and its essential use of the Elsewhere Condition as the entry point of defaults into modern linguistics. Versions of this principle (= "Pāṇini's principle") to regulate rules have been taken up in theories such as Paradigm Function Morphology and Network Morphology. Default as a rule is compared with default as a system, and these conceptions are mapped onto psycholinguistic rule-based approaches and work on language universals. Inheritance hierarchies are shown to allow for default *classes* relating to the system, where the shape of the hierarchy determines what the default is. Defaults are discussed in relation to the cognate notions of regularity, canonicity, productivity, and frequency.

In Chapter 12 ("Implicative Relations in Word-based Morphological Systems"), Farrell Ackerman and Rob Malouf point to principles of systematic organization in the developmental sciences as a way of better understanding the complexity of morphological systems. They outline the program of implicative morphology as opposed to exponent-based morphology, a dichotomy in the lexeme-based approach (§2.5). The surface rather than internal representation of words is the starting point for generalization, where it is the nature of surface contrasts in cells of a paradigm rather than the nature of rules of exponence that explains learnability, use, development, and change of complex morphological systems. The merits of this approach are illustrated with system-defying paradigms from Dinka, Mari, and Pite Sami among others. The chapter presents measures of complexity such as conditional entropy and number and nature of principal parts. This approach evinces a contingency-based view of morphology as a complex adaptive system.

3.4 Morphological Frameworks

Part IV of the handbook offers a sketch of major morphological frameworks, each of which is discussed in relation to the theoretical issues and principles outlined in the preceding parts. Part IV begins with an “historical” chapter on classical morphemics and its traditional alternatives, spanning a range of conceptual frameworks from Bloomfield to Hockett to Robins, many of whose assumptions have been either challenged or refined in subsequent frameworks. The frameworks presented in this part are Natural Morphology (Dressler et al. 1987), Distributed Morphology (Halle and Marantz 1993), Construction Morphology (Booij 2010), Paradigm Function Morphology (Stump 2001, 2016), and Network Morphology (Brown and Hippisley 2012).

In Chapter 13 (“Classical Morphemics: Assumptions, Extensions, and Alternatives”), Laurie Bauer points to the origins of the idea of the morpheme as an analog to the phoneme, and outlines the various developments from the original concept. The chapter presents problems both with the phoneme analogy and with the status of morphemes as signs, elaborating on questions addressed in §1 above and in Chapters 3 and 8. Drawing on evidence from a range of languages, Bauer examines a number of problematic phenomena, including contiguity, zero morphs, extended exponence, cumulative exponence, internal modification, subtraction, and a kind of indirect mapping where the presence of one morph determines the interpretation of another, as in inverse systems. An interesting contrast is drawn between approaches that emphasize the form part of the morpheme sign and those that emphasize the meaning part. This contrast persists even today: the notion of the morpheme emphasizes form over meaning, while the conception of the morpheme assumed by Distributed Morphology emphasizes meaning over form.

Chapter 14 (“Natural Morphology”), by Wolfgang Dressler and Marianne Kilani-Schoch, begins a series of sketches of current morphological frameworks. Drawing on Peircean semiotics and markedness theory, Natural Morphology is unique in assigning a fundamentally iconic or indexical status to the sign in morphology. A universal preference for signs that are natural determines why morphological systems are the way they are and why they develop in the way they do. The chapter begins with a discussion of signs, showing how the framework is both morpheme and lexeme-based. It outlines the seven parameters of universal naturalness, desiderata that include iconicity, transparency, and biuniqueness, and relates them to typological naturalness to explain how potential conflicts among naturalness principles are resolved. Dressler and Kilani-Schoch demonstrate how the framework addresses several issues raised in previous chapters such as productivity, rule competition, complexity, paradigms, and cell realization (directly or by implication). The chapter ends by looking at architectural assumptions of the framework and morphology’s interfaces with other components.

In Chapter 15 (“Distributed Morphology”), Martha McGinnis outlines the fundamentals of Distributed Morphology, unique among current morphological frameworks in rejecting lexicalism in favor of a single generative engine responsible for both phrase structure and word structure (see Chapter 10). The minimal sign is the morpheme, though room is also given to higher-level word and phrase signs whose meaning-form association is unpredictable. Less than fully productive operations, like the nominalizations that ushered in lexicalism (Chapter 10), are accounted for by constraints on syntactic operations. Mechanisms such as morphological merger, head movement, fusion, fission, and impoverishment are invoked to handle form-meaning dissociations such as those discussed in §1 and in Chapter 13. Presenting empirical case studies, McGinnis demonstrates how the framework addresses a number of the issues raised in previous chapters, including syncretism, the role of paradigms, affix ordering, resolution of rule competition, suppletive allomorphy, and dichotomies of morphological function.

In Chapter 16 (“Construction Morphology”), Geert Booij describes Construction Morphology, an approach to morphology which, in the spirit of Construction Grammar (Goldberg 2006), associates form and meaning (and pragmatic and discourse information) through schemas or templates that specify the “construction” of stem and exponent. Such schemas are hierarchically organized based on their degree of abstraction, allowing for the use of class defaults (Chapter 11); they are induced from families of morphologically related lexemes as part of language acquisition. As a lexeme-based framework, Construction Morphology represents word formation as the unification of a schema with lexemes; on the basis of such unification, schemas are indexed according to their productivity. Paradigmatic cases of word formation (e.g., *altruist~altruism*; *Marxist~Marxism*) motivate the postulation of second-order schemas relating one schema to another. Second-order schemas likewise account for inflection in terms of implication-based paradigms (Chapters 3, 12). Schemas also express the grammaticalization path from word to affixoid to affix, and they delineate the boundaries separating derivation proper, compounding, “phrasemes,” and phrase structure proper in a manner consistent with the assumptions of lexicalism (Chapter 10).

In Chapter 17 (“Paradigm Function Morphology”), Olivier Bonami and Gregory Stump discuss an inferential-realizational approach to inflectional morphology in which paradigms play a central role in demarcating morphology from syntax. In this theory, a lexeme *L*’s paradigm is a set of cells, each the pairing of *L* (or its stem) with a morphosyntactic property set. A language’s paradigm function *PF* maps a given cell *c* onto the word-form *PF(c)* that realizes it. The declarative definition of *PF* involves a complex interaction of clauses formulated as realization rules; these may be experience-based—specifying inflectional exponents as direct expressions of a cell’s property set—or implicational—inferring one cell’s realization from

that of another cell (§2.5, Chapter 12). Competition among realization rules is resolved by Pāṇini's principle (Chapter 11). The chapter shows how the framework handles, among other phenomena, suppletive stem allomorphy (Chapter 5), affix ordering (Chapter 7), and form/meaning dissociations such as syncretism, deponency, and defectiveness (§1); as Bonami and Stump show, dissociations of this sort have motivated an elaboration of the theory in which a lexeme *L*'s content paradigm (whose cells determine *L*'s syntax and semantics) are distinguished from its stems' form paradigm (whose cells determine *L*'s morphological expression).

Chapter 18 ("Network Morphology"), by Andrew Hippisley, closes this part of the book on morphological frameworks with a sketch of Network Morphology, which emphasizes the use of defaults and overrides (Chapter 11) to help locate systematicity in a computer-testable way, pointing forward to one of the domains of evaluating morphological theories that are presented in Part VI. Based on the idea that morphological knowledge is distributed over a network of linked nodes, the chapter shows how the framework can account for the now familiar challenges of inflectional classes, suppletive stem allomorphy, syncretism, and deponency through the nature of the links. Three key notions are introduced in this connection—default inheritance, default inference, and default orthogonal multiple inheritance—which are also used to express the autonomous status of morphology and constraints on its interface with syntax.

3.5 The Role of Morphology in Theories of Phonology and Syntax

Part V explores interface issues—specifically, the assumptions about morphological principles and representations that have figured in the development of modern theories of syntax and phonology.

In Chapter 19 ("The Role of Morphology in Generative Phonology, Autosegmental Phonology, and Prosodic Morphology"), Sharon Inkelas examines a key premise of generative phonology, that phonology is fed by a morpheme-based morphology, detailing the challenges that this premise faces and the attempts to meet these challenges. To account for nonconcatenative morphology (§2.1; Chapter 13), the standard view of phonemes as segmental feature matrices is "exploded" to allow for the interaction of distinct autosegmental tiers. In this approach, stress and tone features (here exemplified with evidence from Hausa, Mende, and Kikuyu) belong to a separate tier from which they are associated with a word-form's segmental phonology by general principles; so-called featural lexical entries can be "prefixed" and "suffixed," so maintaining the integrity of the morpheme. Tiered representations also afford a templatic account of Arabic in which the tiers themselves have the status of morphemes. To meet the challenge of phonological rules that exhibit an apparent sensitivity to morphological context (Chapter 5), underlying representations are further elaborated to include moraic structure to which rule application may be sensitive; thus,

an enrichment of the mode of representation facilitates the formulation of rules to which representations are subject. Inkelas shows how these approaches accommodate reduplication, truncation, and subtraction. The chapter also includes a discussion of lexical phonology and morphology, in which conditions on the application of phonological rules are simplified by assigning rules to distinct levels.

In Chapter 20 (“The Role of Morphology in Optimality Theory”), Zheng Xu discusses two distinct arenas in which Optimality Theory (OT) illuminates the nature of morphological patterns. On one hand, OT provides a unique conception of the interface of morphology with phonology, allowing phonologically conditioned alternations to be seen as the effect of ranked constraints on phonological representations rather than as an effect of the interaction of heavily enriched underlying representations with batteries of (morpho)phonological rules. But Xu additionally shows that the relevance of OT to morphology is not limited to the domain of interface issues, arguing that OT affords a novel theory of morphology proper; he illustrates by applying the principles of OT to the elucidation of such morphological phenomena as blocking, extended exponence, and syncretism.

In Chapter 21 (“The Role of Morphology in Transformational Grammar”), Stephen Anderson surveys the rather surprising history of morphology in transformational grammar, showing that Chomsky’s own proposals favor a complex view of morphology, and not simply a wholesale adoption of the structuralist morpheme. Even though mainstream generative grammar tended to trivialize morphology by casting allomorphy as a phonology problem (Chapter 19) and morphotactics as a syntax problem, Chomsky’s work from the 1950s into the 1970s (Chomsky 1970) addressed some purely morphological issues head-on. A two-tier system of morphemes, where for example the affixes in affix-hopping belong to the syntactic tier, captures the inflection-derivation dichotomy (1950s); complex symbols as terminal nodes point to (matching) sets of features associated with lexical entries which suggest a paradigm approach which in turn better accounts for form-meaning dissociations such as those discussed in §1 (1960s); the unverb-like behavior of derived *vis-à-vis* gerundive nominals suggests a non-syntactic treatment of word structure, issuing in lexicalism (Chapter 10). The chapter ends with a conundrum: why has the development of Chomskyan syntactic theory taken so little account of Chomsky’s own advice on morphology?

In Chapter 22 (“Morphology in Constraint-based Lexical Approaches to Grammar”), Olivier Bonami and Berthold Crysmann introduce the constraint-based lexicalist approach as a response to lexicalism (Chapter 21, Chapter 10), where the interaction of constraints is determined not by ranking (as in Optimality Theory, Chapter 20) but by unification. Lexical Functional Grammar (LFG) and Head-driven Phrase Structure Grammar (HPSG) have both been used to address morphological problems. Analyses

in LFG have tended to focus more on the interface of syntax with morphology, employing existing morphological frameworks (in particular Paradigm Function Morphology, Chapter 17) in a multi-modular, formally heterogeneous architecture. Bonami and Cysmann focus on the alternative approach afforded by HPSG, in which the formalism of typed feature structures is used for all grammatical components. They elucidate this approach with reference to productive lexeme formation (Chapter 4), the inflection-derivation split (Chapter 3), affix ordering (Chapter 7), stem indexing (Chapter 5) and morphophonology (Chapter 19). As they show, independently motivated principles of HPSG (e.g. the use of inheritance hierarchies and multiple inheritance) afford a straightforward way of modeling general morphological patterns (Chapter 11).

Part V closes with Richard Hudson's chapter, "Dependency Grammar." Assuming lexical integrity (Chapter 10), Hudson argues that syntax is more satisfactorily defined in terms of dependencies amongst words as syntactic atoms, than in terms of constituency relations. But while a dependency analysis is also seemingly more apt for compounds, many morphological phenomena instead require a constituency-based analysis. As a case in point, he discusses the Welsh soft mutation, which requires a constituency-based analysis because it makes essential reference to a phrasal edge. Moreover, he argues that the part-whole relations of derivational morphology likewise fit better with a constituency account. The lexicalist assumptions of dependency grammar straightforwardly accommodate this assumed difference between morphology and syntax. Hudson gives an overview of two dependency frameworks that have focused on morphology, Mel'čuk's Meaning-Text Model, where all morphology is treated as part-whole, and Hudson's Word Grammar, which is a hybrid approach. The latter represents the relations between words, morphemes, and their realization as a network of nodes where information sharing is in default (Chapters 11 and 18). This approach is illustrated with English inflection and French clitic placement.

3.6 Domains for the Evaluation of Morphological Theories

The final part of the book considers various contexts in which choices among the morphological dichotomies can be assessed. Three of the chapters focus on *methods* of evaluation: frequency, experimental, and computational. And three focus on observational domains where evaluation can be made: linguistic typology, language change, and language acquisition.

In Chapter 24 ("Frequency and Corpora"), Péter Rácz, Viktória Papp, and Jennifer Hay survey the ways in which linguistic corpora are used in morphological research to measure distribution and frequency, given the assumption that the frequency of a word-form approximates its probability of use. The decision about what to count is important, and the distinctions drawn by the authors include lemmas and their surface manifestations,

type and token frequency, pattern frequency and hapax legomena, and absolute and relative frequency, all of which are recast in probabilistic terms. But as distribution can be affected by genre, speech community, and other sociolinguistic factors, sampling is a key part of corpus design. The authors show how corpus linguistics as a method has been used to answer questions about morphological productivity (Chapter 4), morphological processing (Chapter 27), and morphological change (Chapter 26). The chapter ends with questions about whether the relation between frequency and language behavior may be really epiphenomenal, and if so, where that leaves the field.

In Chapter 25 (“Morphology in Typology”) Johanna Nichols explores some of the typological dichotomies mentioned in Section 2.4. Current typological research has moved away from a search for universals, focusing instead on the objective of explaining “what’s where why” in terms of multi-valued variables, with the answer lying (partly) in contingent factors such as history and area. Such findings inform theory in a variety of ways. Nichols begins by pinning down the slippery notion of the word as object of cross-linguistic comparison and then surveys a number of topics for typological investigation: word classes and criteria to identify them; the feature person and the categories of free, bound, and weak pronouns; alignment and hierarchical systems; and the delineation between derivational and inflectional morphology (a dichotomy of morphological function, §2.3). The chapter closes with a discussion of the canonical approach to typology (Chapter 11) and the typological approach to morphological complexity (Chapter 12).

In Chapter 26 (“Morphological Change”), Brian Joseph discusses change of the morphological sign on both the meaning side, for example through metonymic transfer, and on the form side, through sound change which becomes morphologized (Chapters 5, 19 and 20). Morphology is important as an object of historical inquiry because it is the frequent “destination” of language change (a fact that follows from the lexicalist hypothesis). Joseph explores the conditions of change, distinguishing causes internal to the grammatical system such as analogy—based on a drive to restore the canonical, one-to-one mapping between meaning and form (§1)—and system-external causes (e.g., those contingent on language contact), exemplified here with evidence from the Balkan sprachbund. Joseph concludes with a discussion of *directionality* in morphological change, including grammaticalization, showing that morphological change is not invariably unidirectional; for example, while phonological conditioning often develops into purely morphological conditioning, he presents examples of developments with the opposite directionality. He likewise cites counter-directional patterns of grammaticalization, such as the development of the Greek adverb *ksaná* “again” from two bound prefixes.

In Chapter 27 (“Morphology and Language Acquisition”), Constantine Lignos and Charles Yang examine three distinct factors affecting the

acquisition of morphology. First, they discuss the distributional properties of morphology—in particular, the Zipfian sparsity of morphological data in child-directed language (Chapter 24). Second, they consider the developmental patterns in children’s acquisition of morphology, which show that children learn rules of morphology and that the errors that they produce are not in general attributable to analogy but instead involve overuse of productive rules (Chapters 24, 11 and 4). Finally, they demonstrate the important challenges that the psychological setting of unsupervised language acquisition imposes on the child’s task of learning morphology (recalling the concerns of Chapter 12). Lignos and Yang conclude with a call for collaboration among theoretical linguists, developmental psychologists, and computer scientists.

Harald Clahsen’s Chapter 28 (“Experimental Studies of Morphology and Morphological Processing”) surveys key experimental methods, measures, and results that have been used to answer questions about morphological storage, processing, and representation. Drawing on behavioral measures such as lexical decision times as well as on physiological measures such as eye-tracking data, Clahsen looks at how experimentation has been used to shed light on a variety of dichotomies, including those relating to productivity and defaults (§2.2), to the distinction between inflection and derivation (§2.3), to choices of representation and analysis (§2.2, §2.5), and to the motivation of theoretical architecture (§2.5). Clahsen surveys the experimental work on the psychological reality of indexed stems (Chapters 5, 17 and 18) and on the status of paradigms (Chapter 9). He concludes by speculating on future research questions, on the development of neurocognitive models of morphological processing, and on the use of computational simulation.

Lynne Cahill’s Chapter 29 (“Computational Morphology”) concludes Part VI with a discussion of current computational research on morphology; some of this research is theory-oriented (employing computational methods in the formal modeling of morphological theories), and some is more practical in orientation (employing computational methods for processing natural language data). In a brief history of the field, Cahill distinguishes two *symbolic* approaches to computational morphology, the classic finite-state approach pioneered by Kimmo Koskenniemi, which has been used mainly in the service of practical aims; and the more recent default inheritance approach embodied by Roger Evans’ and Gerald Gazdar’s DATR language (Chapters 11 and 18), which was developed to model theoretical claims. Complementing these symbolic approaches are statistical approaches used in machine “learning” of morphological relations (Chapter 27). Each approach necessitates particular choices of implementation; for instance, finite-state models assume morphemes as the minimal contentive unit of linguistic analysis, whereas most DATR theories are instead based on lexemes (§2.1). Cahill also outlines a number of applications that rely on morphological analysis, for example machine translation

and speech-to-text systems. She ends with a discussion of special challenges that certain natural languages have presented for computational morphology; these include the lack of word boundaries in Chinese texts, the nonconcatenative nature of Semitic morphology, and the highly complex morphological systems of Bantu languages, whose exponents are sometimes autosegmental (§1, Chapter 19).

4 The Aim of this Handbook

Language is an association of content and form, and the grammar of a language incorporates principles for the definition of this association at different levels of granularity. The finest-grained part of this definition involves both local lexical stipulations (e.g., the association of the content *show* with the form /*ʃou*/) and principles for expanding on these stipulations (e.g. a rule associating the content “past tense of *show*” with the form /*ʃoud*/). These latter principles, however they are formally represented, are complex things. Their complexity resides in the fact that they define the interface of a language’s semantics with its phonology through the mediation of a distinct system of combinatory principles, and in the fact that this definition has both syntagmatic and paradigmatic dimensions. This complexity is reflected in their acquisition, in their use in producing and processing meaningful utterances, in their diachronic evolution, and in their computational representation. Inevitably, this complexity suggests a variety of dichotomies, and modern approaches to morphology vary according to how—or whether— morphological theory should model a given dichotomy. The aim of this handbook is to illuminate the shared assumptions, contested issues, theoretical interpretations, and empirical methods that characterize the complex landscape of current morphological research.

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Part I

Foundations of Morphological Theory

2

Two Morphologies or One?

Inflection versus Word-formation

Andrew Spencer

1 Inflection and Derivation as Lexical Relatedness

We traditionally distinguish two principal ways in which words can be related through morphology. On the one hand the words *print* and *printed* are related because they are both inflected forms of the verb *print*. This is **inflectional morphology**. On the other hand, *print* and *printable* are related because *printable* is an adjective which is derived from the verb *print*. This is **derivational morphology**, sometimes also called **word formation**. To avoid the ambiguity inherent in the term “word” we often use the term **word-form** for the inflected forms of a single word, and the term **lexeme** for the more general notion of word, such as PRINT and PRINTABLE. A lexeme can be thought of as an abstract characterization of all the linguistically important properties of a word, much like the information found in a dictionary entry.

The set {*print*, *prints*, *printing*, *printed*} comprises all the word-forms of the verb lexeme PRINT. These word-forms, paired with their inflectional meanings, constitute the **inflection paradigm** of the lexeme. On the other hand, we would not normally want to say that *printable* is a “form” of the verb *to print* (or vice versa)—that is, the form *printable* is not a member of the inflectional paradigm of the lexeme PRINT. Instead, we generally say that the lexeme PRINTABLE has been derived from the base lexeme PRINT by a word formation process, or, more accurately, a process of **lexeme formation**.

Compounding introduces additional types of lexical relatedness. The lexemes HOUSE and BOAT are not related to each other but they are both related to the compound nouns HOUSEBOAT and BOATHOUSE. Another type of lexical relatedness is seen with clitics. Thus, the past tense form of the auxiliary HAVE, *had*, appears as the full form /had/ and as the clitic (or reduced) forms /əd, d/ in different contexts. Now, when the clitic forms are attached to a host word or phrase we have an expression that we could

call a **phonological word**, which contracts relations with other types of word. Thus, in *Sue'd already left* we have the name SUE in the form /su:əd/. But this isn't really an inflected form because the clitic /əd/ will attach to any word which happens to end the subject phrase: *The people they wanted to sue'd already left*.

There is an important difference between compounds and clitics on the one hand, and relatedness defined as inflection/derivation on the other. Compounding and cliticization refer principally to the manner in which expressions are constructed. In this respect they are to be contrasted with construction types such as affixation, ablaut (stem-internal vowel change) or even conversion (no morphology at all). By contrast, inflection/derivation refers to the (putative) functions of those constructions: inflection defines word-forms of a lexeme while derivation defines new lexemes. These functions are independent of the construction type which realizes them.

In principle, compounding/cliticization, too, can realize any type of relatedness, just as affixation can. In practice, compounding tends to expand the stock of lexemes, and hence is a kind of lexeme formation. Nonetheless, in some languages (for example, many of the languages of South East Asia) compound verb constructions have come to resemble grammatical categories expressing aspectual notions such as completed event or ongoing process. In this respect the compound verbs are like inflections. Clitics often realize categories similar to inflections, such as tense or case, but clitics also realize the functions of discourse particles, and in many languages reflexive clitics are used to derive new verb lexemes, often with idiosyncratic meanings compared to the non-reflexive base lexeme.

It is generally accepted that the same morphological devices are seen in inflection as in derivation cross-linguistically. We could call this the **Uniformity of Realization Property**. This property strongly suggests that we should describe inflectional and derivational processes using common descriptive machinery (that is, affixation and so on).

In this chapter I will discuss the inflection/derivation distinction in the context of the broader notion of lexical relatedness. Two words are related if they share some central property, such as their form or their meaning, or if a central property of one is properly subsumed in the other. For instance, the form of word might be defined by adding an affix to the form of a base word, or the meaning of the derived word might be obtained by adding semantic content to the meaning of the base. I shall couch the discussion in terms of functions or relations which map one set of representations, features, and so on to an output of some kind. I shall refer to the lexical representations which are included in the domain of this function/relation as the “base” or “base lexeme” and the lexical representation which is outputted by the function I shall call the “derivate.”

I will argue that the division between derivation and inflection is a real division but I will show that there are several other intermediate types of lexical relatedness which cannot easily be defined as inflectional or

derivational. I will use these observations to argue that all systematic, regular, productive patterns of lexical relatedness are paradigm-driven, even if in the case of canonical derivation the paradigms are maximally of two cells: ⟨base lexeme, derived lexeme⟩. From this it would follow that paradigmatic inflection and derivation are essentially different instantiations of a single type of lexical relatedness function, in conformity with the Uniformity of Realization Property.

Such an approach brings with it an important conceptual problem. Let us consider languages with fairly rich morphology—specifically, both inflectional and derivational morphology. If derivational morphology creates a new lexeme then that lexeme may well have to be inflected. How can one and the same mechanism define new lexemes and also the inflected forms of those lexemes? For instance, in our example PRINT~PRINTABLE the verb base and its derivate have entirely different inflectional paradigms. PRINTABLE has no inflected forms, in fact, though in a language such as German the translation equivalents would have different sets of forms (DRUCKEN ‘to print’ {drucke, druckt, drucken, gedruckt} vs. DRUCKBAR ‘printable’ {druckbar, druckbare, druckbaren, ...}). In general, whenever the lexical relatedness function changes the lexical or morphosyntactic category of a base, the derived word will shift to an entirely different inflectional paradigm. This seems to entail that we have to define two distinct types of lexical relatedness after all. I shall call this the **Differential Inflectability Property**. This property introduces a tension between the canonical functions of inflection and derivation and the Uniformity of Realization Property. I address that problem in the final section.

A caveat: the discussion of this chapter is narrowly focused on models that accept broadly speaking a paradigm-based view of morphology (for example Zwicky 1985; Anderson 1992; Aronoff 1994; Stump 2001; Brown and Hippisley 2012; Spencer 2013; see also Chapters 16, 17, 18). For models which continue the American Structuralist morpheme-based tradition (Chapter 13) the discussion of this chapter will be entirely irrelevant, if not incoherent. This seems to include the Minimalist Morphology framework developed by D. Wunderlich and colleagues (Wunderlich and Fabri 1995). In contemporary minimalist syntax (Chomsky 1995) coupled with Distributed Morphology (Halle and Marantz 1993; Chapter 16) there is no real notion of “word” and in particular no notion of “lexeme” that can be reconstructed (see also Borer 2013 for a recent defence of this approach). Morphologically complex expressions are constructed in the syntax by merging roots with other roots or with functional heads. Inflectional morphology and derivational morphology alike are, therefore, both types of (syntactic) compounding, formally speaking (though it is not clear that the notion “compound” as opposed to “phrase” makes much sense in that framework).

One consequence of the Distributed Morphology view is that the head of an inflected word is the outermost inflection of that word, while the rest

of the word serves as a complement to that functional head. The most natural interpretation of the term “lexically related” in such a model is “sharing the same head”. Thus, in compounding, *catfood* and *dogfood*, both headed by *-food*, are more closely related to each other than either is to *catflap* or *dogcollar*. By parity, the words *printed*, *taught*, *sang*, *went* are all related to each other by virtue of being past tense forms, while *print*, *prints*, *printing*, *printed* just happen to share the same root (and are thus like *catfood*, *catflap*, *catnap*, . . .) (Williams 1981). However, we must bear in mind that it is actually incoherent to think in terms of “lexical relatedness” in a framework like Distributed Morphology that accords no status to the construct “word” in the first place.

2 Meaningless Lexical Relatedness

There is an important distinction to be drawn between patterns of lexical relatedness which are part of the grammar of the language and those which are relics of an earlier *état de langue* and no longer the result of living productive processes. The distinction can be hard to draw. Processes can be productive but in restricted ways, limited to certain areas of vocabulary, and moribund morphology can sometimes develop a new lease of life (Bauer 2001). At the same time, languages often increase their lexical stock by ad hoc processes of word creation, which do not represent a systematic grammatical process of any kind. Nonce creations such as *brunch* or *metrosexual* are not the result of a systematic word formation process, though they are in some sense permitted (“licensed”) by the grammar of English.

In lexeme formation generally it is rather common to find words related solely by form and not by meaning. This is very common with semantically idiosyncratic (idiomatic, non-compositional) or lexicalized compounds. The form *text* in *textbook* adds no meaning of its own to the whole and certainly does not give rise to the specific meaning of *textbook* compared with *book*. On the other hand, *gingerbread* denotes something which, while generally containing ginger, is not a kind of bread. The form *cran-* in *cranberry*, notoriously, does not even exist outside the compound (and the same is true of the *-ric* of *bishopric*).

However, a great deal of the morphology discussed under the rubric of derivation is of the same kind. Consider the verb *UNDERTAKE*. Formally this contains (forms of) the lexeme *TAKE*, because it shares the irregular inflectional paradigm of that verb, and this implies that the remnant, *under-*, is a prefix homophonous with the prefix in *UNDERESTIMATE*. But there is no semantic relationship between the prefix and the verb root of *UNDERTAKE* and its components. In the case of inflectional relatedness it is often difficult to assign a meaning as such in the first place to the inflectional component, and instead we tend to say that the inflection **realizes** or expresses some kind of **feature (value)** or **morphosyntactic property**.

The phenomenon of meaningless derivation illustrated by UNDERTAKE may seem somewhat marginal in English but this is misleading. In a language such as Russian a very large proportion of the verb lexicon is constructed from a prefix and a root neither of which can be assigned a meaning. Moreover, English shows a similar pattern with its particle verbs, such as TAKE DOWN/IN/OFF/ON/OUT/UP. In certain of their uses the verb and the particle are completely meaningless: TAKE DOWN ‘record in written form,’ TAKE IN ‘deceive,’ TAKE OFF ‘propel oneself into flight; imitate,’ and so on.

Particle verbs illustrate another issue that has to be considered when we look at the architecture of lexical relatedness – namely, the characterization of “word.” There is an important sense in which, say, TAKE IN ‘deceive’ is a single word-as-lexeme, while being composed of two separate words. A particle verb is thus a multiword expression (MWE) which realizes (the forms of) a single lexeme (see Los et al. 2012 for a detailed synchronic and diachronic study of particle verbs in English and Dutch). Similarly, though more controversially, we might want to say that there exist MWEs which realize inflectional properties – that is, inflectional periphrases (Brown et al. 2012).

A compound is another instance of a MWE in word formation, in that it is a single syntactic word unit formed from two lexemes. However, what usually distinguishes compounds from bona fide phrases is some measure of semantico-syntactic opacity or **lexical integrity** (Chapter 10): the elements of a compound are not subject to the kinds of displacements and discontinuous dependencies found in normal syntax. We cannot normally question, elide, pronominalize, tropicalize, or otherwise affect the *house* of *houseboat* by means of syntactic processes, and in noun-noun compounds it is not even possible to freely modify the modifying (dependent) noun with an adjective. Thus, although we can say *stone wall* and *wall of badly dressed stone* we cannot say **[badly dressed stone] wall*. In this respect compounds are somewhat different from the MWE lexemes exemplified by particle verbs. The morphosyntactic properties of particle verbs tend to inherit properties from syntactic phrasal constructions and do not exhibit the kind of lexical integrity typical of compounds. However, in languages which have rich compounding processes we frequently find borderline cases which are hard to analyze as clearly compounding or clearly phrase formation.

Where lexical relatedness is no longer driven by meaning we cannot speak of a paradigmatic relationship between bases and derived words. On the assumption that only paradigmatic relatedness is governed by the grammar this would mean that opaque relatedness is not strictly speaking a grammatical phenomenon. However, it is abundantly clear that the types of nonce word that can be created will be restricted in various ways by the grammatical organization of the particular language. Thus, while Russian has thousands of semantically opaque prefix-verb combinations it lacks verb particle constructions of the kind found equally abundantly in English,

Scandinavian, and many other languages. Moreover, in contrast to Russian prefixes, those of German, Hungarian, and other languages enjoy the kind of syntactic freedom of placement that is associated with particles.

3 Lexical Representations

Before turning to types of relatedness we need to clarify certain aspects of those representations that relatedness itself is defined over – that is, lexical representations generally.

Assuming that we are describing a language with rich inflectional morphology then any lexical entry for a major category will have to specify at least three sets of properties or lexical attributes. In Spencer (2013) I label these **FORM**, **SYN**(**TAX**) and **SEM**(**ANTICS**). The **SEM** attribute is some kind of semantic representation. The **SYN** attribute determines what kinds of words and phrases the lexeme selects and is selected by. The **FORM** attribute specifies all the information needed to inflect the lexeme, including, of course, the phonology of the basic forms (root, stems, or whatever). In addition, it is convenient to assume an attribute **LEXEMIC INDEX** (**LI**), a unique label (for instance, an integer) which serves to individuate lexemes and allows us to represent notationally the difference between forms of a lexeme and related but distinct lexemes. I shall write the **LI** as the name of the lexeme in small capitals for perspicacity.

We can think of systematic lexical relatedness as being defined over the content of these attributes. Two representations are lexically related if (i) they share the value of an attribute or (ii) the value of an attribute for one word is subsumed in the corresponding value of the other word. For instance, synonyms are lexically related because they share the same **SEM** attribute (and hence, by default, the same **SYN** attribute), while homonyms are related because they share the same **FORM** attribute, but nothing else. Inflected forms of a given lexeme are related because they share **SYN**, **SEM**, and **LI** attributes, as illustrated in Table 2.1.

In Table 2.1 we see a schema for representing lexical relatedness. I represent forms in terms of a pairing of **LI** and a set of inflectional features. The set “u” is the empty set of features, so that $\langle \text{PRINT}, u \rangle$ defines the basic uninflected form of the lexeme, its root (here labelled “STEM0”).

Table 2.1. *Lexical entry for the lexeme PRINT*

	base	derivate
	$\langle \text{PRINT}, u \rangle$	$\langle \text{PRINT}, \{3\text{sg}\} \rangle$
FORM	STEM0(PRINT)=/print/	STEM0(PRINT)=/print/ $\oplus$ z
SYN	VERB(SUBj, OBJ)	_____
SEM	print (x,y)]	_____
LI	PRINT	_____

Table 2.2. *Derivation as lexical relatedness*

	⟨PRINT, u⟩	⟨PRINT, {SubjectNominal}⟩
FORM	STEM0(PRINT)=/print/	STEM0(PRINT)=/print/+ er
SYN	VERB(SUBJ, OBJ)	Noun
SEM	print (x,y)	person (x) such that drive (x,y)
LI	PRINT	PRINTER

Table 2.3. *Lexical entry for the lexeme print*

FORM(⟨PRINT, u⟩)	=	/print/
SYN(⟨PRINT, u⟩)	=	VERB(SUBJ, OBJ)
SEM(⟨PRINT, u⟩)	=	print (x,y)
LI(⟨PRINT, u⟩)	=	PRINT

The 3sg inflected form is related to this base in part because its form subsumes that of the base and in part because it shares all its other properties with the base. That sharing of properties is represented by ____ and it can be thought of as the result of a kind of identity default function (or **General Default Principle** in Spencer 2013: 191; see below, Section 6): “if a morphological rule fails to specify an operation over a part of a lexical representation, then assume that the relevant representation remains unchanged.”

Canonically derived lexemes involve a non-trivial change in all four attributes, as shown in Table 2.2.

The {SubjectNominal} label is that of a derivational feature which governs the (paradigmatic, regular) derivation of a subject nominalization from a verb (cf. Stump 2001: 257). Each of the four attributes is distinct from that of the base form of the verb lexeme (and, indeed, from any of its inflected forms). However, the FORM of PRINTER subsumes that of the base form of PRINT and, more importantly, the SEM attribute of PRINTER is the SEM of PRINT with the added semantic predicate denoting the subject of the predication.¹ Hence, we can say that the base verb and its derived nominal are lexically related (paradigmatically so, in fact).

The LI, however, can also be deployed to define the lexical entry itself. A lexical entry is a representation that is not defined (yet) in terms of any feature content, but which abstracts away from all the possible inflected and derived forms. We can therefore represent a lexical entry as a function from pairings of ⟨LI, u⟩. Thus, for PRINT we will have the lexical entry in Table 2.3.

From the lexical relatedness schemas shown in Table 2.2 and Table 2.3 we can see that (canonical) inflection and (canonical) derivation are maximally different types of lexical relatedness. However, the schemas suggest that

¹ Semantic representations are given in a very much simplified form.

there might be a variety of different types of relatedness intermediate between inflection and derivation. In Spencer (2013: 139) this property of lexical relatedness is enshrined in the **Principle of Representational Independence** (PRI), which states that it is possible to relate words by defining any combination of the four main attributes of a lexical representation as the default or null relation.

I shall explore some of the consequences of the PRI in Section 6 but before that we must consider in more detail the relationship between inflection, derivation, and compounding.

4 Distinguishing Compounding from Inflection/Derivation

In principle there is a very simple way of distinguishing compounding from other types of word formation and from inflection, in that compounding combines forms of two distinct lexemes. However, this still leaves conceptual problems, for two reasons.

First, compounding often results in lexicalized forms that have idiosyncratic semantics, so that we have to treat compounding as a form of lexical stock expansion (in the terms of Beard 1981), and hence a type of word formation. On the other hand, there are many languages in which compounding is extremely productive and frequently “on-line,” so that nonce compound words are created which do not necessarily find their way into the permanent lexicon. English noun-noun compounds are like this, in that it’s possible to create almost any combination of simplex nouns and give them a pragmatically or contextually defined relationship. In a classic study, Downing (1977) cites numerous such instances and the way they are interpreted by speakers. Another instance of productive compounding is found in languages in which a noun functioning as the direct object of a verb can be compounded with that verb, noun incorporation. Thus, in Chukchi it is possible to say either *hunter.ERG killed.TRANS bear.ABS* with ergative-absolutive subject-object alignment and subject-object agreement on the verb, or *hunter.ABS bear=killed.INTR*, with absolutive subject alignment and subject-only (intransitive) agreement. Any appropriate noun can be incorporated into the verb in this way, and any transitive verb will typically permit noun incorporation (Spencer 1995). Perhaps more interestingly, Chukchi also has a very productive process under which an adjective root is incorporated into the noun root that it modifies attributively (Spencer 1995: 477–82). This adjective incorporation is obligatory in some contexts and is the default construction when the modifier itself is not in focus. Other modifier-like elements such as possessive pronouns, demonstratives, question words, and numerals can also be incorporated into the noun they modify.

The significance of such largely unconstrained incorporation phenomena for the architecture of morphology is that we have to decide what is the

lexical status of such compounds. Thus, if (as reported by Downing 1977) a speaker chooses to refer to a particular chair in a particular room at a particular time as *the apple-juice seat* does that mean that we have to say that *apple-juice seat* is a lexeme (in the same way that we would want to say that *houseboat* was a lexeme)? Similarly, suppose a Chukchi school teacher asks in a grammar lesson *rʔa=litsolʔ-ət anqam rʔa=cislolʔ-ət* “what=person-s and what=number-s (of the verb),” incorporating the combining stem *rʔa-* of the wh-word *raʔ* “what” into the nouns for grammatical person and number (Spencer 1995: 479). Do we want to say that *rʔa=litsolʔ-ət*, *rʔa=cislolʔ-ət* are distinct lexemes?

There are two further related issues thrown up by compounds. One concerns their form and the other concerns the meanings of their components. We can illustrate the form question with English berries. It is often stated in introductory texts that English has a variety of berry names headed by the lexeme BERRY but modified by idiosyncratic or even meaningless elements such as *straw-*, *logan-*, *goose-*, *rasp-* and most famously *cran-*. What is less often pointed out is that the pronunciation of the BERRY element in such compounds is usually different from that found when the lexeme is used in isolation or when it is the head of a less lexicalized compound. In *strawberry*, *cranberry* and so on the first vowel is reduced to /ə/ or even deleted entirely (/kranbrɪ/, but such reduction never takes place otherwise, even if BERRY fails to receive primary stress: *winter berries* /wɪntə bɛrɪz/, *wɪntə brɪz/. The question now arises, to what extent do such compounds really contain the lexeme BERRY if the pronunciation is no longer that of the actual lexeme BERRY? Or do we have to say that some lexemes have a special combining form when used in compounds (not a general feature of English compounding)?

As is well known, by gradual semantic bleaching a compounded element often gets grammaticalized as an affix (usually derivational), just as function words often become clitics and then inflections. In words such as *printable* we see an affix that is clearly homophonous with the adjective ABLE (they even share idiosyncratic allomorphy with the suffix *-ity*). However, the *-able* suffix behaves exactly like a suffix. For instance, it cannot take wide scope over conjoined bases: **copy-* or *print-able*.² On the other hand, the similitudinal adjective formative *-like* in *cat-like*, *child-like* may have more freedom of occurrence for many speakers. I find the expression *prefix-* or *suffix-like* formatives perfectly acceptable, for instance. Bauer et al. (2013: 441) explicitly say they treat *-like* as a compound element. They do this on the grounds that it means the same as the adjective LIKE. However, even that judgment is not entirely clear. When used as an adjective (almost always in predicate position rather than attribute position in Modern

² I can say *cut-and-pastable*, but this is an exception that proves the rule, because it is only possible by virtue of the fact that *cut-and-paste* has been reanalyzed (from a syntactically constructed coordination of verbs) as a composite verb (hence the hyphens).

English) LIKE establishes a direct relation of similarity between two objects: *This dog is like a cat*. This certainly corresponds to the favored interpretation of the expression *a cat-like dog*. But in a phrase such as *cat-like gait/smile/cunning* we are not equating the cat with gaits, smiles, or cognitive functioning and we cannot say *This gait/smile/cunning is like a cat*. Rather, the interpretation is *This gait/smile/cunning is like the gait/smile/cunning of a cat*. So it is wrong to say that *-like* means exactly the same as LIKE. In fact, semantically speaking, *N-like* constructions behave exactly like affixally derived similitudinal adjectives found in other languages.³ (See also Kenesei's 2007 distinction between "semiword" and "affixoid.")

5 Distinguishing Inflection and Derivation

It is a commonplace in introductory texts on morphology as well as in monographs to list two sets of contrasting properties characterizing inflection and derivation and then to point out that none of those properties can be considered criterial for either type of lexical relatedness. From this we could conclude that the distinction is illusory or has at best heuristic value. This is the approach taken by American Structuralism and its descendants (especially Distributed Morphology)—that is, models based on the notion of the morpheme (see Chapter 3). A morpheme is a root or affix (possibly without any phonological substance) which has a meaning, for instance $\langle -(e)s, \text{'plural'} \rangle$ for the (regular) English plural morpheme or $\langle \text{cat}, \text{'furry quadruped that meows'} \rangle$. Utterances are combinations of morphemes. But this means that inflectional and derivational affixes are no different in their overall shape from the things we have called lexemes. Hence, all inflection/derivation is really a subtype of compounding.

Diametrically opposed to the morpheme-based architecture is the so-called inferential-realizational class of models (see for instance, Chapters 11, 17, 18). In these models, inflection is the result of applying morphological process to the (root of the) lexeme so as to realize particular properties. Thus, while the lexical entry for CAT might be similar to $\langle \text{cat}, \text{'furry quadruped that meows'} \rangle$, the plural form is defined as the output of a morphological rule which alters the form *cat* by adding $-(e)s$ to it (and which alters the form *man* by changing the vowel to "e"). It is these inflectional rules which define a lexeme's inflectional paradigm. In such models it is important to maintain the architectural distinction between inflection and derivation, and so it is necessary to address the problems posed by the lack of criterial properties. There are two ways of approaching this. The more traditional approach is to characterize the different properties associated

³ Bauer et al. (2013: 312) cite the attested example *a cool iPod-like handheld controller*. Here the interpretation has to be *a handheld controller similar to the controller of an iPod* and not the nonsensical (or at least uncool) *a handheld controller similar to an iPod*.

Table 2.4. *Inflection versus derivation*

Parameter	Inflection	Derivation
1. Purpose	build the form of a lexeme required by a given syntactic context	build a new lexeme from an existing lexeme
2. Syntactic determinism	determined by syntax	not determined by syntax
3. Obligatoriness	function is obligatory	function is not obligatory
4. Productivity	fully productive	not fully productive
5. Transparency	transparent	not always transparent
6. Base inheritance	all base features are inherited	base features that are inherited are limited
7. Exponence order	after derivational exponent; closes word	before inflectional exponent; need not close word

Source: Brown and Hippisley (2012: 37)

with inflection and derivation as (proto)typical properties and concentrate on core exemplars of the two relatedness types. The troublesome cases are then handled by ad hoc expedients. A recent variant of this approach is that proposed by Corbett (2010) within the context of Canonical Typology. On that approach we define canonical properties or criteria for a given phenomenon and then assess the extent to which attested phenomena conform to that canon (see also Spencer 2013: 58–63, 219–49 for discussion). In Section 7 I will propose an alternative way of maintaining the distinction but within the framework of an inferential-realizational model. In this section, however, I will run through the main difficulties in drawing a clear-cut distinction between inflection and derivation.

A useful checklist of properties has been proposed by Brown and Hippisley (2012: 37), summarized in Table 2.4.

Brown and Hippisley's first criterion is the central distinction in lexical relatedness and the one that raises the most serious questions. The problem here is simply "how do we know when we have two distinct lexemes rather than two forms of one and the same lexeme?" I will call this the **Lexeme Individuation Problem**.

For instance, the form *cuttings* in *grass cuttings* presumably realizes a lexeme CUTTING₁, distinct from any of the verb lexemes TO CUT, whereas the form *cutting* in *They are cutting the grass* presumably realizes an inflected form of (one of the lexemes) TO CUT. But what about the form *cutting* in *The cutting of the grass (took two hours)* or *Harriet's cutting the grass*? How do we decide whether these are forms of the verb lexeme as opposed to a related nominal lexeme CUTTING₂ (distinct from CUTTING₁)?

The problem posed by Property 2, syntactic determinism, is that most inflection is what Booij (1996, 2012) calls "inherent inflection," and this typically expresses some sort of inflectional meaning which is not (necessarily) mandated by the syntax.

Obligatoriness (Property 3) seems to be neither necessary nor sufficient for inflectional exponence. First, there is the well-known property of defectiveness: some lexemes simply lack certain forms in their paradigms (Sims 2015). On the other hand, other types of relatedness that we might want to call derivational seem to be extremely productive and transparent, like inflection. A well-known case is that of the *-ly* manner adverb in English, which has sometimes even been claimed to be inflectional (see Bauer et al. 2013: 323–4, for discussion).

The problem of defining productivity (Property 4) in morphology is a complex one, with several distinct aspects (Bauer 2001; Chapter 4). I will take productivity to refer to the more abstract property of lexical relatedness, independent of the morphological means used to express it. Thus, we can speak of a productive process deriving property nominalizations from adjectives, independent of the morphology (*good~goodness*, *sincere~sincerity*, *warm~warmth*). This definition allows us to define inflection as maximally productive because it is (usually) obligatory for a given lexeme class. But as is well known, some derivation appears to be extremely productive, including English de-adjectival property nominalization, de-verbal *-able* adjectives, and others. When we consider transpositions such as de-verbal participles in Latin or Russian we find that these are no less productive than any inflectional relation, though they are clearly not canonical inflection (or canonical derivation).

Transparent relatedness (Property 5) gives rise to words which are systematically related in meaning to their bases. Often, derived lexemes undergo semantic shift and become semantically opaque, but this can happen to inflected forms, too. Halle (1973) drew attention to an instance in Russian in which the instrumental case of nouns denoting the four seasons means ‘during N,’ *leto* ‘summer,’ *letom* ‘in the summer.’ The same pattern is followed by names for parts of the day: *utrom* ‘in the morning,’ *dnjom* ‘during the day.’ However, names for days, months, festivals or other time periods express ‘during’ in other ways. Inflectional case usage here is idiosyncratic, just like preposition selection for comparable expressions in languages such as English.

Property 6, base inheritance, is linked to the property of paradigmaticity together with a further property that typically serves to distinguish inflection from derivation but which isn’t specifically mentioned by Brown and Hippisley, which I shall call “feature intersection.” In a typical inflectional system we see a variety of “dimensions” of inflection, all of which can be freely combined. Thus, a typical verb in an Indo-European language might inflect for person/number subject agreement, past/present/future tense, indicative/subjunctive mood, active/passive voice, and other categories. The paradigms implied by canonical derivational morphology are very different, in that they can be represented as maximally simple arrays comprising just two cells, the base lexeme and the derived lexeme. This means that there is no feature intersection in

derivation, and so it is only trivially paradigmatic, while canonical inflection is radically paradigmatic.

On the other hand, we do not see one inflectional process feeding another to give rise to recursive (or recursive-like) structures. By contrast, it is commonplace to see one derivational process feeding another, as when we derive the word INDECIPHERABILITY from the word CIPHER by applying four consecutive derivational processes. Thus, derivational morphology exhibits a syntagmatic structure which is (typically) lacking in inflection.

The syntagmatic dimension of derivational morphology is what gives rise to failure of base inheritance. By defining a new lexical class the word formation rule defines a new inflectional class, rendering the base lexeme's inflectional properties opaque. But when we compare two inflected forms of a lexeme there is (usually!) no question of one form rendering another form opaque because both belong to an intersective array of feature specifications.

There is another important sense in which an inflected form of a lexeme can be said to show inheritance of features or properties, however. Factoring out argument agreement, we typically find that any finite form of a verb can collocate its arguments, adjuncts, and modifiers in exactly the same way as any other finite form. Similarly, a noun in any case, number, or possessor agreement form might be modified by an attributive modifier in exactly the same way as a noun in any other inflected form. We can say therefore that, in the typical or canonical case, inflected words are syntagmatically transparent.

Derivational morphology is very different from inflectional morphology with respect to syntagmatic transparency. The syntactic privileges of occurrence associated with a noun are usually very different from those associated with a verb. However, Brown and Hippisley hedge their characterization of transparency by saying that it is limited in the case of derivation, not that it is impossible. There are two reasons for such a hedge.

First, there is the practical problem of deciding when we have inflection and when we have derivation, as in the case of transpositions. The present participle *driving*, when used as an attributive adjective or as a noun, has rather different syntax from the participle used in finite progressive clauses. So we can only really talk about a criterion of transparency in unequivocal cases of inflection. Second, semantic predicates can often be treated as having an argument structure—that is, an array of category types that the predicate can or must collocate with in certain ways. In the case of agent nominalizations, we might wish to say that the object argument of the verb is, in part, preserved by the nominalization process, giving rise to so-called argument inheritance (Booij 1988; Randall 1989, 2010): *the driver of the car*, *a car driver*. Although transpositions typically have very different syntax from their bases, they regularly preserve a good deal of the base lexeme's syntax. Thus, in a language in which adjectives agree with nouns, such as Latin or Russian, a present participle used as an attributive modifier

has the external syntax of an adjective, but retains the ability to express the verb's internal arguments and may even retain idiosyncratic properties such as assigning lexical case to its direct object (Haspelmath 1996; Spencer 1999).

When we consider Brown and Hippisley's transparency criterion from this vantage point, it seems that what looked strikingly obvious at first is actually far from clear. The problem is to avoid comparing unlikes. When we say that an agent nominal is opaque to the inflectional properties of the base what we really mean is that there is a considerable distance between certain typical inflected forms of the base lexeme and certain typical inflected forms of the derived lexeme. But we have to be rather careful with such comparisons. It isn't clear, for instance, that the form *driving* in, say, *the driving of fast cars* is more transparently related to the 3sg form *drives* than it is to the agent nominal *driver*, in say *a driver of fast cars*.

Property 7, exponence order, reflects the undeniably very strong tendency for inflections to appear external to derivational markers. However, there are well-known (and some less well-known) problems in establishing affix ordering as a hard-and-fast principle. Stump (2001, 2005) draws attention to the phenomenon of head-application in inflection. A simple example of head-application is afforded by English prefixed verbs such as *understand*. In order to inflect this verb properly we effectively have to "ignore" the prefix, because the lexeme inherits the irregular morphology of STAND: *stood-under-stood*. However this is coded in a grammar, it essentially boils down to the fact that we "first" inflect the stem for tense and "then" attach the prefix, contrary to Principle 7.

A less frequently discussed problem for a thoroughgoing application of Principle 7 is that posed by discontinuous stems. It is not uncommon for a language to have lexemes (typically verbs) whose inflected stems are complex, consisting of, say, a verbal root and a preverb. In a number of language groups that preverb might be separated from the root by a string of affixes, some of which, at least, are typical inflections (for instance, subject agreement markers). The Athabaskan group and its distant kin the Yenisseian group (now represented by the isolate Ket, spoken in Siberia) are well-known instances (see Rice 2000 for a detailed discussion of Athabaskan, and Vajda 2004 for Ket).

6 Intermediate Categories

One of the reasons why it is difficult to distinguish inflection from derivation is that there are a number of types of lexical relatedness which lie between the two. Spencer (2013) explores these issues in detail. Here I present a brief synopsis of the description given there.

We have already seen one example of such an intermediate category—namely, transpositions such as de-verbal participles. This is a type of

Table 2.5. *Lexical relatedness schema for transposition*

	base	derivate
FORM	⟨PRINT, u⟩	⟨PRINT, {prs.ptcp}⟩
SYN	STEM0(PRINT)=/print/ VERB(SUBJ*, OBJ)	STEM0(PRINT)=/print/+in ADJECTIVE(HEAD*) ARG-ST(SUBJ*, OBJ)
SEM	print (x,y)	_____
LI	PRINT	_____

relatedness characterized by a shift in morphological and syntactic category, much like derivation, but it does not add a semantic component to the lexical representation and it does not create a new lexeme, making it like inflection (Haspelmath, 1996, refers to it as category-changing inflection). Spencer (2013) shows that cross-linguistically each of the three major lexical categories noun, verb, adjective can be transposed into each of the others. The lexical relatedness schema for a typical present participle is shown in Table 2.5.

The SYN representation indicates that the participle is an adjective, modifying a nominal phrase which corresponds to the SUBJECT role of the base verb lexeme. The participle retains the argument structure (ARG-ST) of the verb, however, in that it can take a direct object; compare *The girl is printing the file* ~ *the girl** [SUBJ]* *printing the file*. In a language such as Russian or Latin the FORM attribute of the derivate will also specify the participle's inflectional class.

Certain types of inflection-like relatedness seem to add a meaning component to the lexical representation, much like canonical derivation. Examples of such meaning-bearing inflection include aspectual and aktionsart marking on verbs (as opposed to more grammaticalized tense/aspect/mood marking), semantic case marking (as opposed to "structural" case marking), and comparative and superlative marking on adjectives. In Table 2.6 we see the lexical relatedness schema relating the root form of a Hungarian noun *HÁZ* "house" to the inessive case form of that noun, *házban* "in (a) house."⁴

In Table 2.6 the SEM representation for *házban* adds a semantic predicate corresponding to the notion "(be) in," but the LI representation remains unchanged, showing that we are dealing with an inflected form of the noun lexeme.

Another type of relatedness which is difficult to classify as inflection or derivation is seen in argument structure alternations. Many language groups have a family of alternations including passive (or antipassive), applicative, causative, reflexive/reciprocal alternations among others. The terminological quandary posed by argument structure alternations

⁴ The SEM representation for the inessive can be read as "the property of being some P such that the relation 'P is in x' holds of P and a house, x."

Table 2.6. *Hungarian inessive case*

	base	derivate
	$\langle \text{HOUSE}, u \rangle$	$\langle \text{HOUSE}, \{\text{inessive}, \text{sg}, \text{non-possessed}\} \rangle$
FORM	STEM0(HOUSE)=/ház/	STEM0(HOUSE)=/ház/+ban
SEM	$\lambda x[\mathbf{house}(x)]$	$\lambda P \lambda y \lambda x[P(y) \wedge \mathbf{house}(x) \wedge \mathbf{in}(y, x)]$
LI	HOUSE	

can be seen by perusing a range of grammatical descriptions for languages with such alternations. Typically, the passive alternation is described as inflectional, no doubt because it generally has no semantic import, but simply serves to detransitivize a predicate. On the other hand, a causative alternation will frequently be described as derivational, presumably because it adds meaning. And yet we frequently find these alternations co-occurring within the same morphological system. Moreover, these alternations are often extremely productive, so that grammarians speak of “the passive/causative/applicative form of the verb V” rather than speaking of a new lexeme or dictionary entry.

Spencer (2013) follows many authors in taking argument structure to be a separate level of syntactic representation. This means that systematic lexical relatedness can be defined exclusively at that level, in principle independently of other properties of the representation, in accordance with the Principle of Representational Independence.

Evaluative or expressive morphology refers to the type of morphology that adds evaluative connotations without changing lexical meaning. In many languages regular morphological processes define diminutives and augmentatives. Such forms have as their main semantic contribution the meaning “little/big N” but these frequently turn into evaluative forms (“dear little N, horrible great N”). The morphology of evaluative forms sometimes resembles derivation and in other cases seems to be part of the inflectional system (Stump 1993; Spencer 2013: 113–22; see also Brown and Hippisley 2012: 265–9). In some languages, evaluative morphology defines its own set of properties, such as inflectional class and gender of nouns, much like derivation. Thus, the diminutive suffixes *-chen* in German and *-ki* in Greek create neuter gender nouns and define the inflectional class, whatever the gender/class of the base lexeme. On the other hand, in other languages evaluative morphology is transparent to (some) of the base lexeme’s properties. Thus, in Romance and Slavic languages the gender of the base lexeme is preserved in evaluative morphology.

I have characterized a transposition as being a meaning-preserving type of relatedness and this is what principally distinguishes transpositions from canonical derivation. However, Spencer (2013: Chapter 10) discusses a remarkable instance of a transpositional type in the Samoyedic language Selkup in which a transpositional denominal adjective acquires an additional semantic predicate.

Selkup has a very regular process of relational adjective formation, realized by the suffix *-λ*. However, it also has two further denominal adjectivization processes, giving rise to similitudinal adjectives (“similar to a wolf”) and locational adjectives (“located in a house”) (Helimski 1998: 560; Spencer 2013: 397). The relational adjective is derived from the basic (unsuffixed) nominative singular stem form, the similitudinal adjective is derived from the coordinative case form and the locational adjective is derived from the locative case form. Thus, from *qo:k* ‘leader,’ stem *qo:-*, we obtain *qo:-λ* ‘pertaining to a/the leader’; from the coordinative case form *qo:ffaλ* we obtain *qo:ffaλ* ‘similar to a/the leader’; and from *qopiλin*, the locative case of *qopi* ‘skin, hide,’ we obtain *qopiλiλ* ‘on a/the hide’ (animate nouns lack a locative case and hence a locational adjective form).

Selkup has four numbers (singular, dual, plural, and collective) but all three derived adjectives are neutral as to number in the sense that they are only derivable from the unmarked (by default, singular) form. However, Selkup also has possessor agreement morphology and the possessor agreement category is preserved in all three denominal adjectives. In other words it is possible to say ‘pertaining to my leader,’ *qo:ηniλ*; ‘similar to your (dual) leader,’ *qoktr:faλ*; or ‘on their (3+) hide,’ *qopo:qintitiλ*. This is a clear indication that the three denominal adjectives are part of the noun’s inflectional paradigm. This point is strengthened by the observation that the possessed forms of the pure relational adjective are derived not from the nominative case possessed form but from the genitive case: *qo:ηmi* ‘my leader.NOM,’ *qo:ηni* ‘my leader.GEN,’ *qo:ηniλ* ‘pertaining to my leader.’

Finally, there are various types of lexical relatedness which are morphologically “inert,” in the sense that the FORM attributes of the base are inherited by the derivate, contrary to default expectations. In many languages, forms of the verb paradigm arise from grammaticalization of periphrastic constructions involving clitic pronouns, auxiliary verbs, and nominalizations or participles. The result is that we often find that a part of the verb paradigm inflects as though it were a noun or adjective. A clear case of this is found with the Russian past tense, which has almost exactly the same agreement morphology as a predicative (“short form”) adjective, agreeing in gender and number but not in person (the present tense forms agree in person/number but not gender).

A very interesting example of morphologically inert relatedness is illustrated by what I have called *Angestellte(r)* nouns (Spencer 2013: 123, 273). The German verb *anstellen* ‘to employ’ has a passive participle form *angestellt*, which inflects as any other adjective: m sg nom *angestellter*, f sg nom *angestellte*, and so on. This participial form can be converted to a noun, *Angestellte(r)* ‘employee.’ The meaning of the converted noun is often transparently derived from that of the verb via the participle. What is particularly interesting about this type of relatedness is that the derived noun preserves all of the morphology of the original adjective, including the distinction between weak/strong declension. German adjectives take

different inflections depending (broadly speaking) on whether they are in a definite noun phrase or an indefinite phrase. This distinction is equally observed with *Angestellte(r)* nouns.

This type of adjective-to-noun shift is widespread across languages. It raises an intriguing question, which probably has to be answered on a case-by-case basis: is such a derived noun a distinct lexeme from the base, and hence a de-adjectival noun, or is it a form of the base lexeme, and hence a nominal use of the adjective? Corresponding formations in English, for instance, preserve much of the syntax of the adjective and fail to acquire nominal plural marking (though they usually have plural interpretation): *the very poor*, *the undeserving rich*, *the most wildly optimistic*, *the taller (of the two)*. This suggests that they might best be thought of as adjectives-used-as-nouns, rather than novel lexemes.

7 Two Morphologies or . . . More? Factorizing the Lexicon

The previous section has outlined some (but not most!) of the multifarious types of lexical relatedness that can be identified, but has not yet addressed the central problem: how can we unite the mechanism used to define inflected forms of a lexeme and the mechanism used to define new (and newly inflectable) lexemes?

The solution proposed by Brown and Hippisley (2012: Chapter 7) relies on the concept of hierarchical network in Network Morphology (see Chapter 18). That model defines lexical relatedness in terms of sets of defaults and overrides. For inflection these define the inflectional paradigms, independently of lexeme selection. For derivation Brown and Hippisley assume two hierarchies, a lexemic hierarchy and a derivational hierarchy. The lexemic hierarchy is effectively the model's lexicon. It defines all the idiosyncratic information about each lexeme's phonology, morphology, syntax, and semantics. The derivational hierarchy consists of lexeme-formation templates (LFTs). In essence, these are morphological constructions, as in Booij's (2010) model of Construction Morphology (Chapter 16), and fulfill the same role as word formation rules in earlier models. A derived lexeme such as *DRIVER* therefore inherits information from its base *DRIVE* and also from the orthogonal hierarchy which includes the lexeme-formation template defining *-er* subject nominalizations. That template either adds content to the base's entry (the affix itself and the additional semantic predicate) or overrides existing information (e.g., the syntactic class of the derived word).

Derivational morphology of this sort largely conforms to the canonical definition of derivation. Brown and Hippisley then provide a description of three less canonical types of derivation. The first is conversion, in which the LFT overrides or modifies all the base lexeme's information except its phonology. Hence, the derived lexeme inherits the form of its root directly

from the base lexeme. The second is the transposition, in which the LFT fails to modify the semantic entry of the base, which therefore passes on its meaning to the derived lexeme. The third deviation from canonical derivation is category-preserving derivation, as exemplified by evaluative morphology such as Russian diminutives. In this case it is the syntactic information which is inherited from the base lexeme.

Brown and Hippisley's Network Morphology treatment does not include an explicit distinction between lexeme-preserving morphology and lexeme-changing morphology. Thus, the three non-canonical types of relatedness are each treated as ways of defining new lexemes and each requires, along with canonical derivation, information-changing relations rather than just information-specifying relations, as we find in (canonical) inflection.

Spencer (2013) proposes a similar solution to that of Brown and Hippisley, in that he assumes that lexical relatedness is defined in terms of defaults and overrides (Chapter 11). Both derivation and inflection are defined in terms of a paradigm function in the sense of Stump (2001) (Chapter 17), but generalized so that it can define FORM, SYN, SEM and LI attributes, the Generalized Paradigm Function (GPF). At the same time the FORM, SYN, SEM attributes are defined over pairings of $\langle \text{Lexemic Index}, \{\text{feature set}\} \rangle$. The $\{\text{feature set}\}$ for derivation is the label of the derivational relation itself. A basic uninflected lexical entry is given by defining the GPF over the pairing $\langle \text{Lexemic Index}, u \rangle$, where "u" is the empty feature set. The specification of a LI for each lexeme permits a broader typology of relatedness, as we have seen.

For standard inflection, which does not introduce a semantic predicate and does not change the syntactic category, the GPF will non-trivially specify only the FORM properties. The SYN, SEM, LI attributes will therefore remain unchanged by virtue of the **General Default Principle**. The GPF is then effectively equivalent to the paradigm function of standard Paradigm Function Morphology (PFM). However, for other types of intra-lexemic relatedness, such as evaluative morphology, meaning-bearing inflection, and transpositions, non-trivial changes will be effected over the SYN and/or SEM attributes by the f_{syn} and/or f_{sem} components of the GPF.

With canonical derivation, however, the GPF effects non-trivial change in all four attributes, as illustrated schematically in Table 2.2. Let *AbilAdj* be the derivational feature governing *-able* adjective formation (as in *printable*). Then, the pairing $\langle \text{PRINT}, \{\text{AbilAdj}\} \rangle$ will be mapped to the full lexical representation of PRINTABLE. Assuming that this process is entirely regular (i.e., paradigmatic) we can define the LI for the derived word in terms of the derivational category itself and the LI of the base lexeme. In other words, we can say that the LI for PRINTABLE is not just some arbitrary integer or label such as PRINTABLE but is the value of a function, f_{li} , which maps $\langle \text{PRINT}, \{\text{AbilAdj}\} \rangle$ to $\langle \text{PRINTABLE}, \{\text{AbilAdj}\} \rangle$. This is achieved by defining $f_{li}(\langle \text{PRINT}, \{\text{AbilAdj}\} \rangle) = f_{\text{AbilAdj}}(\text{PRINT})$, where f_{AbilAdj} is a function over LIs defined with respect to the derivational feature *AbilAdj* (see

Table 2.7. *Schematic representation of the SubjectNominal GPF*

	$\langle \text{PRINT}, u \rangle$	$\langle \text{PRINT}, \{\text{SubjectNominal}\} \rangle$
FORM	STEM0(PRINT)=/print/	STEM0(PRINT)=/print/⊕er
	Other morphological properties = $\langle \dots \rangle$	Other morphological properties = u
SYN	VERB(SUBJ, OBJ)	u
SEM	[<i>Event</i> print (x, y)]	[<i>Thing</i> person (x) such that drive (x, y)]
LI	PRINT	$f_{\text{SubjectNominal}}(\text{PRINT}) (= \text{PRINTER})$

Spencer 2013: 179). We then invoke the **Derived Lexical Entry Principle** (Spencer 2013: 200), according to which any GPF that introduces a non-trivial but systematic (paradigmatic, hence productive (Chapter 4)) change in LI of this sort gives rise to a representation which is equivalent to $\langle f_{\text{AbilAdj}}(\text{PRINT}), u \rangle$. This is equivalent to saying that the label PRINTABLE is the (derived) LI of the output lexeme, and that it is an as yet uninflected lexical representation, hence effectively the lexical entry for the derived lexeme.

Finally, we can observe that in well-behaved (that is, near-canonical) cases of derivation we find that the SYN properties of the derived word are projectable by default from the SEM properties. To reflect this Spencer (2013: 201) proposes a principle under which the SYN properties of the output of the GPF, as well as most of the FORM properties, are replaced by the empty set (i.e., effectively deleted). This representation then triggers the operation of a general **Default Cascade**, under which the SYN properties of a paradigmatically derived lexeme are inherited by default from the SEM attribute (so that a word denoting a Thing is by default syntactically a noun, while a word denoting an Event is by default a verb). Thus, the schematic representation of the derivational GPF for *er*-nominalizations in English shown in Table 2.2 can be replaced by Table 2.7.

In sum, we can individuate lexemes by means of an arbitrary (numerical) index, LI. We can then deploy that index to define the lexical representation itself as well as the lexical relatedness functions that change the various aspects of inflection, derivation, and other types of relatedness. Where we have derivational morphology—that is, where the lexical relation defines a new lexeme and hence a new LI—we invoke the principle that the derivational paradigm function defines a representation $\langle f(\mathcal{E}), u \rangle$, where $\mathcal{E}$ is the LI of the base lexeme. In this way we can unify the functions which govern inflection, derivation, and all intermediate types of relatedness, thus addressing the question which opened this section.

8 Conclusions and Summary

Inferential models of lexical relatedness appear to require a strict separation between principles defining the inflected forms of lexemes and principles defining new lexemes from existing base lexemes, a consequence of the

Differential Inflectability Property. However, it is well known that there are no differences in the morphological realization of inflection and derivation. This means that we would expect the same formal machinery to cover both types of lexical relatedness, the **Uniformity of Realization Principle**.

For prototypical examples of inflection and derivation it is easy to see the differences. However, there are well-known problems in identifying sets of criteria which will unambiguously pick out all and only the inflectional and the derivational processes. We can define canonical inflection/derivation (Corbett 2010; Brown and Hippisley 2012) but there are several intermediate types which have to be seen as non-canonical inflection, non-canonical derivation, or perhaps both at the same time. Especially problematic is the central criterion, the principle that derivation defines new lexemes while inflection defines forms of a lexeme. The problem here is the **Lexeme Individuation Problem**: there is no way to determine when two distinct words belong to the same lexeme or different lexemes.

The separation between inflection and derivation is further compromised by intermediate categories, such as transpositions, evaluative morphology, and several other types, which show some properties of inflection and some of derivation. Constructions such as transpositions are particularly problematic because they deliver a word of a different lexical class from the base, and hence a different inflectional paradigm, yet they seem to be a form of the base lexeme. This is especially problematical in case such as the Russian past tense, in which the word class seems to change (to predicative adjective) even though that set of word forms is realizing a set of verb properties. Conversely, we have morphologically inert types of relatedness, such as *Angestellte(r)* nouns, which unexpectedly preserve the base lexeme's word class and inflectional paradigm (adjective) while behaving in the syntax as though they belonged to a different class (noun).

I have suggested a solution to the apparent incompatibilities engendered by the **Uniformity of Realization Property** on the one hand and the **Differential Inflectability Property** on the other. Systematic (that is, productive; Chapter 4) lexical relatedness is paradigm-driven. It is defined over a factorized representation of the lexical entry (Spencer 2005, 2013; Brown and Hippisley 2012), respecting Spencer's (2013) **Principle of Representational Independence**. Assuming a coarse-grained factorization into FORM, SYN, SEM attributes and a Lexemic Index (LI), we define a Generalized Paradigm Function (GPF) which maps pairs $\langle \text{Lexemic Index}, \{\text{feature set}\} \rangle$ to various types of output. The GPF consists of (at least) four functions defined over the four lexical attributes, f_{form} , f_{syn} , f_{sem} , f_{li} . A trivial version of the GPF is defined over the pairing $\langle \text{Lexemic Index}, u \rangle$ for the empty feature set, u , and this defines the lexical entry itself. Inflection is defined non-trivially over the FORM attribute leaving the other attributes unchanged. This is essentially Stump's (2001) Paradigm Function, a special case of the GPF. Derivation typically (and canonically) defines a non-trivial change over all four main attributes, including the LI. If δ is a derivational

feature governing a paradigm-driven derivational relationship then the GPF defined over $\langle \mathcal{L}, \delta \rangle$ for LI $\mathcal{L}$ will include a LI function, f_{li} , defined in terms of a function $f_{\delta}(\mathcal{L})$ which defines the LI of the derived word. By the **Derived Lexical Entry Principle**, $f_{li}(\langle \mathcal{L}, \delta \rangle) = f_{li}(\langle f_{\delta}(\mathcal{L}), u \rangle) = \mathcal{L}'$, the LI of the derived lexeme. This defines a new lexical entry which in turn can be the input to inflectional instantiations of the GPF. In this way, we are able to unify the machinery of inflectional and derivational morphology and still draw a distinction between “form of lexeme” and “new lexeme.” The role of the LI attribute is crucial to this solution.

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3

The Minimal Sign

James P. Blevins

Following Saussure (1916), it is conventional to view language as a system of “signs.” Morphological approaches have traditionally been distinguished with reference to the locus of the units that they treat as minimal signs within a grammatical system. Initial versions of morphemic analysis regarded morphemes as signs. Word and paradigm models, whether realizational or implicational, identified lexemes as minimal signs. However, as morphemic models have assumed a more realizational character, the fundamental semiotic divide has shifted, from a contrast between morphemic and lexemic models to an associative/discriminative split within the class of lexemic approaches.

1 The Semiotic Legacy

Most contemporary linguistic models adopt a broadly semiotic perspective in which “la langue est un système de signes exprimant des idées” (Saussure 1916: 33). In models that regard morphology as a primary point of entry of meaning into a linguistic system, this perspective is expressed in terms of minimal Saussurean *signes*, each relating a conceptual *signifié* to an acoustic (or gestural or orthographic) *signifiant*.

1.1 Morphological Signs

Models that approach morphology as the study of word structure can identify either whole words or parts of words as the locus of the basic sign relation. This choice largely determines the standard division of morphological models into “morphemic” and “lexemic” classes. Following Hockett (1954), the two principal morphemic archetypes are the “item and arrangement” and “item and process” models developed within the Bloomfieldian

tradition. Hockett's class of "word and paradigm" models likewise divides into "realizational" and "implicational" types (Blevins 2006).

On the usual assumption that words are not unanalyzable wholes, the sign relation is in turn mediated by a relation between recurrent "units of form" and discrete "units of meaning." Morphemic models establish a primary sign relation between minimal recurrent units of form and corresponding units of meaning. Words are, like other larger forms, constructed from these minimal signs by combinatorial operations, which may be formulated either as "arrangements" or as "processes." As a class, lexemic models establish a primary sign relation between a word-form and a feature complex that represents the grammatical properties of the word. However, the role of recurrent form units differs substantially within this class. In realizational models, the sign relation is mediated by realization rules that interpret or "spell out" properties in the complex by form elements. The relation between properties and forms is many-many, and the form elements introduced by rules are not *signifiants* of the properties they interpret but are merely exponents that "signal" those properties. Implicational models do not even treat minimal units of form as signaling properties in isolation. Instead, these units function as part of a system of discriminative form contrasts that are related to a system of discriminative feature contrasts.¹

1.2 The Locus of Minimization

Although the unit-based classifications derived from Hockett (1954) register a division between two morphological lineages, this is a derivative and increasingly anachronistic split. The distinction between morphemic and lexemic models derives ultimately from more basic assumptions of these models, notably the trade-off between the "granularity" and "indeterminacy" of form-meaning relations. From the initial explicit procedures of analysis formulated in Harris (1942) and Hockett (1947) onwards, the morphemic tradition was guided by the minimality condition in (1).

(1) Segment Minimalization

The *signifiants* of a system are the minimal recurrent units of form ("morphs").

By grounding the form-meaning relation in a correspondence between properties and morphs, morphemic models avoided the redundancy, and loss of "scientific compactness," that Bloomfield had associated with recurrent elements of form:

¹ For recent elaborations of implicative models, see Ackerman and Malouf (2013), Blevins (2016) and Chapter 12 of this volume. For discriminative models, see Baayen et al. (2011) and Ramscar et al. (2013).

our traditional grammars fall short of scientific compactness by dealing with an identical feature over and over again as it occurs in different paradigmatic types. Thus, in a Latin grammar, we find the nominative-singular sign -s noted separately for each of the types *amicus* 'friend,' *lapis* 'stone,' *dux* 'leader,' *tussis* 'cough,' *manus* 'hand,' *faciēs* 'face,' when, of course, it should be noted only once, with a full statement as to where it is and where it is not used. (Bloomfield 1933: 238)

Reflecting their origins in the classical word and paradigm tradition, lexemic models focus on minimizing the indeterminacy between meaning and form rather than unit size. It is the primacy assigned to grammatical stability, as expressed in (2), that leads lexemic models to identify words as the main locus of the sign relation.

(2) Uncertainty Minimalization

The *signifiants* of a system are the minimally indeterminate units of form.

Hence the locus of the sign relation is not an independent choice in either morphological tradition but follows from more general concerns. In morphemic models, treating morphs as *signifiants* is meant to contribute to the reduction of redundancy. In lexemic models, treating words as *signifiants* serves the goal of minimizing indeterminacy. These contrasting goals in turn reflect different assessments of the trade-off between redundancy and indeterminacy. Lexemic models grew out of a classical tradition that was concerned primarily with inflectional patterns and systems. Viewing language from this perspective places an emphasis on the fact that there is a generally many-to-many relation between form and meaning, and that this relation becomes more variable as an analysis moves from utterances to individual formatives. The task of morphological analysis thus involves an intrinsic compromise between the ideal notions of minimality in (1) and (2). As stated concisely by Robins (1959), an optimal analysis represents an optimal trade-off, isolating units that are small enough to describe the distributional regularities of a system and large enough to minimize indeterminacy in associating units with grammatical properties:

The word is a more stable and solid focus of grammatical relations than the component morpheme by itself. Put another way, grammatical statements are abstractions, but they are more profitably abstracted from words as wholes than from individual morphemes (Robins 1959: 128).

1.3 Problems of Morphemic Analysis

In contrast, much of the appeal of the initial models of morphemic analysis in Harris (1942) and Hockett (1947) derived from the idea that an analysis could disassemble forms into minimally recurrent signs and combinatory devices, with no loss of information and no increase in

grammatical indeterminacy. Morphemic models approached language as a simple, transparent, and economical code for expressing discrete meanings by recurrent forms. The problem, as acknowledged already in Hockett (1947), is that few if any languages conform to this idealized description.

The specific problems that arise in treating minimal recurrent units as signifiants have reflexes in each component of morphemic analysis, from the isolation of units of form, through the association of units of meaning, and the interpretation of complex forms. In order to understand the subsequent development of morphemic approaches, particularly their rapprochement with realizational models, it is useful to briefly summarize these problems. The challenges that arise in segmenting the speech stream into minimal units of form were recognized at the outset of the morphemic tradition. As Lounsbury (1953) clearly recognizes, forms in fusional languages may exhibit irresolvable segmental indeterminacy:

In a fusional language, if one seeks to arrive at constant segments in such a manner, conflicts arise in the placing of the cuts. One comparison of forms suggests one placement, while another comparison suggests another. Often, in fact, no constant segment can be isolated at all which corresponds to a given constant meaning. Situations of this kind often permit of more than one solution according to different manners of selecting and grouping environments. (Lounsbury 1953: 172)

The recalcitrance of this problem is reflected in what Spencer (2012: 93) terms the “Segmentation Problem.” Spencer summarizes the strategies explored in the intervening 60 years with the observation that “In general, for any complex word in any language, there is (apparently) no way to establish a segmentation algorithmically.”

Although the problems that arise in associating segments with discrete meanings received less attention in the morphemic tradition, these problems are no less recalcitrant. For a concise illustration, we can turn to the patterns of syncretism described as “Priscianic” in Matthews (1972, 1991) and as “morphomic” in Aronoff (1994) and Maiden (2005). The examples in Table 3.1 illustrate a familiar case of this kind, involving a “third” stem that recurs in a set of nonfinite forms of Latin verbs.

The recurrent stems in these forms make no consistent morphosyntactic contribution in addition to the properties that can be associated with the verb root. Hence they cannot be associated with informative features in isolation. Instead, their function is predictive rather than denotative, as Maiden (2005) stresses:

The third stem constitutes an allegedly inviolable distributional regularity—what Aronoff terms a **morphome**—in that its presence in any one member of the specified, idiosyncratic, set of cells, always implies its presence in all of the other members of the set. (Maiden 2005: 137)

Table 3.1. *Priscianic syncretism in Latin conjugations*

	Verb	SUPINE	PAST PASS PART	FUT ACT PART
AMŌ	"to love"	amāt-um	amāt-us	amāt-ūr-us
TEGŌ	"to conceal"	tēct-um	tēct-us	tēct-ūr-us
MONEŌ	"to advise"	monit-um	monit-us	monit-ūr-us

The Latin pattern in Table 3.1 is merely the most familiar example of this type. Similar patterns recur in the modern Romance languages Maiden (2005) and permeate the inflectional system of modern Estonian (Blevins 2007, 2008).

The third, and in some respects most disruptive, challenge to morphemic analysis comes from forms in which neither segmentation nor association appears problematic. The issue in these cases derives from the fact that the economy achieved by morphemic analysis rests on the assumption that recurrence involves redundancy. This assumption explicitly underlies Bloomfield's charge that "traditional grammars fall short of scientific compactness by dealing with an identical feature over and over again." The repetition of an "identical feature" in a description is only redundant if the feature in question is genuinely identical. It is not sufficient that an orthographic or phonemic system fails to distinguish separate occurrences of an element; the item must also be produced and interpreted identically by speakers.

Yet the assumption that phonemic transcriptions are precise enough to capture the notion of "identity in form" that is relevant for speakers has been systematically challenged by the emerging literature that probes sub-phonemic contrasts. Careful acoustic and psycho-acoustic studies of units ranging in size from words to single-segment affixes have shown that speakers consistently produce and comprehend durational differences and other phonetic variation that do not determine phonemic contrasts. At the word level, Gahl (2008) found systematic differences in duration between ostensibly homophonous items such as English *time* and *thyme*. Drager (2011) reported similar variation for English *like* in its different functions. At the segment level, Plag et al. (2015) found "significant differences in acoustic duration between some morphemic /s/'s and /z/'s and non-morphemic /s/ and /z/, respectively." In the domain of word formation, Davis et al. (2002) found suggestive differences in duration and fundamental frequency between a "monomorphemic" word like *captain* and a morphologically unrelated onset word such as *cap*.

Of more direct relevance to the issue of "scientific compactness" are studies of inflectional formations. The exploratory study of Baayen et al. (2003) found that a sample of speakers produced Dutch nouns with a longer mean duration when they occurred as singulars than when they occurred as the stem of the corresponding plural. In a follow-up study, Kemps et al. (2005) tested speakers' sensitivity to prosodic differences, and concluded

that “acoustic differences exist between uninflected and inflected forms and that listeners are sensitive to them” (Kemps et al. 2005: 441). That is, from the perspective of a Dutch speaker, singular forms like *rat* ‘rat’ and *geit* ‘goat’ do **not** recur in the corresponding plurals *ratten* ‘rats’ and *geiten* ‘goats’ but instead have a distinctive prosodic profile that speakers are sensitive to.

As Kemps et al. (2005) note in their conclusion, this effect calls into question a fundamental assumption of a combinatoric approach, namely that complex units are constructed via the assembly of simple units drawn from a fixed “alphabet”:

The prosodic mismatch effect documented in this study has important consequences for our understanding of the morphological structure of complex words. The way words are written in languages such as Dutch and English suggests that they consist of stems and affixes that are strung together as beads on a string. Phonemic transcriptions convey the same impression. Our experiments show that this impression is wrong. *Plurals are not just singulars with an additional suffix. The precise acoustic realization of the stem provides crucial information to the listener about the morphological context in which the stem appears.* (Kemps et al. 2005: 441, emphasis added)

These sub-phonemic effects demonstrate that it is not sufficient for a morphemic model to solve recalcitrant segmentation and association problems, because success in segmentation and association is no guarantee of a correct analysis. A form like *geiten* can be segmented into a stem *geit* and suffix *-en*, and the stem can be assigned lexical properties while the suffix is assigned grammatical properties. However, as Kemps et al (2005) show, it is a error of analysis to identify the plural stem *geit* with the singular form *geit* or to associate plurality solely with the suffix *-en*. The morphotactic split between *geit* and *-en* does not correlate with a division in grammatical meaning between “caprine” and “plurality.” Instead, the plural stem is tuned to its morphological environment, suggesting that the affix provides a learning context for speakers rather than carrying any independent grammatical meaning.

1.4 The Lexemic Turn

In sum, the attempt to treat morphs as *signifiants* confronts two types of challenges. The first type includes the problems of segmentation and association that arise when word-forms are disassembled into minimal recurrent units of form. Throughout the morphemic tradition, these types of problems tended to be treated as “technical” challenges that could be addressed by technical refinements. Within a decade of the first explicit models of morphemic analysis in Harris (1942), the descriptivists had come to regard these purely technical correctives as deficient (as “equivalent ... to removing the keystone of the whole [item and]A

[rrangement] arch” (Hockett 1954: 394)), though further technical refinements of morphemic models continued to be pursued into the generative period. Reflecting on this tradition some forty years later, Hockett (1987) concluded that morphemic analysis ultimately revealed more about the typological biases of the model than about the structure of morphological systems, and characterized the enterprise as “the great agglutinative fraud”:

We were providing for alternations by devising an “agglutinative analog” of the language and formulating rules that would convert expressions of that analog into the shapes in which they are actually uttered. Of course, even such an agglutinative analog, with its accompanying conversion rules, could be interpreted merely as a descriptive device. But it was not in general taken that way; instead, it was taken as a direct reflection of reality. We seemed to be convinced that, whatever might superficially appear to be the case, every language is “really” agglutinative. (Hockett 1987: 83–4)

The sub-phonemic effects described above present a more fundamental challenge, in that they suggest that the analytic assumptions of a morphemic model are motivated by an appeal to a conception of economy founded on imprecise orthographic and phonemic notions of “identity.” If seemingly recurrent units are not genuinely identical, then there is no redundancy in a description that contains their distributional variants, and consequently no economy is achieved by a description that collapses variants into a single item. In this case, morphemic analyses are merely “lossy” descriptions that achieve no gain in “scientific compactness,” and it becomes immaterial whether they ever solve problems of segmentation and association.

From a lexemic perspective, the problems faced by morphemic models illustrate the cost, in terms of increased instability of form and indeterminacy of feature analysis, that is incurred by locating the sign relation below the level of words. To some extent this point is conceded in current descendants of morphemic models. Although models such as Distributed Morphology (DM; Halle and Marantz 1993) retain the term “morpheme,” the notion in DM has at most a historical connection to the original “morpheme-as-sign” conception.² Models like DM represent a subtype of realizational account in which the term “morpheme” is applied to various structures that mostly lack a specific label in other realizational approaches but are in any case devoid of any semiotic content. The recent development of morphemic models is outlined in Section 2.2 below. However, the most general effect of these developments is that they relocate the basic semiotic contrast from a morphemic/lexemic split to an associative/discriminative split within the class of lexemic approaches.

² For more detailed discussion of DM, see Chapter 15 of this volume.

2 Associative and Discriminative Lexemics

The challenges that confront a morphemic model can also be described in terms of a conflation of the signs of a system and what we might call the **variants** – that is, the “minimal units of variation” within that system. This conflation entails that each point of variation in a form must correspond to some discrete meaning. In a morphemic model that enforces a strict biuniqueness condition, each discrete meaning must likewise correspond to a unique variant. Having origins in a grammatical tradition that evolved to describe the flectional patterns in Latin and Ancient Greek meant that lexemic models were designed to capture the generally many-to-many relation between form and meaning in a morphological system. The modern revival of a lexemic model began with a detailed study of Latin conjugations from morphemic and realizational perspectives which leads Matthews (1972) to conclude:

One motive for the post-Bloomfieldian model consisted, that is to say, in a genuinely factual assertion about language: namely, that there is some sort of matching between minimal “sames” of “form” (morphs) and “meaning” (morphemes). *Qua* factual assertion this has subsequently proved false: for certain languages, such as Latin, the correspondence which was envisaged apparently does not exist . . . One is bound to suspect, in the light of such a conclusion, that the model is in some sense wrong. (Matthews 1972: 142)

The descriptive flexibility of lexemic models derives from the dissociation between signs and variants. The sign relation holds between the feature complexes that represent (or are proxies for) the grammatical meaning of a word and the forms that realize those complexes. As illustrated in Table 3.2, the realization of a complex is mediated by exponents that represent individual points of form variation. In contrast, a morphemic model identifies *signifiants* and variants. In item and arrangement models, they are both morphs; in item and process models, they are both processes.

The distinction between *signifiants* and variants relates to a global dissociation between meaning and form, which, following Beard (1995), is termed the “Separation Hypothesis.” Within lexemic models, forms and meanings are assigned to separate domains, each governed by its own set of principles. This independence frees morphological rules to perform a purely interpretive function, mapping between meaning and form domains. The

Table 3.2. *Morphological signs and variants*

	Lexemic	Morphemic
Signifié	feature complex	individual feature
Signifiant	word-form	morph/process
Variant	exponent	morph/process

interpretive character of these mappings determines the generally many-to-many relation between features and forms. Features may be biuniquely realized, as in morphemic models. But multiple features may also be realized cumulatively by a single form. Conversely, a feature or set of features may be realized by multiple rules. Features present in a feature complex may also remain unrealized, if there is no applicable rule to interpret them. These varieties of exponence relations are outlined in Matthews (1972, 1991) and elaborated in a range of subsequent studies including Anderson (1992), Aronoff (1994), and Stump (2001).

2.1 Signals or Oppositions?

There are, however, important differences in how grammatical meanings are interpreted by variants within lexemic models. The “spell-out” rules of a realizational model are, in essential respects, descendants of the “interpretive phonological rules” outlined in Chomsky’s (1965) programmatic remarks on German declension.

The system of paradigms is simply described as a system of features, one (or perhaps some hierarchical configuration) corresponding to each of the dimensions that define the system of paradigms. Interpretive phonological rules, some quite specific, some of considerable generality, then operate on the phonological matrix of the lexical entry, giving, finally, a phonetic matrix. (Chomsky 1965: 172)

Realization rules are unlike morphemes in that they do not assign grammatical meanings to units of form. Yet realization rules are also like morphemes in that they establish an **association** between a particular feature configuration and a specified pattern of exponence. That is, each realization rule states an individual feature-form correspondence in isolation from the larger system of contrasts in which it occurs. Hence, if a rule spells out specifications in the realization of one feature complex, it will in general spell out the same specifications when they occur in other complexes. For the most part, this is desirable; it is the mechanism that permits realizational analyses to express consistent patterns of exponence within a system. But if there are deviations from a uniform pattern, the expected rule must somehow be inhibited.

The associative orientation of morphemic and realizational approaches contrasts markedly with the **discriminative** perspective adopted in classical Word-and-Paradigm (WP) models and their modern implicational descendants. From a discriminative perspective, the role of form variants is not expressed by a static association with a set of features. Instead, form variants always function within a larger **system** of contrasts that collectively distinguish the forms of that system. The difference between these conceptions is schematized in Figure 3.1 below. In realizational—as in morphemic—models, the relation between meaning

	Morphemic	Realizational	Discriminative
Features	F	[F ₁ ...F _n]	F ₁ ~ ... ~ F _n
	↕	↓	⇕
Variants	μ	μ	μ ₁ ~ ... ~ μ _m

Figure 3.1. Mediated relations between meaning and form

and form in a system is broken down into an inventory of individual form-meaning associations. In morphemic models, these associations are expressed as morphemes, whereas in realizational models they are expressed as interpretive rules. Both types of associations establish a discrete, isolable, relation between specific features or feature sets and individual form variants.

In contrast, a discriminative model establishes a global relation between a system of meaning contrasts and a system of discriminable form contrasts. Individual form variants define and are defined by the oppositions within that system and have no discrete function or meaning in isolation from the rest of the system. While this conception underlies the notions of analogy developed in classical WP tradition, it finds its most overt expression in the semiotic theory of Saussure (1916). On the reading of Saussure, the units of a linguistic system are defined in terms of their opposition to other units of the system and have no value outside that system.³

Appliqué à l'unité, le principe de différenciation peut se formuler ainsi: *les caractères de l'unité se confondent avec l'unité elle-même*. Dans la langue, comme dans tout système sémiologique, ce qui distingue un signe, voilà tout ce que le constitue. C'est la différence qui fait le caractère, comme elle fait la valeur et l'unité.

La langue est pour ainsi dire une algèbre qui n'aurait que des termes complexes. Parmi les oppositions qu'elle comprend, il y en a qui sont plus significatives que d'autres; mais unité et fait de grammaire ne sont que des noms différents pour désigner des aspects divers d'un même fait général: le jeu des oppositions linguistiques. (Saussure 1916: 167–8)

Moreover, although lexemic models were initially formulated in associative terms, a discriminative perspective is often implicit in descriptions of contrasts of these models. For example, Matthews' description of exemplary paradigms emphasizes the role that contrasting variants play in discriminating forms of an item:

³ Applied to units, the principle of differentiation can be stated in this way: *the characteristics of the unit blend with the unit itself*. In language, as in any semiological system, whatever distinguishes one sign from the others constitutes it. Difference makes character just as it makes value and the unit. Language, in a manner of speaking, is a type of algebra consisting solely of complex terms. Some of its oppositions are more significant than others; but units and grammatical facts are only different names for designating diverse aspects of the same general fact: the functioning of linguistic oppositions. (Saussure 1959: 121–2)

Table 3.3. *Future indicative paradigm of k'vla 'kill'*

Subject	Object				
	1sg	1pl	2sg	1pl	3
1sg	—	—	mogk'lav	mogk'lavt	movk'lav
1pl	—	—	mogk'lavt	mogk'lavt	movk'lavt
2sg	momk'lav	mogvk'lav	—	—	mok'lav
2pl	momk'lavt	mogvk'lavt	—	—	mok'lavt
3sg	momk'lavs	mogvk'lavs	mogk'lavs	mogk'lavt	mok'lavs
3pl	momk'laven	mogvk'laven	mogk'laven	mogk'laven	mok'laven

Source: Tschenkeli (1958: §31)

Pupils begin by memorising paradigms. These are sets of words as wholes, arranged according to grammatical categories. This is not only traditional, it is also effective. *They learn that different members of a paradigm are distinguished by their endings ...* They can then transfer these endings to other lexemes, whose paradigms they have not memorised ... (Matthews 1991: 187–8, emphasis added)

An even more explicitly discriminate perspective is expressed in the extended discussion of “contrastive deduction” in Anderson (1992: 87). Anderson’s general point is that “information may sometimes be conveyed by ... the fact that certain other material is *absent*.” But as the reference to “other material” makes explicit, this type of deduction relies on a system of contrasts. Literally unmarked verb forms are interpreted in opposition to all of the explicitly marked forms of a paradigm.

Consider the Georgian Verb form *mogk'lav* in [Table 3.3], for example, ... This form represents agreement with a first-person singular Subject and a second-person singular Direct Object ... But while an overt affix (/g/) is present to signal agreement with the second-person Object, no affix marks the fact that the Subject of this Verb is (and must necessarily be) first-person singular. This agreement can be inferred from the following information. The Subject cannot be second person, because if it were, the sentence would be reflexive—but reflexive forms in Georgian are grammatically third person, and this Verb has a second-person Object. Similarly, the Subject cannot be third person, since, if it were, there would be a suffix (/s/) at the end of the Verb. Thus ... the Subject must be first person. But it must be singular, rather than plural, since a first-person plural Subject would trigger the introduction of a suffix /t/ at the end of the Verb. We know therefore that the Subject of this Verb must be first-person singular, but this fact is not signaled by the presence of any overt affix in the word. (Anderson 1992: 87)

Intriguingly, the realizational approach that Anderson outlines does not in fact model this interpretive dynamic. This is illustrated by the most extreme case of “contrastive” exponence in Table 3.3, *mok'lav*, which realizes both the stem of the paradigm and the cell with 2sg subject and

3pl object features. In a realizational model, the agreement properties of the word-form *mok'lav* are expressed by an analysis in which no rule spells out either 2sg subject features or 3pl object features. This is an elegant solution within an associative frame of reference and certainly an improvement over morphemic analyses that would express contrastive paradigmatic exponence in terms of maximally nondiscriminative “zero” morphs.

However, the lack of applicable spell-out rules is a static fact about a particular rule inventory and in no way captures the dynamic process of interpretation outlined by Anderson.

It is unsurprising that a dynamic system of contrasts cannot be modelled by a set of static independent associations. In one sense, this is a virtue of a realizational analysis, which makes it clearly preferable to an online “morphological blocking” account of the type proposed in Andrews (1990) or Blevins (1995). Speakers who have learned Georgian can be presumed to know that there is no formal realization of 2sg subject features and 3pl object features in transitive verbs, and there is no reason to believe that they invoke “process of elimination” deductions each time that they encounter an unmarked form. From a discriminative perspective, it is equally implausible that these deductions would be invoked in the course of online processing. However, the procedure of contrasting unmarked forms with marked alternatives is naturally interpreted as describing stages of the **acquisition** process.

The deductive steps sketched by Anderson can be thought of as representing **events** in the training of a discriminative learning network of the kind outlined in Baayen et al. (2011) and Ramscar et al (2010, 2013). Each of the deductions described by Anderson corresponds to an event that strengthens the association between a form ω that contrasts with *mok'lav* and features Φ that contrast with 2sg subject features or 3pl object features. Each such event also weakens the association between *mok'lav* and Φ , and, given the way that discriminative models learn, strengthens the association between *mok'lav* and 2sg subject features or 3pl object features. Hence, as a result of learning the meanings of marked verb forms, a discriminative network will also learn the correct interpretation of unmarked forms. The prediction-driven features of the learning model that determine this outcome are described in more detail in Rescorla and Wagner (1972), Rescorla (1988), and Ramscar et al (2013: §767ff.). In the present context, the main point is that this type of learning model provides a locus for the dynamic process described by Anderson.

Other patterns exhibited by the forms in Table 3.3 bring out more fundamental differences between realizational and discriminative perspectives. Consider again Anderson’s form *mogk'lav*, which illustrates a familiar case of “slot competition” in Georgian. As Anderson (1986: 6) notes elsewhere, “we see that instead of the combination of *v-* and *g-* which we might expect, only the *g-* appears.” The operative generalization is that the prefix

v- marks 1pl subject features except in forms with 2pl object features, in which case *g-* marks the object features and *v-* fails to occur.

The contrast between realizational and discriminative treatments of this pattern is instructive. To account for the contexts in which the prefixes *do* occur, realizational models introduce a pair of rules, one that spells out 1pl subject features by *v-* and a second that spells out 2pl object features by *g-*. In cells that contain 1pl subject features and 2pl object features, the requirements of both rules are met. Given that only *g-* actually occurs in such cases, a realizational model must somehow assign priority to the rule that spells out 2pl features. Competition between rules that apply at the same point in a form is usually regulated by a constraint (such as the “Elsewhere principle” (Anderson 1992: 132), or “Pāṇini’s principle” (Stump 2001: 21ff.)) that assigns priority to a more specific rule.⁴ However, Georgian prefixal competition does not fall straightforwardly within the scope of a specificity-based condition, given that 2pl object features are in no obvious way more specific than 1pl subject features.

Solutions to this problem have of course been explored in different realizational frameworks but it is the logical structure of the challenge that is particularly relevant here. Because they interpret feature specifications, realization rules apply to the natural classes of cells characterized by those specifications. Patterns of form variation that are associated with a non-natural class of cells are attributed to the interaction of rules, each of which applies to a natural class of cells, but which overlap in a way that creates a distribution over a non-natural class. In a realizational analysis of the paradigm in Table 3.3, the rule that spells out 1pl subject features by *v-* is applicable to the natural class of cells with 1pl subject features but only applies to those with 3pl objects because it is preempted by the rule that spells out 2pl object features.

From a discriminative perspective, the problem faced by realizational analyses of Georgian is symptomatic of an initial overgeneralization. “Pupils” who, as Matthews suggests above, “begin by memorising paradigms” would be expected to learn from the patterns in the language that *v-* does not appear in forms that realize 2pl object features. The knowledge that such a speaker acquires about the distribution of *v-* is not accurately represented by a rule that introduces *v-* as the realization of 1pl subject features everywhere. Within a realizational model, the problem of overgeneralization is endemic to the rule format and cannot readily be corrected by making a rule more specific. For example, the rule introducing *v-* could be revised so that it applies to cells with 1pl subject features and “non-2pl” (or 3pl) objects. This refinement would have the desired effect for transitive verbs. Yet this solution creates the need for a separate rule to introduce *v-* in

⁴ See Chapter 17 for further discussion of Pāṇini’s principle in the context of PFM.

the realization of intransitive verbs, which specify no object features that “compete” for the prefixal slot.

Grammatical models developed within the general symbolic framework of formal language theory tend to impose a sharp contrast between the structured analyses assigned by a rule system and brute-force rote learning. From this perspective, observing that speakers learn the distribution of Georgian prefixes from the forms of their language leaves all of the interesting questions unaddressed. This is where a discriminative learning model is again useful in offering a structured description of mechanisms that can extract distributional regularities from the Georgian conjugational paradigms. Let us consider a simplified learning context consisting of sets of input and output units connected by weights. The inputs are forms containing agreement markers and the outputs are cells containing agreement features (coded as lexomes, for the reasons outlined in Baayen et al. (2016)). The association weights between forms and cells are strengthened whenever a form realizes a particular cell and weakened when it does not realize that cell. Training will establish a strong association between *g-* and 2pl object features, since every form that contains *g-* realizes 2pl object features. There will also be a strong negative association between *v-* and 2pl object features, since no form that contains *v-* realizes 2pl object features. There will of course be an association between *v-* and 1pl subject features, but also between *g-* and 1pl subject features, given that *g-* occurs in the realization of four of the six cells marked for 1pl subject features in a transitive paradigm.

A description of prefixal patterns in terms of discriminative learning does not make the distribution of prefixes seem more natural or explain why the prefixes have the distribution that they do. However, even this brief illustration shows how a learning-based account can avoid the difficulties that arise from inducing an overgeneralized distribution. Moreover, this perspective also suggests that overgeneralization is a symptom of isolating a single contrast from a system of contrasts. In a realizational analysis, it would be natural to associate *g-* with “2pl object features” and highly unnatural to associate *g-* with “1pl subject features.” Yet within transitive verb paradigms, *g-* is in fact a more reliable cue for 1pl subject features than the 1pl subject prefix *v-*. Conversely, it would be natural within a realizational analysis to identify the spell-out of “2pl object features” as just the prefix *g-*. However, the strong negative association between 2pl object features and *v-* also forms part of the dynamics of the system. The learning model, like the human learner, comes to recognize that “2pl object features” and *v-* exhibit perfect complementarity. But there is nowhere in a system of static feature-form associations to express this exceptionless pattern.

2.2 Systems and Inventories

A comparison of the challenges faced by realizational models with the deficiencies of the morphemic models described in Section 1.3 suggests

that both derive ultimately from the common goal of reducing a dynamic system to a static inventory. Whereas realizational models represent form variation by means of spell-out rules (possibly augmented by other rule types and devices), morphemic accounts encapsulate variation in an inventory of minimal signs. For Bloomfield, morphemes were “lexical forms” with meanings, which he termed “sememes.” Hence morphemes represent the *signifiants* within a Saussurean sign and sememes represent the *signifiés*. There is no Bloomfieldian term for the sign itself. This position is clearly expressed in Postulate 9 in Bloomfield (1926) and repeated in Bloomfield’s *Language*:

In the case of lexical forms, we have defined the smallest meaningful units as morphemes and their meanings as sememes . . . (Bloomfield 1933: 166)

Rather than regarding the morpheme as a single form, Bloomfield’s successors defined it as an abstract unit, modeled on the phoneme (Hockett 1942). What came to be known as the “structuralist” morpheme consisted of a set of forms, termed “morpheme alternants” (Harris 1942) or “(allo)morphs” (Hockett 1947). The forms assigned to a morpheme were required to “have the same meaning” (Harris 1942: 179) and satisfy various distributional conditions. There is no counterpart of the sememe in this model. An implicitly discriminative contrast between “sameness” and “difference” of meaning determines the assignment of morphs to morphemes.

Other notions of the “morpheme” (or cognate terms in other languages) were in circulation at roughly the same time, along with initial criticisms of the American “structuralist” notion.⁵ Nevertheless, a morphemic orientation gained in influence, particularly within the subsequent generative school. There were, however, few explicit attempts to define the morpheme after Hockett (1947, 1954) and the vigorous debate of the early period was “simply broken off in the middle” (Hockett 1987: 53).

Contemporary attempts to establish viable models of morphemic analysis tend not to resume this debate. They also do not address the additional challenges raised by studies such as Matthews (1972) or those summarized in Section 1.3 above. Instead, the term “morpheme” is simply appropriated for notions that are in essential respects closer to a lexemic perspective. For example, in initial models of DM, the term “morpheme” is used to refer ambiguously to (i) a grammatical feature bundle, which occurs as the terminal element of a syntactic tree, or (ii) a grammatical feature bundle, together with a phonological feature bundle.

The terminal elements of [syntactic] trees consist of complexes of grammatical features. These terminal elements are supplied with phonological features only after Vocabulary insertion at MS [morphological structure].

⁵ See, among others, the commentary in Bolinger (1948) and Bazell (1949), the historical summaries in Hockett (1987), Anderson (1992, 2015), and Blevins (2016), and the references cited therein.

Although nothing hinges on this terminology in what follows, we have chosen to call the terminal elements “morphemes” both before and after Vocabulary insertion, that is, both before and after they are supplied with phonological features. (Halle and Marantz 1993: 114)

On the first conception, the morpheme corresponds to the Bloomfieldian sememe, or the *signifié* of a Saussurean sign. On the second, it encompasses the whole sign.

The break from the Bloomfieldian tradition of morphemic analysis is complete in later elaborations of DM, in which “morpheme” is applied to an “abstract unit.”

a morpheme is an abstract syntactic unit that finds an interpretation in form and in meaning ... The notion of “abstract” when applied to morphemes characterizes not only the independence of a particular morpheme from a specific realization in form but also its independence from a specific semantic value. For example, the “plural” morpheme in English is the same morpheme, appearing in the same syntactic position with respect to the noun stem, whether it conveys a meaning associated with “more than one” (as in “cats” and “oxen”) or whether it does not (as in “(eye-)glasses” or “pants”). More generally, the features associated with morphemes by linguists, while connected to their syntactic and semantic properties, find their grammatical import (their role in the syntax in particular) independent of their possible semantic (or phonological) interpretations. (Marantz 2013: 1–2)

On this view, the “plural” morpheme need not be associated with a constant “unit of form,” since it the “same” morpheme in *cats* and *oxen*. It also need not be associated with any stable “unit of meaning” since it may or may not convey a notion of plurality.

Whatever the merits of defining such an “abstract” unit, it shares nothing in common with the original conception of a Saussurean sign linking units of form with units of meaning. On the contrary, DM occupies an extreme anti-morphemic position within the family of realizational approaches, given that it eliminates all of the components of the traditional Bloomfieldian morpheme (meaning, form, and linkage) and simply reassigns the term “morpheme” to an abstract syntactic “unit.”

The main innovations in DM are derivative of a shift to a realizational perspective. The idea that morphological patterns can be described as the interpretation of abstract features restates the fundamental insight developed in Matthews (1965). The abstractness that DM ascribes to “morphemes” is likewise characteristic of the features in a realizational model. The independence of features “from a specific realization in form” is expressed by the fact that a set of realization rules may spell out common features by different units of form. The independence of features “from a specific semantic value” is implicit in the fact that realization rules interpret a wide range of features that cannot be associated with an unambiguous “unit of meaning.”

The one apparent novelty of DM is the claim that features are packaged into bundles termed “morphemes.” Yet even this claim is more terminological than substantive. In a realizational model, a rule may realize a single feature such as “plural” by an exponent, as in the *-s* of English *cats*, or it may realize “plural” cumulatively with other features, as in the *-e* that marks “partitive plural” in the Estonian counterpart *kasse*. The set of feature specifications that are spelled out by the rules of a language have no status within a realizational model because there appear to be no generalizations that make reference to this set. However, in any realizational model, it is possible to extract the set of feature specifications from the rules of the model and designate that set as a class of abstract “morphemes” in the sense of DM.

The retreat into abstractness in DM also illustrates a more general point about the interdependence of form and meaning. Within a traditional model of morphemic analysis, not all sequences of phonemes are classified as “morphs” and assigned to morphemes, but only those that share the same meaning. Conversely, the “units of meaning” do not include all discriminable properties in the world, but only those that condition variation in the shape or arrangement of forms. Hence the original conception of the “morpheme-as-sign” mediates between a system of two interdependent domains. The discussion in Sections 1.3 and 2.1 summarizes some of the problems that arise when individual form-meaning pairs are extracted from this system. However, insofar as these problems are due to extracting pairs from a system of contrasts which defines their function, the problems will only be exacerbated by restricting attention to one or the other component of an isolated pair.

3 Conclusion

The study of morphological systems in the nearly one hundred years since the publication of the *Cours de linguistique générale* supports a broadly lexicemic conception which, as Hockett (1987: 96) put it, “in surprising measure harks back to Saussure.” For Saussure (as for Hockett (1987)), a language was not an inventory of independent signs, but a system of elements defined by a network of mutual opposition.⁶

⁶ Mental association creates other groups besides those based on the comparing of terms that have something in common; through its grasp of the nature of the relations that bind the terms together, the mind creates as many associative series as there are diverse relations. For instance, in *enseignement* “teaching,” *enseigner* “teach,” *enseignons* “(we) teach,” etc., one element, the radical, is common to every term; the same word may occur in a different series formed around another common element, the suffix (cf. *enseignement*, *armement*, *changement*, etc.); or the association may spring from the analogy of the concepts signified (*enseignement*, *instruction*, *apprentissage*, *éducation*, etc.); or again, simply from the similarity of the sound-images (e.g., *enseignement* and *justement* “precisely”). Thus there is at times a double similarity of meaning and form, at times similarity only of form or of meaning. A word can always evoke everything that can be associated with it in one way or another. (Saussure 1959: 125–6).

Les groupes formés par association mentale ne se bordent pas à rapprocher les termes qui présentent quelque chose de commun; l'esprit saisit aussi la nature des rapports qui les relient dans chaque cas et crée par là autant de séries associatives qu'il y a de rapports divers. Ainsi dans *enseignement*, *enseigner*, *enseignons*, etc., il y a un élément commun à tous les termes, le radical; mais le mot *enseignement* peut se trouver impliqué dans une série basée sur un autre élément commun, le suffixe (cf. *enseignement*, *armement*, *changement*, etc.); l'association peut reposer sur la seule analogie des signifiés (*enseignement*, *instruction*, *apprentissage*, *éducation*, etc.), ou au contraire, sur la simple communauté des images acoustiques (par exemple *enseignement* et *justement*). Donc il y a tantôt communauté double du sens et de la forme, tantôt communauté de forme ou de sens seulement. Un mot quelconque peut toujours évoquer tout de ce qui est susceptible de lui être associé d'une manière ou d'une autre. (Saussure 1916: 173–4)

The discriminative perspective outlined above can be seen to restore the dynamic aspect of Saussurean semiotics. One way of conceptualizing the split within the class of lexemic models is to think of a realizational description of a system as a symbolic approximation of the state of a discriminative network that has learned the system. To the extent that contemporary morphemic models represent variants of realizational approaches, they can also be interpreted as symbolic approximations.

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4

Productivity

Georgette Dal and Fiammetta Namer

1 Introduction

The notion of productivity is in principle applicable both to word-formation and to inflection, but in this chapter we focus exclusively on word-formation.

Since Schultink's seminal work of 1961, morphological productivity has been understood as the possibility, for language users, to coin unintentionally an, in principle, uncountable number of new morphologically complex words.

Productivity has been a focus of increasing discussion in morphological analyses (see Plag 1999 and Bauer 2001, both titled *Morphological Productivity*); most handbooks in the field of morphology have dedicated an entire chapter to this concept (among others: Aronoff and Anshen 1998; Koefoed and van Marle 2000; Rainer 2000; Bauer 2005; Baayen 2009; Aronoff and Lindsay 2014; Gaeta and Ricca 2015), not to mention partial chapters devoted to this concept in other textbooks.

The reason for this popularity is that morphology actually *is* productivity (and the question arises as to whether productivity, in turn, *is* morphology). Indeed, according to Aronoff and Anshen (1998), “morphology deals only with potential words.” And, even more, “morphological theory should account only for processes of word formation which are productive” (Baayen and Lieber 1991: 801–2). Determining which processes are productive and which are not is thus a key issue in morphological research. Baayen addressed this issue in such a way as to supersede intuitive judgments on productivity, and achieved significant results (Baayen 1992) that have subsequently given rise to a significant amount of statistically based research (e.g., Baayen and Renouf 1996; Baayen and Neijt 1997).

Both qualitative (as in Schultink 1961) and quantitative (as in Baayen 1992) definitions of productivity have been widely commented upon and disputed.

In what follows, we first outline the general principles and main definitions relating to this notion, with classic examples from the literature as well as new ones taken from French (Section 2). This section provides an opportunity to consider qualitative and quantitative approaches to the concept. In Section 3, we explain why productivity is a central concept in morphology and describe factors that may influence productivity: word internal complexity, its either formal or semantic (ir)regularity, and other phonotactic criteria. In this section, we also refer briefly to the traditional opposition between productivity and creativity and discuss its appropriateness. Finally, Section 4 addresses the issue of how productivity has (in)directly changed the way research in morphology is carried out—in particular, how corpus-based, empirical approaches, together with a renewed attention to hapaxes, are nowadays producing a shift towards uncontrolled, real-data-driven reasoning in morphology.

2 Definitions

Productivity can be approached from both a qualitative and a quantitative point of view.

2.1 Qualitative

Although the concept is older in the morphological field (as early as 1942, Jespersen used it for research in English, while, according to Schultink (1992), grammarians of Sanskrit already made use of the notion), the classical definition is best attributed to Schultink (1961: 113), who defines productivity as the possibility, for language users, to coin unintentionally an, in principle, uncountable number of new morphologically complex formations.¹

This definition has been commented upon (*inter alia*, by Plag 1999; Evert and Lüdeling 2001; Dal 2003; Gaeta and Ricca 2003, 2015). The main points of criticism deal with unintentionality, newness, and uncountability.

Two issues emerge with respect to unintentionality: (a) how should it be evaluated? and (b) what is the connection between unintentionality and the possibility for a morphological process or pattern to be used to coin new formations?

In some cases, as in (1), it is easy to determine the user's intentionality; in *sauçaille* in (1a), the author is known to coin new words (Frédéric Dard, the French author of *San Antonio*, had this reputation); in *gentlemancambrioleurerie* in (1b), quotation marks indicate the intentionality of the speaker; in (1c), new formations (in bold) appear in contexts such as series or chiasmus:

¹ For a synthesis of others qualitative definitions, see among others Dal (2003) and Bauer (2001, 2005).

- (1) a. Quant au canard, il baignait dans une saucaille aqueuse en compagnie de pêches en conserve.
[As far as the duck is concerned, it bathes in a watery sauce-
[PEJORATIVE MARKER], in the company of canned peaches]
- b. Maniérisme luxuriant des derniers chefs-d'œuvre baignant dans un post-cinéma dorénavant étouffant, [...] « gentlemancambrioleurerie » insignifiante avec Cary Grant et Grace Kelly.
[Luxuriant mannerism of the latest masterpieces bathing in a henceforth suffocating post-cinema, [...] insignificant
“gentlemanburglar-NESS” with Cary Grant and Grace Kelly]
- c. cette fois encore nous démarrons dans les véhicules, **levage**, **douchage**, **mangeage** et enfin 30 minutes de **rangeage** et nous voilà.
[Here again, we pull out in our vehicles, **get-up-AGE**, **shower-AGE**, **eat-AGE**, and finally 30 minutes **tidy-up-AGE** and here we are]

Linguists, however, do not always have such textual or paratextual clues at their disposal.

Eliminating intentional formations from observation also means that the deliberate use of a given morphological process or pattern to coin new terms in a given domain says nothing about its availability. This position is disputable. For example, in German, the bound stem *-itis* ‘inflammation,’ repeatedly used in a medical context, has made inroads into everyday language. To focus on the medical field, the appearance of about one hundred *-itis* nouns in medical contexts at the beginning of the twentieth century (see Lüdeling and Evert 2005) is anything but unintentional: it is because scientists had to name inflammations that they intentionally choose the *-itis* pattern. Our position is similar to that of Bauer (2001: 66–8) and Gaeta and Ricca (2015): even the intentional use of a morphological process, especially in emergent terminologies, says something about its availability.

The unintentionality criterion has a further disadvantage in that it discards evaluative morphology, whose purpose is precisely that of marking speakers’ subjectivity and appreciation. More generally, if strictly applied, this criterion would amount to considering that, whenever speakers voluntarily coin a specific complex word appropriate in a given utterance context or in order to meet nomenclatural purposes, this new word could not illustrate the productivity of the morphological process it results from.

As regards the criterion of newness, the question arises concerning precisely what should be considered a new formation: what is the reference of newness? If the reference is dictionaries, then we adopt a social perspective (that is, the lexicon as a sum of knowledge of an ideal speaker about what is or is not conventional); if the reference is the mental lexicon of users, then the perspective is more individual. From a productivity

perspective focusing on users, this second point of view is more interesting: in (2), for example, the quotation marks and the content of parentheses show that, for the speaker, *dératisation* ['de-ratting'] is a new formation, and that he/she productively uses prefixation in *dé-* to coin it. The presence or absence of this noun in dictionaries is irrelevant:

- (2) [...] il faudrait que vous fassiez venir un expert en “dératisation”
 (je ne sais pas si ça se dit...) pour éliminer ces rongeurs.
 [We should have an expert in “de-ratting” (I do not know if I may
 say that) to get rid of these rodents]

Concerning the criterion of uncountability, different constraints can limit the use of a morphological process. The main constraint is certainly the saturation of appropriate bases, referred by Gaeta and Ricca (2015) as “the size of the input domain selected.” For example, suffixation with *-u* in French coins adjectives indicating inalienable possession, and applies to bases typically referring to parts of the body (see Aurnague and Plénat 2013): *barbe* ‘beard’ > *barbu* ‘bearded’; *cheveu* ‘hair’ > *chevelu* ‘hairy’; *ventre* ‘stomach’ > *ventru* ‘pot-bellied.’ However, the limited number of such bases hampers the productivity of the rule. The fact remains that the rule is productive with appropriate bases.

To avoid the criticisms cited above, we simply define morphological productivity, following Aronoff and Anshen (1998: 242), as the extent to which a particular process or pattern “is likely to be used in the production of new words in the language,” where newness can be observed from either an individual or a collective perspective. In this sense, the notion coincides with Corbin’s (1987) concept of “disponibilité,” translated by *availability* in Carstairs-McCarthy (1992).

2.2 Quantitative

In quantitative approaches, in order to address the issue of productivity and to eliminate recourse to intuitive judgments, the major work is that of Baayen (1992), and research initiated by its achievements (see among others Baayen and Renouf 1996; Baayen and Neijt 1997). Previous attempts to quantify productivity do exist, but they were mainly based on dictionaries, less commonly on samples of actual text. Some, such as Aronoff’s index in 1976, combined attested and possible lexicon (for a criticism of this, see among others Baayen and Lieber 1991 and Dal 2003).

Baayen and his followers distinguish three sorts of productivity.

- The first, called **realized productivity**, evaluates the presumable success of a morphological process or pattern in the past, independent of its actual use. Realized productivity is similar to what Corbin (1987) names “rentabilité” (*profitability* in Carstairs-McCarthy’s (1992) terms), but restricted to past achievement (Baayen 2009: 901). The realized

productivity of a given morphological process corresponds to the type count V of its members in a corpus, which can be a dictionary or any other sort of word set. For example, we can compare the realized productivity of the French de-adjectival suffixations with *-ité* and *-itude* and conclude that, in *Le Trésor de la langue française (TLF)*,² the more profitable is the first one with 1,154 types versus 47 types for the second (see Koehl 2012a: 34).

The two other indexes, P^* and P , are ratios calculated in a text corpus C , and take as a dividend the number n_1 of hapax legomena (words formed by a given morphological process or pattern with a frequency 1 in C). Some linguists have objected that hapax legomena (henceforth simply “hapaxes”) may only be rare events that do not necessarily illustrate the possibility for the relevant morphological process to be used to coin novel words. The objection is well founded in small corpora. But the bigger the corpus, the better the chance that hapaxes in C coincide with new coinages from both an individual and a social viewpoint.

- **Expanding productivity**, noted P^* , also referred to as the hapax-conditioned degree of productivity (Baayen 1993), is obtained by dividing n_1 by the number N_1 of hapaxes of all types (including misspelled items, proper names, and so on) belonging to C . P^* estimates the proportion of hapaxes in C which result from the morphological process under study. For Baayen (2009: 901), it corresponds also to Corbin’s profitability, but “oriented to what is expected for the near future.”
- To obtain **potential productivity**, noted P , n_1 must be divided by the total number N of the tokens found in C belonging to the same morphological category as hapaxes counted under n_1 . P gives the proportion of new words for a given morphological category, and thus estimates the growth rate of the vocabulary of the morphological category itself: it provides the probability that, having counted N tokens in C , a new instantiation of this category emerges. Despite the existence of the two other sorts of measures, P is certainly the most usual and most useful measurement. P can be used to compare productivity of different processes in a single corpus, or to compare productivity of the same process in different corpora, as pointed out by Bauer (2005: 325).

A number of objections have been raised against Baayen’s measures. We mention here only three of them.

Following Bauer (2005: 331), one can first object that what these measures estimate is the profitability of a morphological process or pattern, never its availability. This is true: by definition, from a qualitative approach, productivity is a potentiality. And a potentiality cannot be

² The *TLF* is a 16-volume French dictionary of general language. It has been developed between 1971 and 1994 at the CNRS Inalif Institute, and is freely accessible at URL: <http://atilf.atilf.fr/tlf.htm>.

observed. More precisely, we can only observe data and speculate about what these data say about future occurrences, in other terms, about data not yet observed.

Second, Gaeta and Ricca (see 2003) have proposed a modification of Baayen's procedure for the calculation of *P* by adopting what they call "the variable-corpus approach." In order to compare *P*-values for different morphological patterns and to avoid overestimating the productivity of low-frequency patterns with respect to more frequent ones (see criticisms in van Marle 1992), their proposal is to divide *C* in different subcorpora so that in each subcorpus, *N* has the same value for each pattern.

A third objection is more about the automatic nature of the measures than about the measures themselves. Evert and Lüdeling (2001) claim that no morphological system is available to preprocess the data in order to certify the quality of the calculation of productivity rates: any corpus contains incorrect data (mistagged or misspelled items); automatic calculation does not distinguish between what Dal et al. (2008) call synchronic and diachronic analyzability nor between direct or indirect analyzability (see two paragraphs below): if the purpose is to count the number *N* of complex words formed by a given morphological category, in case of multiple successive operations the system must be able to detect the hierarchical structure of these words, in order to count only what Gaeta and Ricca (2006) call "outer cycles."

As an example of the limitation of automatic procedures, Evert and Lüdeling (2001: 170) contrast raw and manually corrected vocabulary growth curves for *-bar* and *-sam* in German. With raw measures, the vocabulary *V* (i.e., the realized productivity) of both suffixations continues to grow along the corpus studied, showing productive patterns; with manual corrections, the curve of *-bar* suffixation still shows a productive pattern, while that of *-sam* suffixation flattens out, and converges to a constant value, indicating an unproductive process.

To cite another example, let us consider the suffixation of *-able* in French. Dal et al. (2008) distinguish three types of analyzability: 1. synchronic analyzability, 2. diachronic (or diatopical) analyzability, and 3. indirect analyzability. A synchronically analyzable lexeme is in both a semantic and a formal conformity with a given morphological pattern in a modern language; an either diachronically or diatopically analyzable lexeme inherits its morphological complexity from another language; an indirectly analyzable lexeme contains the studied process, but in an inner cycle. In some cases, a given lexeme can be seen as exhibiting more than one sort of analyzability: for example, *acceptable* can be analyzed both as a French construction from the verb *accepter* and as inherited from the Latin adjective *acceptabilis*.

Table 4.1, inspired by Dal et al. (2008), illustrates each type of analyzability with *-able* suffixed adjectives. We conflate here diachronic with diatopical analyzability under "borrowed analyzability": According to this

Table 4.1. *Synchronic, borrowed and indirect analyzability*

1. Synchronic analyzability	Fr. <i>acceptable</i> 'acceptable' < Fr. <i>accepter</i> 'to accept'
	Fr. <i>mangeable</i> 'eatable' < Fr. <i>manger</i> 'to eat'
2. Borrowed analyzability	Fr. <i>acceptable</i> < Lat. <i>acceptabilis</i>
	Fr. <i>friable</i> 'friable' < Lat. <i>friabilis</i>
3. Indirect analyzability	Fr. <i>autocassable</i> 'self-breakable' < Fr. <i>cassable</i>
	'breakable' < Fr. <i>casser</i> 'to break'
	Fr. <i>immangeable</i> 'uneatable' < Fr. <i>mangeable</i> < Fr. <i>manger</i>

Table 4.2. *Data to be taken into account*

1	<i>acceptable, manageable, friable, autocassable, immangeable</i>
1 and 2	<i>acceptable, manageable, friable, autocassable, immangeable</i>
1 without 2	<i>acceptable, manageable, friable, autocassable, immangeable</i>
1 and 3	<i>acceptable, manageable, friable, autocassable, immangeable</i>
1 and 2 and 3	<i>acceptable, manageable, friable, autocassable, immangeable</i>

tripartite conceptualization, the data to be taken into account vary considerably, as shown in Table 4.2, also inspired by Dal et al. (2008).

Dal et al. (2008) apply these three categories to calculate the productivity of *-able* suffixation in the newspaper *Le Monde* (years 1995 and 1999). It appears that indirect analyzability is crucial for the suffixation in *-able*: depending on whether or not one takes account of the indirect analyzability, the resulting calculations of the different sorts of productivity differ radically. The reason is the existence of a great number of French adjectives containing both the prefix *in-* and the suffix *-able* (for an analysis of adjectives in *inXable*, see Dal and Namer 2014).

Despite the above objections, Baayen's measures are standard in current works on productivity.

3 Why is Productivity a Central Concept in Morphology?

As a result, it is easier to understand why productivity is a central concept in morphological theory and why, according to Baayen and Lieber (1991: 801–2), “morphological theory should account only for processes of word formation which are productive.”

The reason is that, in evaluating the productivity of a pattern, one estimates the probability of its use in forming (what users consider to be) new lexemes. In other words, productivity deals not with the actual lexicon but with a future lexicon based on observation of the existing one.

Determining which patterns are productive and which are not is thus a delicate issue. In Schultink's definition (1961), the notion is necessarily binary (a morphological process is or is not productive), and there is an

absolute distinction between productive and unproductive rules. Yet, even within the qualitative approach, scholars are divided between those who consider productivity as a discrete notion (for example, Booij 1977 and Zwanenburg 1983: 29–30) and those who view it as a continuum: see among others Aronoff (1976), Aronoff and Anshen (1998: 243), Bauer (2005: 330) or, in naturalness theory, Dressler (2005: 290–1).

Within the quantitative approach, the notion is by essence scalar: a quantitative result, whatever type of productivity is concerned, says nothing on its own and needs to be compared to other results.

Our position is that productivity allows for scalarity, with unproductive word-formation at one extreme, productive word-formation at the other extreme, and intermediate cases between the two. In order to illustrate the scalar dimension of productivity and to show how it varies along a continuum, we compared the P values, estimated for three French word-formation processes and calculated within the frWaC corpus.

The frWaC corpus is a 1.6-billion-word corpus built by web crawling and provided with basic linguistic annotation (i.e., part-of-speech tagging and lemmatization). It is part of the result of a large-scale project (WaCky: see Baroni et al. 2009) aimed at sampling web content in ten European languages and making these samples freely available to the linguistic community. The frWaC corpus can be queried within a specific formal language (the Corpus Query Processor language) through an online interface.

We start with the suffixation in *-estre*, an example of a word-formation process present in French adjectives, which can be assumed not only to be unproductive today, but also never to have been productive. In fact, the content of French dictionaries reflects a lack of *-estre* formations through time. The multi-volume *TLF* dictionary, for instance, has fewer than ten adjectives (*alpestre* ‘alpine,’ *équestre* ‘equestrian,’ *pédestre* ‘pedestrian,’ *rupestre* ‘rock,’ *sylvestre* ‘sylvan,’ and *terrestre* ‘terrestrial, earthly’), supplemented by prefixed or compound forms where relevant (*cyclopédestre* ‘cyclo-pedestrian,’ *extraterrestre* ‘extraterrestrial’). However small, the adjective set instantiates a regular pattern: all of them are relational adjectives that can be related to a concrete noun represented by a Latinate bound stem (*equ-* ‘horse,’ *ped-* ‘foot,’ *rup-* ‘rock,’ *sylv-* ‘forest’). The most recent adjective contained in the *TLF*, *rupestre*, dates from 1812; the oldest one, *terrestre*, has been stored in the French lexicon since 1050. All are borrowed from Latin except *alpestre*, which comes from Italian.

The lack of availability of *-estre* suffixation suggested by this data is confirmed by the null P measure performed on the frWaC corpus. Apart from adjectives which are derived from adjectival bases in *-estre* by prefixation (e.g., *néo-rupestre* ‘neo-rockly’) or compounding (*humano-extraterrestre* ‘humano-extraterrestrial’), and which therefore cannot actually be included in the *-estre* adjective class, the frWaC corpus contains only three adjectival hapaxes in *-estre*: *planestre* ‘plane-ESTRE,’ *campestre* ‘field-ESTRE,’

and *blogestre* ‘blog-ESTRE.’ The first one comes from a twelfth-century document (it is not a neologism); the second is part of a Latin term (*acer campestre* ‘rustic maple tree’). Finally, in *blogestre*, *-estre* is certainly a variant of *-este*, another form of the *-esque* suffix appearing in the context of a velar plosive consonant as the effect of a dissimilative constraint (according to Plénat et al. 2002).³

A second example from the frWaC corpus estimates the measure of a slightly more productive morphological process, the verb-based rule of *-is* (/i/) suffixation, which forms activity or result nouns such as *semis* ‘“sow-IS”=seeding’ from *semer* ‘sow.’ Once manually validated, the hapax list includes 32 nouns (e.g., *patouillis* ‘paw-IS,’ *farfouillis* ‘grope-IS’) out of 960,870 *-is* suffixed nominal occurrences. Clearly the potential productivity P of the *-is* process is very low (0.0033%). Compared to *-estre*, however, this pattern is still available, moreover with a better-realized productivity (430 types vs. 18 for *-estre*).

At the other end of the spectrum, let us now examine the notably productive word-formation pattern deriving nouns in *-itude* that denote properties (in the broader sense). As Koehl (2012b) points out, three occurrences in the evolution of the French lexicon were the occasion for this morphological process to prove its dynamicity by presenting renewed productivity. Following the TLF, the first observed pattern builds measure nouns (*longitude*, *altitude*) and is hegemonic, though barely productive, until 1934. At that date, a publication by the politically committed Martiniquan poet Aimé Césaire brought to the fore the neologism *négritude* (the concept of “blackness” or black identity) which functions as the forerunning word of a new prolific series of nouns expressing the claim to the identity of various communities, be they ethnic (*corsitude* ‘corsican-ITUDE’), or not (*femellitude* ‘female-ITUDE’; *mec-itude* ‘guy-ITUDE’).

Finally, the last, sudden, explosion of neologisms in *-itude* is the consequence of the statement in 2007 by a candidate to the French presidential elections, Ségolène Royal, who uttered the new word *bravitude* ‘brave-ITUDE.’ Because of the peculiar political circumstance, the competition of *bravitude* with the noun *bravoure* ‘bravery,’ long stored in the lexicon, has been the pretext for negative, widely circulated media coverage of this neologism, which became the source of a wide range of (mostly playful) new *-itude* nouns. The measure P of 0.2 percent, estimated on the basis of the frWaC content, confirms the current vitality of the *-itude* word-formation pattern: 758 *-itude* ending hapaxic nouns (e.g., *ségolénitude* ‘Ségolène (Royal)-ITUDE,’ *spleenitude* ‘melancholy-ITUDE’) have been found out of 361,091 occurrences of nouns ending in *-itude* or *-itudes*.

A further consequence of a scalar approach to productivity is the neutralization of differences between productivity and creativity. This matter

³ On the web (February 2015), when occurring with the same noun *promenade(s)* “walk(s),” *bloguesque(s)* counts 3,190 occurrences; *blogeste(s)*, 34; and *blogestre(s)*, 28.

directly links to the issue, frequently cited in the literature, of the distinction between neologisms and nonce-formations, the former being considered as the next step in the life of a formerly nonce formed word resulting from a productive rule (e.g., in Hohenhaus 2005: 363), whereas the term *creativity* is reserved for the case in which the (nonce) coined word obviously transgresses the morphological system, such as in poetry or playful creations. Analogical creations are also sometimes considered to be cases of creativity rather than productivity.

The often observed distinction between productivity and creativity is related to the disputed opposition mentioned above between intentionality and unintentionality in word formation: among proponents of such distinction, see for example Lyons (1977), van Marle (1985), Bauer (2001), Štekauer (2005: 207–332; 2009: 272–97), or Fernández-Domínguez (2010).

For reasons already explained in Section 1, where we have considered that (un)intentionality is not an adequate criterion for productivity, and that an adequate morphological description must account for all formations, we prefer to consider that creativity is a particular case of especially low productivity: in other words, it corresponds to the low pole of the productivity continuum.

Determining which factors contribute to the productivity of a given process is another delicate – and controversial – issue.

A classic claim (see among others Zimmer 1964; Booij 1977; Plag 2006: 522) is that the degree of productivity is inversely proportional to the number of grammatical (phonological, morphological, semantic, syntactic) restrictions on that process. However, as pointed by Baayen (2009), it is difficult to correlate such restrictions with productivity. Dealing with “constraints on productivity,” Rainer (2005: 335) establishes types of constraints that lexemes must satisfy to serve as input to a given morphological process. In this sense, productivity is confused with morphology studies.

Other regularly mentioned factors are (high) frequency, transparency, and regularity. Although each of them is certainly implicated in productivity, none of them is sufficient to predict the productivity of a given process:

- First, some processes produce new words – they are productive – but at a very low rate (Bauer (2001: 48) cites formations such as *aclutter* and *awhirl*) while others, as the English verb-to-noun suffixation rule in *-ment*, producing a great number of conventional lexemes, do not appear to be frequently used in the coining of new formations.
- As for the criterion of phonological transparency (see for example Hay 2001), Bauer (2005: 320) points out that *-ness* is a better candidate than *-ity* with bases in *-able* (*-ableness* vs. *-ability*), in terms of formal transparency of the result; in spite of this, English speakers prefer the *ability* combination.

- Concerning semantic transparency, some processes, although semantically transparent, are not productive, as with the above French suffixation in *-estre*, while, according to Bauer (2005: 321), productive patterns are sometimes not semantically coherent.
- Finally, the notion of regularity is unclear, and is often confused with that of productivity.

According to Plag (2006: 550), productivity is also influenced by fashion, regardless of any need to name things. Therefore, affixes may be widely used at a given time (such as *giga-* in English) only to be superseded after a while by a newly popular word formation rule. Likewise, new word creation is not always meant to satisfy nomenclatural requirements, but can be motivated by social factors or pragmatic needs. According to Rainer (2005: 349), restrictions on productivity may be a sociolinguistic matter, on the output (some patterns are confined to informal situations, others are neutral, still others stilted, etc.), or, though less frequently observed, on the input. Rainer (2005: 349) cites learned affixes limited to learned bases, and evokes the jocular effects they produce when they are applied to ordinary words.

A final explanation sometimes advocated to explain a lack of productivity is blocking. The concept of blocking, defined in Aronoff (1976: 43) as “the non-occurrence of one form due to the simple existence of another” has been widely commented upon (see among others, Rainer 1989, Scalise et al. 1983, Scalise 1990, Dal and Namer 2003, the very well-documented bibliography in Bresnan 2001, and, recently, Aronoff and Lindsay 2014). Aronoff’s idea, in 1976,⁴ was that the emergence of a new formation, even structurally adequate, should be blocked because of the existence of another (simple or complex) lexeme in the conventional lexicon: for example, according to this concept, the coining of *gloriosity* or *stealer* should be blocked by the existence respectively of *glory* and *thief*. In fact, blocking does not stand up to an examination of the real data: *gloriosity* and *stealer* are widely produced on the web, with respectively 5,700 and more than 2 million occurrences in February 2015. As pointed out by Rainer (2005: 348), it can readily be observed that children, non-native speakers or even adult native speakers with a full command of their own language when they momentarily fail to retrieve the established term produce complex words of the *stealer* type.

In light of the above, productivity in word formation is a complex and widely discussed concept. There is no doubt that the major advance in this discussion is the emergence of statistical methods which allow calculations on large corpora, allowing in turn comparisons between related processes, or between time periods or between genres or registers.

⁴ For a recent revision of the concept of blocking by Aronoff himself, cf. Aronoff and Lindsay (2014).

4 Productivity and Changes in Morphology

Research in productivity provides a significant impetus to research in morphology, in terms of both methodology and results.

On the **methodological** side, the development of research in productivity has contributed to the emergence of an empirical account of today's morphological analysis. More and more, corpus-based and data-driven approaches are carried out and substituted for methodologies relying on constructed examples (for an overview on how massive electronic data have changed the way researchers interact with morphology, see Fradin et al. 2008; Dal and Namer 2015). Scholars have become aware of the importance of corpora, and therefore take advantage of the popularization of quantitative methods in morphological analysis, in order to master the manipulation of large amounts of text. These new working methods change (if only indirectly) the way in which the role of morphology in grammar is perceived.

This consequence manifests itself in two forms:

- First, an increasing consideration is being given to **contextual influences** on the processes of word construction and to the role of interaction between (spoken or written) conversation partners; for instance, Smyk-Bhattacharjee (2006) examines factors contributing to the interpretation of novel words found in English blogs, such as speaker acceptability and his/her expected familiarity with these new formations; Piantadosi et al. (2012) propose an information-theory-based measure in order to weigh the communicative function of ambiguity in discourse, thus assessing the impact of context in the speaker/hearer balance during the communication exchange. By building on their results, Hathout and Namer (2014) hypothesize that the trade-off between the interests of the speaker and those of the hearer can be spelled out in terms of morphological optimization, so that the use of seemingly deviant new words can be partly seen as reflecting strategies devised by speakers in order to achieve optimal derivatives.
- Second, the design of morphological patterns from the observation of large sets of real data increasingly reflects the growing consciousness of morphologists of the **network-like aspect** of word formation: complex words are assigned as many morphological relations as there are members in both their morphological family and the derivational series they belong to (Hathout 2011). New assumptions in word formation, drawing on optimality theory, explain the existence of morphologically complex words by the combination of competitive constraints rather than by a one-way relation between a derived word and its base (see, e.g., Burzio 1998). In other words, the hegemony of binary word-formation rules as a way to construct derivatives is increasingly challenged by alternative theoretical frameworks, such as Bochner's

Cumulative Patterns (Bochner 1993), Booij's *Construction Morphology* (Booij 2010) or Blevins' *Word and Paradigm Morphology* (Blevins 2016).

As far as **results** are concerned, productivity has brought to light the key role played by rare events in general (see Rácz et al., Chapter 24 this volume, who makes use of the statistical measure of "large number of rare events") and by hapaxes in particular. This is reflected in the progressive but ineluctable shift in scholars' perception as far as word formation theory is concerned: they realize that morphological analysis must rely on newly created words much more than on the long-recorded lexicon. Several papers witness the crucial role these rare lexical data play in morphological process (re-)design. In French, for instance, Plénat et al. (2002) discovered hapaxes online, which enabled them to confirm a hypothesis, established sixty years before by another linguist (Édouard Pichon), on the basis of a single example. Other findings have enabled Hathout et al. (2003) to show that the constraints Fradin (2003) describes to explain the formation *-able* suffixed adjectives is by far too restrictive to account for all real data. Of course, similar research is performed in other languages as well. Concerning English, for instance, readers can refer for example to Fernández-Domínguez et al. (2007), who focus on the study of the less-productive word-formation rules in English.

In fact, the focus on hapaxes initiated by productivity has emphasized the importance of neologisms inasmuch as hapaxes are good indicators of neologisms, although both notions must be distinguished, as, for example, Szymanek (2005: 430) points out.

Acknowledging the importance of neologisms has led to new and crucial answers to questions related to complex word analyzability, where dictionary-based traditional morphological analyses have to cope with words stored in the lexicon for a long time and which have lost their compositional meaning, and therefore are confronted with the so-called "irregular" constructed words.

Another consequence of the renewed interest in neologisms is that morphologists have become concerned with stylistically marked, creative, often playful words which were previously discarded by linguists, who looked at them as deliberate deviations from well-formedness.

Therefore, morphologists are starting to show increased interest in spontaneous complex words, displayed in so-called user-generated content (that is, created by the users of an online system) such as blogs, wikis, discussion forums, posts, chats, tweets. In parallel, new developments in annotated corpus constitution focus on user-generated data: see, for instance, the French Social Media Bank (Seddah et al. 2012) or the SMS (short message service) text message corpus for French (Panckhurst et al. 2013). In fact, words coined in the course of an online discussion are no longer rejected as quasi-pathological anomalies but considered as valid and relevant illustrations of what language variations allow to be created, following a paradigm

inspired by usage-based morphology and according to which words are finally acknowledged as being invented by speakers—and not by and for linguists.

From there, the question of *why* new words are created becomes a research issue as much as the question of *how* they are formed, thereby putting in perspective the actual role played by grammatical constraints on productivity, as presented for instance in Plag (2006: 549–53) as well as the analysis proposed for French by Roché (e.g., 2011) or studies performed on suffix rivalry, for example in Lignon and Namer (2010) and Namer and Villoing (2015).

Several recent collections of papers are devoted to various aspects of current trends in word-formation (see, e.g., Munat 2007 or Štekauer 2006). In a volume where particular attention is paid to circumstances surrounding the coining of new complex lexemes (Pruñonosa-Tomas et al. 2013), some works examine the playful intent of word formation (Bagasheva and Stamenov 2013), while others (Arnaud 2013) propose a typology of nonce formation noticeability: in what conditions will a new word go unnoticed to a listener/reader or, on the contrary, be considered as inventive, by him/her? Another new topic of interest emerging from the renewed attention paid to neologisms is related to the way (false) borrowings (mainly from English) are assimilated in the target language (Balteiro and Campos 2012; Renner and Fernández-Domínguez 2014).

Beside the impressive impact of productivity in the area of psycholinguistic studies (see Rácz et al., Chapter 24 this volume), this new way of examining word formation raises questions on text type (see Baayen 1994; Baayen and Renouf 1996; Baayen and Neijt 1997; Gaeta and Ricca 2006; Roldán-Vendrell and Fernández-Domínguez 2012) and speech register (Plag et al. 1999). Productivity measures across texts lead to new findings on their typology. For instance, Chmielik and Grabar (2011) automatically assign a label to medical texts according to the intended audience (specialists, students, general public) by comparing productivity values of neoclassical compounding rules. Concerning sociolinguistic aspects, the literature shows how Word Formation Rule productivity varies according to diatopic parameters (see, e.g., Keune et al. 2005), and, more generally, how productivity results lead to further progress in sociolinguistic approaches (e.g., Wielding et al. 2014).

In short, research approaches in productivity have brought in its wake the start-up of new working techniques and new ways of reasoning in morphology. Productivity measures, the influence of the number of discovered hapaxes, as well as the analysis of their values, not to mention the fact that language is accounted for from the point of view of its massive productions (both written and oral), have shifted the lines in many respects, and henceforth make it possible to envisage new topics and new directions in current as well as future morphology research.

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Part II

Issues in Morphological Theory

5

Alternations: Stems and Allomorphy

Mary Paster

1 Introduction

This chapter discusses stem allomorphy and its theoretical analysis. Four different general theoretical approaches to the analysis of stem allomorphy are presented, and their positive and negative attributes are evaluated relative to what is currently known about properties of stem allomorphy cross-linguistically. It is argued that no single model is ideal to account for all types of stem allomorphy; therefore, it is proposed that multiple frameworks may be needed. The distribution of labor among those models is discussed as an issue for future research, pending refinement of our understanding of the typology of stem allomorphy based on further cross-linguistic research and in-depth empirical studies of morphologically complex languages.

“Allomorphy” is defined here as any case of a single set of semantic/morphosyntactic features having two or more different context-dependent phonological realizations. This includes cases where a straightforward phonological rule/constraint may be invoked as well as more complex examples involving suppletive allomorphy, where multiple underlying forms are involved whose distribution may be morphologically, lexically, and/or phonologically governed. A “stem” is defined as a form that can be inflected (meaning that a stem may consist only of a root, or it may be a root plus one or more derivational and/or inflectional affixes). Although most allomorphy probably occurs in affixes rather than stems, the examples in this chapter will be of allomorphy specifically in stems wherever possible, given the focus of the chapter. (For discussion of affix allomorphy, as it relates to paradigms, see Chapter 9 of this volume.)

The chapter will be structured as follows. In Section 2, I present an overview of the basic types of allomorphy, giving examples of each. In Section 3, I describe four different theoretical models, explaining how each would analyze a sample case of stem allomorphy. In Section 4,

I discuss some outstanding research questions relating to stem allomorphy. Section 5 concludes the chapter.

2 Types of Allomorphy

Allomorphy was defined above as “any case of a single set of semantic/morphosyntactic features having two or more different context-dependent phonological realizations,” but it should be noted that there exist other definitions of the term. Before describing the types of allomorphy, I will provide some background regarding the concept and other understandings of it. See also Paster (2014, to appear) for further discussion.

The definition of allomorphy being used here subsumes phenomena that many researchers would view as having two fundamentally different loci/sources—namely, some would be considered phonological in nature and others morphological. Section 5 will provide further discussion of the architecture of the grammar and how different theoretical approaches to allomorphy relate to different ideas of the distinction (if any) between phonology and morphology. The present definition of allomorphy is focused on the surface form of the stem. Instances where the phonological form of the stem varies contextually are all considered to be examples of allomorphy under this definition, regardless of which component of the grammar is responsible for the variation. A distinction can then be made between what I refer to as “suppletive allomorphy” (defined below, and used interchangeably here with the term “suppletion”), which involves multiple underlying forms and is therefore a result of *morphological* functions of the grammar, versus non-suppletive allomorphy, which involves a single underlying form where variation is due to the action of regular rules/constraints in the *phonological* component of the grammar.

Some researchers, however, would refer to non-suppletive allomorphy as “morphophonology,” reserving the term “allomorphy” specifically for suppletive allomorphy. Further, at least one definition of “allomorphy” (Stockwell and Minkova 2001: 73) is not only limited to what I call suppletive allomorphy, but it also requires allomorphs to have a “historically valid” relationship—in other words, that they are etymologically related. In Stockwell and Minkova’s typology, cases of what I call suppletive allomorphy but where the underlying forms are not phonetically similar would not be described as allomorphy; the phenomenon would be labeled “suppletion” (but not “suppletive *allomorphy*”) in the case of stems, or “rival affixes” in the case of affixes. Under the definitions of “allomorphy” and “suppletive allomorphy” (or “suppletion”) that I am using in this chapter, there is no distinction between the phenomena referred to by Stockwell and Minkova as “rival affixes” versus “suppletive allomorphs.”

Having defined some important terms and provided some clarification regarding how my use of the relevant terminology relates to that of other researchers, I turn now to a discussion of the types of allomorphy.

To begin, it is useful to distinguish two major types of allomorphy, as alluded to above. The first is non-suppletive phonologically derived allomorphy. This is a situation where a regular phonological rule of a language applies in a particular phonological context, yielding alternations. This type of allomorphy commonly applies to stems, even if it applies preferentially to affixes and not stems in some languages. An example of regular phonologically conditioned stem allomorphy is found in Polish, which exhibits word-final obstruent devoicing. When a stem underlyingly ends in a voiced obstruent, if there is no suffix after the stem, the devoicing rule produces a stem allomorph with a final voiceless obstruent, as can be seen by comparing the genitive singular versus nominative singular forms of the nouns in (1) (note that examples are given as phonetic transcriptions rather than in the Polish orthography, which does not reflect devoicing).

(1)	<i>Gen sg</i>	<i>Nom sg</i>	<i>Gloss</i>
	klub-u	klup	‘club’
	ob ^j ad-u	ob ^j at	‘dinner’
	targ-u	tark	‘market’
	gaz-u	gas	‘gas’
	stav-u	staf	‘pond’
	gruz-u	grus	‘rubble’

A straightforward analysis would have a single underlying form of the stem, reflected in the genitive singular form, and a regular phonological rule applying in the nominative singular, where the lack of a suffix puts the stem-final segment into the word-final environment that triggers devoicing. Thus, the allomorphy is derived purely in the phonology. (Note that this must be analyzed as word-final devoicing rather than pre-vocalic voicing, since stem-final underlyingly voiceless obstruents do not alternate; cf. *pobit~pobit-u* ‘stay.’)

The second major type of allomorphy is suppletive allomorphy. This is a type of allomorphy where there are two or more underlying forms that express the same set of semantic/morphosyntactic features. The grammar must somehow select among the different underlying forms, whose surface realizations are in complementary distribution. The basis for selection may be morphosyntactic, lexical, or phonological—or a combination of these. We deal with each of these types of suppletive allomorphy below.

In morphosyntactically conditioned suppletive allomorphy, the selection of an allomorph is conditioned by the morphological or syntactic category of the word. In the case of stem allomorphy, a specific form of a stem might be used in a particular morphological context such as past tense versus other tenses, or when the word belongs to a particular syntactic category such as when it is used to form a noun vs. a verb. An example is found in Hopi, as shown in (2), where certain nouns have a stem form used in the plural that differs in unpredictable ways from the stem form used in the singular and dual (Hill and Black 1998: 865; Haugen and Siddiqi 2013).

(2) Singular	Dual	Plural	Gloss
wùuti	wùuti-t	momoya-m	‘woman’
tiyo	tiyo-t	tooti-m	‘boy, young man’
pöösa	pöösa-t	pövöya-m	‘house mouse’

This case of allomorphy is treated as suppletive since there is no uniform phonological change to the stem in the plural relative to the singular/dual form. It is morphologically conditioned since it is the plural category that triggers the use of the special stem form. Crucially, a given case of stem allomorphy is only analyzed as morphosyntactically conditioned suppletive allomorphy if it is the morphosyntactic category *per se* that conditions the use of the allomorph, rather than a phonological *property* of that morphosyntactic category. For instance, the use of the allomorph [twelf] with a voiceless stem-final consonant in the English word *twelfth* is conditioned by the ordinal suffix, but this should probably not be considered morphosyntactically conditioned suppletive allomorphy because (1) it is arguably the voicelessness of the suffix (and not the fact that it is an ordinal form) that conditions the use of a stem allomorph with a voiceless final consonant; and (2) the allomorphy is not suppletive since it can be analyzed via a phonological devoicing rule.

Lexically conditioned suppletive allomorphy defines a situation where suppletion is idiosyncratic to particular lexical items. Lexically conditioned suppletion is probably more relevant in the domain of affix allomorphy than stem allomorphy, and in fact lexically conditioned suppletion in the domain of stem allomorphy will necessarily involve some additional type of conditioning (since some other property in addition to the lexical item needs to vary in order for allomorphy to manifest itself). Lexically conditioned suppletive allomorphy often occurs in tandem with morphosyntactic conditioning – for example, different classes of verbs in a language may have different conjugation patterns (which would usually be categorized as allomorphy in the inflectional endings, rather than in the stem). A parallel example involving stem allomorphy would be one where, for example, a certain class of verbs has a special stem form that is used in certain tenses. An example is the so-called “strong” verbs in Germanic languages (verbs like *eat*, *sing*, and *break*), whose past tense forms have a special stem allomorph that is historically derived from phonological ablaut but is arguably suppletive (at least in modern English). The remainder of this chapter will not consider the lexically conditioned type of suppletion in as much detail as the other types, given its limited relevance to stem allomorphy specifically.

A final type of suppletive allomorphy is phonologically conditioned suppletive allomorphy (PCSA). This is a phenomenon where the selection of suppletive allomorphs is determined by a phonological criterion. This situation is crucially different from the type of regular phonological allomorphy described earlier where a single underlying form corresponds to multiple surface forms due to the operation of a phonological rule, since

PCSA by definition involves multiple underlying forms. Interestingly, although many cases of PCSA seem to mirror the effect of phonological rules in terms of the surface results of a particular distribution of allomorphs, this is not always the case; sometimes the distribution of allomorphs appears to be phonologically arbitrary (though still phonologically determined). In the realm of stem allomorphy, cases of PCSA as defined here seem to be rare. In fact, as discussed below in Section 3.1, in lexical subcategorization-based approaches to allomorphy, strictly speaking, PCSA in stems is predicted not to exist. However, some cases are known. An example that could be seen as phonologically conditioned stem allomorphy is found in Italian (Hall 1948), where some stems have allomorphs ending in /isk/ that occur only in morphological contexts where the word stress falls on the stem-final syllable—namely, in the present and subjunctive 1sg, 2sg, 3sg, and 3pl and in the 2sg imperative (Hall 1948: 25, 27). One such stem is *fin-* ‘finish’; some examples are shown in (3) (Hall 1948: 214) with the forms in [isk] (and its surface phonological variant [iff]) shown in bold.

(3) *Present*

finísk-o	‘I finish’	<i>fin-iámo</i>	‘we finish’
finíff-i	‘you (sg) finish’	<i>fin-íte</i>	‘you (pl) finish’
finíff-e	‘s/he finishes’	finísk-ono	‘they finish’ ¹

Subjunctive

finísk-a	‘that I finish’	<i>fin-iámo</i>	‘that we finish’
finísk-a	‘that you (sg) finish’	<i>fin-iáte</i>	‘that you (pl) finish’
finísk-a	‘that s/he finish’	finísk-ano	‘that they finish’

Imperative

		<i>fin-iámo</i>	‘let’s finish’
finíff-i	‘(you (sg)) finish!’	<i>fin-íte</i>	‘(you (pl)) finish!’

Other stems of this type include *aġ-* ‘act,’ *argu-* ‘argue,’ *dilu-* ‘add water,’ *ment-* ‘lie,’ *diminu-* ‘diminish,’ and *ammon-* ‘admonish’ (Hall 1948: 43–5, 52, 61). There appears not to be any semantic or phonological generalization regarding which stems pattern with this class of verbs in Italian, so the allomorphy must be lexically conditioned (arbitrarily, by the specific verb stem) in addition to being phonologically conditioned.²

¹ Thanks to Anna Thornton for correcting the transcription of this form, which was incorrectly reported in Paster 2006.

² I have described the Italian case in terms of the phonological generalization, but the standard analysis appears to be in terms of arbitrary stem patterns. A number of verbs other than the *isc* verbs have the same pattern in the present tense (having a stem form that appears with 1sg, 2sg, 3sg, and 3pl subjects and a different form occurring with 1pl and 2pl); Maiden 2004 terms this the “N pattern.” Interestingly, there are multiple other types of N-pattern stems that do not involve *isc*, including some where a vowel differs between the two versions of the stem but not in a way that is described by a regular synchronic phonological rule, and the verb *andare*, whose two stem variants are etymologically unrelated. The fact that these three very different types of N-pattern stems can all be described in the same phonological terms may be used in support of an account in terms of phonological optimization, but a more standard view seems to be that the N pattern is an abstract morphological pattern that diachronically has attracted a number of stems into its class (see, e.g., Thornton 2007; Da Tos 2013).

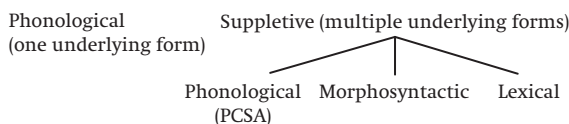


Figure 5.1. Types of allomorphy

To summarize the typology of allomorphy that I have presented above, we have discussed two main types of allomorphy (regular phonological allomorphy and suppletive allomorphy), and, within what I have called suppletive allomorphy, three subtypes based on the type of conditioning involved. We can schematize this conception of allomorphy as in Figure 5.1.

It should be pointed out that many cases of suppletive allomorphy are conditioned simultaneously by more than one of the factors represented in Figure 5.1. It has already been observed that for stems specifically, lexical conditioning is accompanied by another type of conditioning, such as morphological conditioning, as in the example of the Germanic strong verbs. Another example of multiple types of conditioning is the Hopi case, where it was noted that only certain nouns exhibit the pattern in (2). Other nouns have uniform stem forms for singular, dual, and plural. Thus, in addition to being morphologically conditioned (by the plural category), this case of stem allomorphy is also lexically conditioned by the noun being used. The morphologically conditioned stem suppletion only applies if the noun does not belong to the regular class, whose membership, if arbitrary, would have to be called lexical. Any adequate theory of suppletive allomorphy will have to be able to accommodate the common situation where more than one type of conditioning factor is involved.

Having seen a few examples of stem allomorphy and discussed how the different types are categorized, we turn now to the discussion of how stem allomorphy can be analyzed theoretically.

3 Analyzing Stem Allomorphy

In this section, I present four different theoretical approaches to the analysis of stem allomorphy. In each case I give an overview of how stem allomorphy is handled using each theory, and then I discuss the advantages and drawbacks of each theory with respect to how well the known cases of stem allomorphy are handled. Some discussion, particularly in Section 3.1 and Section 3.2, draws considerably from Paster (2015), to which I refer the reader for more detail about the treatment of the PCSA type of suppletive allomorphy in particular.

The four approaches to be discussed in this section are lexical subcategorization (§3.1), constraint-based approaches (§3.2), allomorphy rules (§3.3), and indexed stems (§3.4). We begin with lexical subcategorization.

3.1 Lexical Subcategorization

In a subcategorization model (Lieber 1980; Kiparsky 1982; Selkirk 1982; Inkelas 1990; Orgun 1996; Yu 2003, 2007; Paster 2006), affixation satisfies missing elements specified in the lexical entries of morphemes. In this type of model, suppletive allomorphy is a phenomenon that results when two or more different morphemes with identical morphosyntactic and semantic specifications³ have different phonological forms and different subcategorizational requirements. These requirements are schematized via subcategorization frames, which indicate the selectional requirements imposed by morphemes.

To illustrate how this model works, we return to the Hopi example presented in Section 2, repeated in (4).

(4) Singular	Dual	Plural	Gloss
wùuti	wùuti-t	momoya-m	‘woman’
tiyo	tiyo-t	tooti-m	‘boy, young man’
pöösa	pöösa-t	pövöya-m	‘house mouse’

Representations of subcategorization frames for the two stem forms of ‘woman’ are given in (5a), and a subcategorization frame for the plural suffix is given in (5b).

- (5) a. ‘woman’ (plural stem) ‘woman’ (elsewhere stem)
 [[momoya]_{stem, plural}] word, plural [wùuti]_{stem}
 b. [[]_{stem -m}] word, plural

A higher-level node representing the plural word *momoya-m* ‘women’ is shown in (6), with the plural stem and plural suffix as its daughters.

- (6)
- $$\begin{array}{c}
 \text{[[momoya-]_{stem, plural -m}] word, plural} \\
 \swarrow \quad \searrow \\
 \text{[[momoya-]_{stem, plural-}] word, plural} \quad \text{[[]_{stem -m}] word, plural}
 \end{array}$$

This is a complete word, since the missing elements in the subcategorization frames of both daughters have filled each other in, yielding a representation with no gaps.

Some theoretical questions arise in the representation of the two stem variants in this example. First, why is it not specified that the plural suffix

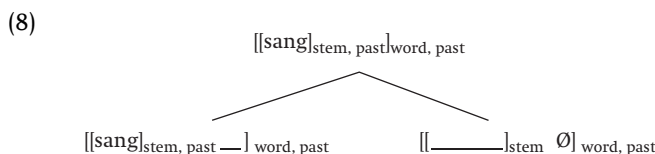
³ By some definitions of the term “morpheme,” multiple underlying phonological forms that have identical morphosyntactic and semantic features would all be considered to be stored as one “morpheme.” That definition is not useful in the present context, since suppletive allomorphy relies on there being multiple stored underlying forms (sound-meaning pairs), and we need a term to identify each of those stored forms. Some researchers might use the term “morph” for this purpose, but since the term “morph” does not capture the fact that we are referring to underlying forms rather than surface alternants, I use the term “morpheme” instead. In this chapter I will not address the question of whether there is a linguistically significant higher-level unit that subsumes all of the stored forms that have the same morphosyntactic and semantic properties but possibly different phonological forms and/or subcategorizational requirements (i.e., groups of what I am calling “morphemes” that have identical morphosyntactic/semantic features).

subcategorizes for a plural stem, and given this, how does the plural suffix select for the plural stem in words like “woman”? The reason that the plurality of the stem is not specified in the subcategorization frame of the plural suffix is that, as mentioned earlier, some stems do not have a special allomorph in the plural. Some examples of these regular nouns are given in (7) (Hill and Black 1998: 870; Haugen and Siddiqi 2013).

(7) <i>Singular</i>	<i>Dual</i>	<i>Plural</i>	<i>Gloss</i>
sino	sino-t	sino-m	‘person’
kawayo	kawayo-t	kawayo-m	‘horse’
Tasavu	Tasavu-t	Tasavu-m	‘Navajo’

Specifying that the plural suffix subcategorizes for a plural stem would have the undesirable consequence of requiring that nouns like those in (7) have two homophonous, listed stems—one specified as plural and one not. This is why the subcategorizational requirement of the plural suffix is stated only as a “stem” rather than a plural stem. The plural suffix’s selection of the plural stem, in nouns where a special plural stem exists, follows from Pāṇini’s principle (i.e., the selection of the elsewhere stem is blocked by the availability of a more highly specified stem that is still compatible with the affix).

Now that we have seen how this model deals with morphosyntactically conditioned suppletive allomorphy, I will briefly discuss how it handles other types of allomorphy. Regarding lexically conditioned allomorphy, as we have already discussed, some additional type of conditioning will always be present when the allomorphy involves stems. Consider the lexically conditioned aspect of the Hopi example discussed above. What differentiates the suppletive stems from the regular stems in this case, in a lexical subcategorization approach, is simply the fact that the suppletive stems have two separate stored forms, while the regular stems have only one. Examples like the Germanic strong verbs would be treated similarly, except that the past tense form of a strong verb stem would not subcategorize for a suffix; it would merely be limited to occurring in the context of a past tense word. A representation of the past tense of a strong verb might be as shown in (8).



A possible criticism of this approach to Germanic strong stems is that it fails to capture the phonological systematicity of the stem alternations (i.e., that the past tense stem is identical to the elsewhere stem except for the last vowel, which exhibits ablaut). This relates to the more general criticism of the subcategorization approach (what Embick 2010 refers to as the “putative loss of generalization argument”) that it treats apparent

regularities in allomorph distribution as arbitrary or coincidental. The position that will be adopted here, regarding the Germanic example, is that the apparent ablaut is the reflex of a phonological rule that is inactive in the phonology of modern English. Thus, from the point of view of the synchronic grammar, the apparent systematicity of the vowel changes in strong stems is indeed coincidental; the stem variants are lexically listed, and as far as the grammar is concerned, the vowel alternations could just as easily be completely unsystematic and random-seeming if the history of the language had somehow unfolded that way. Support for this view comes from the lack of a regular ablaut rule in the phonology of modern English and the impossibility of writing a plausible rule (or constraint ranking) to account in phonological terms for the alternations.

I have discussed the treatment of PCSA in the subcategorization approach at length elsewhere (see Paster 2005, 2006, 2009, 2014, 2015, to appear, and references therein). Briefly, the approach to PCSA is identical to the approach to morphosyntactically conditioned suppletion, except that the element that is subcategorized for in PCSA is phonological, rather than morphosyntactic. This possibility was made explicit by, for example, Orgun 1996 and Yu 2003. This allows the subcategorization frame to account not only for PCSA, but also for affix placement (prefix, infix, suffix). See Paster (2009) for an overview.

Regarding the Italian example discussed in Section 2, because the lexical subcategorization approach requires words to be built from the inside out, the model as I have defined it here does not allow phonological properties of affixes to condition PCSA in stems. This does have the advantage of explaining the apparent extreme rarity of examples of this type (see, e.g., Paster 2006), but it also requires a reanalysis of those examples so that we can understand them as being consistent with the “inside-out” generalization. One important fact about the Italian case is that, segmentally, the shorter stem allomorph is a subset of the longer allomorph. This allows us to analyze *-isc* as a separate affix. Some previous analyses of Italian stem allomorphy (e.g., DiFabio 1990; Schwarze 1999) do treat *-isc* as an affix or “stem extension.” Analyzing *-isc* as an affix is helpful in reconciling the example with the lexical subcategorization model, but it is still problematic since this would still appear to be an example of PCSA with an “inner” suffix being conditioned by an “outer” suffix, which is also not allowed by the model. A further move that we need to make in order to maintain the “inside-out” generalization is to analyze *-isc-* an infix rather than a suffix. This allows us to assume that the word is built as follows: first, the subject agreement suffix is added to the root, and *then* the *-isc-* infix (which I assume to have inherent stress) will be inserted between the root and the suffix whenever the suffix is not inherently stressed. The infixing analysis may provoke some skepticism, but, in fact, this has been proposed independently; for example, DiFabio (1990) and others analyze *-isc-* (or *-sc-*) as an infix. While the infixing analysis may seem like a trick to uphold the “inside-out”

generalization, one must concede that the lack of cases of phonologically conditioned stem allomorphy is striking given the number of cases involving affix allomorphy. Furthermore, it is not the case that any possible putative case of stem allomorphy could be explained away. The infixation account is possible for Italian because *isc* is present in all of the extended stems.

Regarding the treatment of cases of non-suppletive allomorphy such as the Polish example described in Section 2, the lexical subcategorization model does not necessarily dictate a particular approach. It is compatible with both constraint-based and rule-based theories of phonology. One thing to be mentioned in this regard is that in the version of lexical subcategorization that I have articulated here and elsewhere, it is assumed that phonology and morphology are separate components of the grammar, and that all regular phonology occurs after morphology, *modulo* interleaving as in Lexical Phonology (Kiparsky 1982). Given this, subcategorization frames, being part of the lexicon/morphology, are not especially relevant to regular phonological alternations in stems. The morphology, via subcategorization, merely supplies the underlying forms to which the regular phonology later applies.

An advantage to this approach is that it correctly predicts opaque interactions between suppletive and non-suppletive allomorphy in a single language. An example of this, as I have discussed in Paster (2009), comes from Turkish (Lewis 1967) (from the domain of affixes; I am not aware of cases of stem allomorphy that behave this way). As seen in (9), the third-person possessive suffix has suppletive allomorphs /-i/ and /-si/. The /-i/ form occurs when the stem ends in a consonant, while the /-si/ form occurs when the stem ends in a vowel (examples are from Aranovich et al. 2005 and from Gizem Karaali, personal communication; note that vowel alternations are due to regular Turkish vowel harmony).

(9)	bedel-i	'its price'	deri-si	'its skin'
	ikiz-i	'its twin'	elma-sı	'its apple'
	alet-i	'its tool'	arı-sı	'its bee'

At first, this looks like a straightforward case of PCSA. We could analyze the /-i/ form as subcategorizing for a consonant at the end of the stem, and/or the /-si/ allomorph subcategorizing for a vowel at the end of the stem. However, Aranovich et al. (2005) point out that the selection of the suffix allomorph is opaque in some words due to the operation of a regular Velar Deletion rule (Sezer 1981) that deletes intervocalic /k/. Some examples are given in (10).

(10)	açlı-ı	'its hunger' (cf. <i>açlık</i> 'hunger')
	bebe-i	'its baby' (cf. <i>bebek</i> 'baby')
	gerdanlı-ı	'its necklace' (cf. <i>gerdanlık</i> 'necklace')
	ekme-i	'its bread' (cf. <i>ekmek</i> 'bread')

In these examples, it appears that the /-i/ form has been incorrectly selected after a vowel, but the citation forms show that each of these stems is underlyingly consonant-final. The lexical subcategorization approach allows for a simple explanation of the pattern: the morphology selects the /-i/ allomorph of the possessive suffix in these forms due to the presence of stem-final /k/ in the underlying form. The affixed forms are then passed on to the phonology. Due to the presence of the /-i/ suffix, the /k/ is now in intervocalic position and is therefore deleted. Such cases of opacity are more difficult to deal with in constraint-based approaches, to which we now turn.

3.2 Constraint-based Approaches

A constraint-based approach to allomorphy uses conflicting constraints to account for allomorph distribution. In the case of suppletive allomorphy, a classic constraint-based approach to PCSA in Optimality Theory (OT) is the ‘P >> M’ ranking schema (McCarthy and Prince 1993a, 1993b), later updated by Wolf (2008, 2013) (see also Chapter 20 of this volume for more on OT approaches). The basic idea is that a phonological markedness constraint (P), such as a constraint on syllable structure, outranks a morphological constraint (M), such as one requiring that a certain morphological category should always be marked by one particular variant of an affix. Where relevant, the phonological constraint can force the morphology to deviate from the preferred surface realization of the morpheme in question, instead choosing an allomorph that allows the word to satisfy the phonological constraint while still expressing the function/meaning of the morpheme in question. Crucially (in the P >> M approach and most other constraint-based approaches), the separate listed allomorphs of the morpheme are all present in the input, so that even the selection of a special or dispreferred allomorph satisfies faithfulness constraints. The Italian example discussed earlier would be modeled as a conflict between, on the one hand, a set of P constraints relating to stress (perhaps one requiring exactly one stress per word, in conjunction with one requiring faithfulness to inherent stress on suffixes), and on the other hand an M constraint such as UNIFORM EXPONENCE (Kenstowicz 1996) (11).

- (11) UNIFORM EXPONENCE: Minimize the differences in the realization of a lexical item
(morpheme, stem, affix, word)

Both allomorphs of the stem would be present in the input (for “we finish,” for example, the input would be /{finísk-, fin-}, -iámo /). The ranking P >> M would select a form with the short stem allomorph (*fin-*), i.e., *fin-iámo*.

There is less published work on constraint-based theories of morphology *per se*, since the P >> M approach emerged from the OT phonology literature. Therefore there is no definitive statement as to how the OT approach would handle morphosyntactically or lexically conditioned suppletive

allomorphy. Regarding morphosyntactic conditioning, presumably it would be conflicts among M constraints (rather than between P and M constraints) that would yield suppletive allomorphy in an approach along the lines of the P >> M approach to PCSA. In the case of the Hopi example discussed above, for example, the M constraint being violated in forms with the special allomorph might be UNIFORM EXPONENCE, discussed above. The higher-ranked constraint forcing violations of UNIFORM EXPONENCE in plural words would need to have the function of Pāṇini's principle, combining with the specification of the plural stem form with a plural feature to force the selection of the special plural stem allomorph in plural words where such a stem allomorph exists. For ease of exposition, let us call this constraint SPECIAL PLURAL (12), although it may reduce to something more general⁴ (see also Chapter 17 of this volume for discussion of Pāṇini's principle).

(12) SPECIAL PLURAL: Use the plural stem allomorph in plural forms.

As in the P >> M approach to PCSA, for other types of suppletive allomorphy, all listed allomorphs would appear in the input to the tableau for any word containing the stem in question, such that input-output faithfulness constraints do not distinguish between candidates containing one allomorph versus the other. This assumption, combined with the ranking SPECIAL PLURAL >> UNIFORM EXPONENCE, would cause the plural stem to be selected in plural forms (13a) and the elsewhere stem to be selected in non-plural forms (13b).

(13) a. *momoya-m* 'women_{PL}'

/ {momoya _{PL} , wùuti} , -m _{PL} /	SPECIAL PLURAL	UNIFORM EXPONENCE
<i>a. momoya-m</i>		*
<i>b. wùuti-m</i>	*!	

b. *wùuti-t* 'women_{DU}'

/ {momoya _{PL} , wùuti} , -t _{DU} /	SPECIAL PLURAL	UNIFORM EXPONENCE
<i>a. momoya-t</i>		*!
<i>b. wùuti-m</i>		

Other analyses are possible in a constraint-based approach depending on one's theory. For example, if constraints on inputs are allowed, Pāṇini's principle could be considered a constraint on inputs rather than a violable

⁴ One proposal to capture Pāṇini's principle in constraint form is SUBSET BLOCKING (Xu 2007: 80): "An exponent (Exponent₁) cannot co-occur with another exponent (Exponent₂) if the latter (Exponent₂) realizes a subset of feature values that are realized by the former (Exponent₁).". This was proposed to deal with inflectional morphology; attempting to use this constraint for stem allomorphy seems to backfire. In the present case, SUBSET BLOCKING would only be satisfied either by choosing the less specified stem or by not expressing the plural suffix, since the plural feature of the suffix is a subset of the features of the plural stem. If a higher-ranked constraint forced the plural suffix to surface anyway, this would then force the selection of the less specified stem in order to satisfy SUBSET BLOCKING.

constraint, such that only the most highly specified stem allomorph that is compatible with the features of the word as a whole appears in the input.

In this type of model, non-suppletive phonological allomorphy would be handled using ranked phonological constraints, as in OT phonology and its relatives. A full explanation of constraint-based analyses of phonological alternations is of course far beyond the scope of this chapter. One point to be made here is that a putative advantage of the constraint-based approach to allomorphy is that the same P constraints are responsible both for PCSA and non-suppletive phonological allomorphy. This is claimed to be an advantage because in some languages there are instances of suppletive allomorphy that appear to be driven by the same phonological considerations as regular phonological alternations and/or phonotactic generalizations in the language. For example, Wolf (2008: 103–5) discusses an example from Kɔnni (Cahill 2007) where the noun class system appears to conspire with the regular phonotactics of the language to avoid flaps in adjacent syllables. No flap-final roots occur in the noun class that has a flap-initial suffix, and in addition, the sequence [rVr] does not occur within morphemes. Wolf argues that OT offers a better analysis of this example than the lexical subcategorization approach does, because the OT analysis unifies the two phenomena via a single markedness constraint, while the subcategorization approach would have to treat the two phenomena separately.

Because the OT approach handles both PCSA and regular phonological allomorphy (as well as static phonotactics) with the same P constraints in the same component of the grammar, it predicts that examples of PCSA will be phonologically “optimizing” (since they are driven by phonological markedness constraints in this model). This means that the distribution of allomorphs should be better from the point of view of some phonological markedness constraint(s) than it would be if the distribution of allomorphs were reversed. As I have pointed out elsewhere (Paster 2005, 2006, 2009), and as also noted by Bye (2007), this does not seem to be an accurate prediction; there are many languages having instances of PCSA that are not phonologically optimizing in any identifiable way and that apparently cannot be analyzed using markedness constraints which have been proposed elsewhere in the literature. A well-known example comes from Haitian creole, where the definite determiner suffix has the form /-a/ after vowel-final stems and /-la/ after consonant-final stems. As discussed by, for example, Bye (2007), this distribution of suffix allomorphs is the opposite of what syllable structure constraints (ONSET, NoCODA) would predict.

3.3 Allomorphy Rules and Readjustment Rules

The Distributed Morphology (DM) approach to grammar (Halle and Marantz 1993; see also Chapter 15 of this volume for an overview), like lexical subcategorization, distinguishes between suppletive and morphophonological

allomorphy, but the distinction is made differently. In DM, suppletive allomorphy is modeled via competition between different vocabulary items (VI; essentially morphemes, including phonological content) for insertion into syntactic nodes during what is called “spell-out.” The competing VIs are specified as to the environment (morphosyntactic or phonological) into which they will be inserted, just as in lexical subcategorization. Morphophonological allomorphy, where the allomorphs in competition are phonologically similar, is handled via a single VI being inserted, followed by the application of readjustment. Readjustment rules are different from phonological rules in being less constrained formally; for example, where rules in most versions of rule-based phonology can target only a single segment, readjustment rules in DM can change entire sequences. Related to the readjustment rule is the allomorphy rule (see, e.g., Aronoff 1976), which changes the segments of a morpheme into another string of segments in some morphologically defined environment. A possible critique of both readjustment rules and allomorphy rules is that they are overly powerful; while “rewrite” rules in phonology have been criticized for their excessively powerful ability to change any segment into any arbitrarily different segment in any stable environment (see, e.g., Coleman 1998), readjustment rules and allomorphy rules have exponentially greater power since they can target entire *sequences* of segments. Another drawback of the allomorphy rule approach that has been discussed in the literature (see, e.g., Rubach and Booij 2001) is that it is often not possible to write a rule that applies in a natural class of environments. Any theory has to acknowledge that stem allomorphy often occurs in unnatural groupings of morphological environments, but incorporating this fact into an analysis greatly diminishes the simplicity and elegance of an allomorphy rule, while it is more straightforward to capture in other approaches like stem indexation, to be discussed in Section 3.4.

In DM, the Hopi example discussed earlier would presumably be treated as suppletive allomorphy since the allomorphs are not phonologically similar. Early statements in the development of DM suggested that roots do not compete with each other for lexical insertion, but stems do apparently compete. For example, in the analysis of Latin stem allomorphy given by Embick (2010: 85–6), multiple forms of the verb stem “be” including *fu-* and *es-* are in competition, resolved by *fu-* being limited to occurring in the perfective form. Using Embick’s notation, the VIs for the two Hopi stem allomorphs would be as given in (14), where ‘ $\_ \neg \text{Num}[\text{pl}]$ ’ indicates that the *momoya* allomorph is limited to the context where it is concatenated with the plural suffix. This VI will take precedence since it is the more specific of the two.

- (14) $[n_{\text{woman}}] \leftrightarrow \text{momoya} / \_ \neg \text{Num}[\text{pl}]$
 $[n_{\text{woman}}] \leftrightarrow \text{wùuti}$

In contrast to the Hopi nouns, the Germanic strong verbs would be handled in DM via readjustment rules since the competing allomorphs

are more closely phonologically related. See, for example, Embick and Marantz (2008: 2): “A morphophonological readjustment rule changes the phonology of *give* to *gave* in the context of the past tense morpheme.”

The treatment of PCSA in DM is considered in detail by Embick (2010). A key feature of DM that is relevant to PCSA is late lexical insertion. In other theories, affixation and other morphological operations apply to morphemes whose phonological form is visible to the grammar from the beginning of the derivation. In DM, most such operations apply in the syntax to abstract nodes prior to spell-out, meaning that the phonological content is not yet visible. Under the strongest interpretation of late lexical insertion, no phonological content would be available to the grammar at the point of spell-out, meaning that PCSA should not be possible. However, it has been proposed that spell-out applies cyclically by phase,⁵ meaning that phonological material is visible to the grammar if it was spelled out on an earlier cycle (see Embick (2010) for a detailed articulation of this mechanism). Thus, PCSA is possible when the phonological environment needed for the insertion of a particular VI is under a node in the same phase or a phase that triggered an earlier cycle of spell-out, but not in a phase that will undergo spell-out later in the derivation. This limits the possible types of PCSA in interesting ways, in that it allows for limited instances of ‘outside-in’ suppletive allomorphy conditioning, where a phonological property of an affix conditions the selection of an allomorph of an affix “inside” it (closer to the root) or of the stem itself. The possibility of “outside-in”-conditioned PCSA has been a point of contention between proponents of the subcategorization versus constraint-based approaches, since Paster’s (2006) large cross-linguistic survey of examples of PCSA revealed no clear cases, while Wolf (to appear) has since identified some languages that he claims instantiate outside-in conditioning, and Embick (2010: 61) presents a possible case of outside-in conditioning from Hupa (Golla 1970) he claims supports the DM approach specifically. (The generalization in Hupa is that the 1sg subject prefix allomorph *e-* is used when preceded by perfective prefix and the verb is non-stative; the prefix *W-* occurs elsewhere. If this example holds up, it constitutes outside-in conditioning since the perfective prefix occurs farther from the root than the prefix whose allomorphy is sensitive to it.) The Italian example discussed earlier would also be compatible with the DM approach, if it could be demonstrated that the stem and the inflectional suffixes (whose stress patterns are claimed to drive the stem allomorphy) are spelled out in a single cycle.

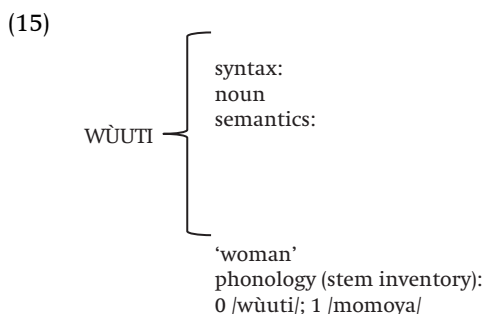
As with the lexical subcategorization approach, the DM approach and allomorphy rules do not necessarily specify an approach to regular non-phonological allomorphy.

⁵ On phases, see Chomsky (2008) and references therein.

3.4 Indexed Stems

A final approach to be considered here is the use of stem indexation (see, e.g., Aronoff 1994). The concept of stem indexation has been incorporated into multiple different frameworks, including Network Morphology (Hippisley 1998; see also Chapter 18 of this volume) and Paradigm Function Morphology (Stump 2001; see also Chapter 17 of this volume). As a result of the observation that in many languages stem allomorphs are distributed in unnatural ways, in this model stem allomorphs are indexed such that all the different stem contexts can be coindexed to match the correct stem allomorph, obviating the need for the stem itself to bear a list of the contexts in which it appears.

Following Hippisley's (1998) notation, a representation of the Hopi lexeme meaning "woman" in an indexed stem approach might be as in (15).



The rules for realizing singular and dual forms would then reference the stem index 0, while the rule for realizing a plural form would reference the stem index 1. In this case, the distribution of stem allomorphs could alternatively be characterized as [+plural] versus [-plural], so the advantage of the stem indexation approach is not as clear as in other examples. The benefits of stem indexation are more dramatically observable in languages where stem allomorphy occurs in large inflectional paradigms (see, e.g., Stump 2001, Chapter 6 on Sanskrit; Hippisley 1998 on Russian). Essentially, the approach is similar to lexical subcategorization approach in that morphemes select for other morphemes, but it is different in that affixation is handled by realization rules here, so the stem is not necessarily present in the representation prior to affixation, as opposed to the way that words are built from the inside out under the version of lexical subcategorization that I have described. On the one hand, this is an advantage of the indexed stems approach if there are examples of stem allomorphy that cannot be handled by lexical subcategorization; on the other hand, it is a liability if it turns out that affix-conditioned stem allomorphy in general is extremely rare (i.e., if Paster's (2006) findings in the domain of PCSA turn out to be generalizable to morphologically conditioned suppletion as well) and all the putative examples turn out to be reanalyzable.

PCSA in stems conditioned by phonological properties of affixes can be handled in this approach via a "morphological metageneralization" rule

(Stump 2001: 180–3). Such a rule would look at all of the realization rules and could create a set of rules whose output contains affixes with a certain phonological property (for example, in the Italian case, inherent stress). That set of affixes would then be subject to a rule referring to a specific stem index (in the Italian example, the rule for the inherently stressed suffixes would refer to the index of the *fin-* allomorph). Note that, as in the lexical subcategorization approach, the indexed stems/morphological metageneralization approach treats PCSA as phonologically arbitrary rather than being driven by phonological markedness. Thus, it has the same apparent advantage of the lexical subcategorization model in terms of predicting and being able to account for cases where PCSA seems to be arbitrary rather than optimizing; on the other hand, it is vulnerable to the same criticism that proponents of constraint-based models have leveled against lexical subcategorization, namely that in the cases of allomorphy that do appear to be optimizing, the model does not explain the relationship between the choice of allomorph and the conditioning environment.

As with the subcategorization approach and the allomorphy rules/readjustment rules approach, the indexed stem approach does not necessarily presuppose a particular theory of phonology. Therefore, it does not appear to prescribe a treatment of non-suppletive allomorphy.

Having demonstrated and evaluated four possible approaches to the analysis of stem allomorphy, in Section 4 we will discuss remaining problems and issues for future research.

4 Outstanding Issues

In Section 3 we have seen four different theories/frameworks for analyzing stem allomorphy: lexical subcategorization, constraint-based approaches, readjustment rules, and indexed stems. For each theory, we have discussed how the various types of stem allomorphy would be approached. We have also discussed some advantages and drawbacks of each model. The question now remains as to which model is superior and ought to be adopted – or, if some combination of these approaches is indicated, how can they be reconciled with each other in terms of an appropriate division of labor?

As has been discussed, the various models make “cuts” in different places between different types of allomorphy. In the typology that I presented in Section 2, there are two basic types of allomorphy: phonological (non-suppletive) vs. suppletive, defined as involving one underlying form of the morpheme (in the non-suppletive case) versus two or more (in suppletion). The version of the lexical subcategorization approach that I have presented here aligns with this typological division, since non-suppletive allomorphy is handled by the phonology, while a distinct morphological component of the grammar is responsible for suppletive allomorph selection.

Both the readjustment rules approach and the indexed stems approach also appear to leave non-suppletive allomorphy to the domain of phonology, but the readjustment rules approach makes an additional distinction relative to the subcategorization and indexation approaches. With readjustment rules, some cases of suppletion are dealt with as separate underlying forms that compete for insertion, while some other cases of what the other two models would deem “suppletion” (and would handle via two separate underlying forms, whether as separate listed morphemes under subcategorization or as separately indexed stems in a single lexeme under stem indexation) are treated via a single underlying form. The criterion distinguishing the two cases is phonological similarity: if the two allomorphs are similar, it is assumed that there is only one basic form of the VI that is inserted and may then be subject to readjustment rules, which are more powerful than phonological rules/constraints and can therefore handle greater variability between surface forms of a single underlying form than the other two models would tolerate. A major challenge and source of vulnerability for the readjustment rules approach relative to the other two is to define what constitutes sufficient phonological similarity to reduce the allomorphs to a single underlying VI. Presumably the answer is that they must be similar enough to be relatable via one or more valid readjustment rules, but this then raises the equally challenging question of what is a possible readjustment rule. At present, there does not appear to be any consensus—for example, among practitioners of Distributed Morphology—regarding a theory of readjustment rules. One could level a similar critique against the other two models on the grounds that the decision to analyze allomorphy as suppletive or not depends on a theory of rules/constraints, but it can be argued that there has been more progress in this area and that this is not as hard a problem as a theory of readjustment rules. I will take this point up again later.

The constraint-based approach differs from the other three in that it does not distinguish significantly between PCSA and what the other models would treat as non-suppletive phonologically driven allomorphy. Both are handled within a single component of the grammar (which contains both phonological and morphological constraints). The only difference between the two phenomena from the point of view of a constraint-based theory is that in PCSA, all of the different stem allomorphs are present (in curly brackets) in the input to a tableau, as opposed to non-suppletive allomorphy where there is only one listed form in the input. This does align with the idea of separately listed morphemes (in the subcategorization approach), indexed stems (in the stem indexation approach), or VIs (in the readjustment rules approach), but its effect is very different since the stem allomorphs have equal status in the input for any form that will contain one of the allomorphs on the surface. For a given case, it is essentially trivial whether one or multiple underlying forms are posited, since as far as faithfulness constraints are concerned, whichever allomorph is chosen on

the surface will already have been present in the input as if it were selected in advance. The ability of the constraint-based model to generalize to morphologically and lexically conditioned suppletive allomorphy will be determined by the successful development of a constraint-based theory of morphology. See Caballero and Inkelas 2013 for one recent effort in this area.

In deciding which model offers a superior approach to allomorphy (setting aside non-suppletive allomorphy, since of the four models only the constraint-based approach actually dictates an approach to that type of allomorphy), considerations of empirical adequacy are relevant. In the domain of PCSA, as referenced above, there has been a detailed cross-linguistic survey of the phenomenon (e.g., Paster 2006) and considerable argumentation over details of the cross-linguistic generalizations (see references above), particularly as they relate to the debate between lexical subcategorization and constraint-based approaches, but more recently the readjustment rules approach in Distributed Morphology as well. Much of the debate has concerned (1) whether allomorphy is optimizing and (2) whether it can be conditioned from the outside in.

Regarding optimization, I and others (Bye 2007; Embick 2010) have argued elsewhere that being able to capture apparent phonological optimization in PCSA is not an advantage of the constraint-based approach in light of the fact that not all cases are optimizing. The purported advantage is entirely self-generated: the theory is claimed to have an advantage in being able to account naturally and without stipulation for cases that it treats as optimizing via a theory of optimization, but the fact remains that this model treats the non-optimizing cases (when they are discussed at all in the OT literature) via stipulative, language-specific, and sometimes decidedly unnatural constraints. The superior “explanatory power” of the model is thus reduced to an ability to explain some subset of the attested examples, in comparison to other models which are said not to explain any of them. Thus, this does not in my view constitute a valid argument in favor of the constraint-based approach. I argue in Paster (to appear) that the synchronic grammar is not the proper locus for the “explanation” of any of the patterns, whether they appear on the surface to be optimizing or not.

Regarding the direction of conditioning, I asserted (Paster 2006), extrapolating from results of a cross-linguistic survey of PCSA, that true “outside-in” conditioning does not exist, meaning that PCSA in stems should not be conditioned by a property of an affix. Some examples that appeared on the surface to constitute outside-in conditioning were shown to be reanalyzable. However, as noted earlier, some examples have since been put forward that may pose tougher challenges to the claim (see Wolf 2008, 2013; Embick 2010). A closer look at the details of these examples will determine whether they do constitute counterexamples. If so, what explains the cross-linguistic rarity of outside-in conditioned PCSA? And is there a strict limit to the theoretically possible cases (as Embick 2010 proposes) or not? The case

from Sanskrit discussed by Stump (2001: Chapter 6), where verb stem allomorphs are distributed based on whether the inflectional suffix is consonant- or vowel-initial, should be added to the list of examples to be evaluated.

Outside the domain of PCSA, more cross-linguistic research would be helpful to the analysis of other types of suppletive allomorphy in stems and more broadly. A broad cross-linguistic search for known cases of morphologically conditioned stem allomorphy, for instance, would be useful. Considerable progress on the typology of suppletion has been made by the Surrey Morphology group (see, e.g., Brown et al. 2004; Chumakina 2004; Corbett 2007). A fuller understanding of the range and parameters of suppletive allomorphy in the world's languages will shape the development of theoretical approaches to the phenomenon.

Setting aside the empirical questions raised above that do not yet have answers, there are some ways in which the decision among competing approaches to allomorphy will rely on theoretical argumentation. For example, it was mentioned earlier that the readjustment rules approach is lacking a coherent theory of the form and limits of readjustment rules. Such a theory is needed both for the development of the general theory (e.g., of Distributed Morphology) and also for the analysis of a given language, since the question of whether a single underlying form or multiple underlying forms is involved in a given case of phonologically conditioned allomorphy depends on what readjustment rules can or cannot do. The related question of what the “regular phonology” of a language can do (whether in a rule- or constraint-based framework) is relevant to similar decisions about underlying forms in the lexical subcategorization and indexed stems approaches. For the lexical subcategorization approach, I have elsewhere discussed a number of criteria for determining whether a given case of phonologically conditioned allomorphy is suppletive or not. Fuller discussion of these is given in Paster (2006: 27–31) (see also Paster 2014), but to restate it briefly here, the criteria are adapted from Kiparsky (1996: 17):

(16)	Suppletive	Non-suppletive
	A item-specific	general (not item-specific)
	B may involve more than one segment	involve a single segment
	C obey morphological locality conditions	observe phonological locality conditions
	D ordered prior to all morphophonemic rules	follow all morpholexical processes

Kiparsky does acknowledge that these criteria “cannot claim to provide an automatic resolution of every problematic borderline case” (1996: 16). I have argued that criterion (A), involving the generality of the pattern, is one of the more useful criteria. If a phonological rule needed to analyze a

pattern of allomorphy in one morpheme can also account for other patterns of allomorphy in the language, this suggests that the allomorphy is not suppletive. On the other hand, if the rule needed to account for a pattern of allomorphy would only apply to that particular morpheme, then the allomorphy is more likely suppletive.

A related factor is the plausibility of the proposed rule. If the rule is item-specific but is also formally simple, then this is an argument in favor of non-suppletive allomorphy. On the other hand, if the proposed rule would be formally complex (perhaps involving multiple operations or affecting multiple segments simultaneously – thus relating to Kiparsky's criterion (B)), the pattern should be analyzed as suppletive. Applying this criterion does require a commitment to some formal model for which it is clear what constitutes an allowable operation, trigger, target, and so forth, so that the plausibility of a rule can be assessed. I have assumed a rule-based phonology that includes autosegmental representations and extrinsic rule ordering, though what I have said here may be compatible with a wide variety of approaches to phonology.

Any model of allomorphy will have to be paired with its own statement of criteria for distinguishing between types of allomorphy. A comparison among models could then be based in part on theoretical argumentation regarding how powerful a phonological system is required by each model and the plausibility of such a model.

5 Conclusion

In this chapter, I have presented an overview of the logically possible types of stem allomorphy, giving examples of each type. I have discussed four different theoretical approaches to stem allomorphy and shown how each would deal with the different types of allomorphy. In the preceding section, I have compared some features of the different approaches and discussed how further empirical research and/or theory development might help to distinguish among them.

In some respects, the choice of theoretical approaches to allomorphy may be a subject on which there will never be consensus. Some of the four approaches discussed in this chapter are radically different from each other, and of course these four do not represent the full range of possible approaches that exist in the literature or could be proposed. It is daunting to imagine finding common ground among them, and perhaps it is tempting to remain agnostic or to continue working within one's own theory while allowing that other models may also have their advantages and may be scientifically useful theories in the way that they inspire new research and thinking. On the other hand, the decision as to which approach to take is important not only in itself but in some cases in much larger questions about the nature of human language. For example, the

constraint-based approach treats phonology and morphology as part of a single component of the mental grammar, while the lexical subcategorization approach treats them as crucially distinct from each other, and the realization rules approach within Distributed Morphology conceives of the division among components of the grammar in yet another radically different way. Thus, while it may be difficult to demonstrate the superiority of one approach over another, the effort to do so is crucial to advancing our understanding of human language.

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6

Morphological Semantics

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1 Introduction

The relation between linguistic form and function, taking the latter in an extended sense that includes the value of inflectional categories, lies at the core of the study of word structure. Because the question of how morphology relates to interpretation is so central, the answers it receives depend on fundamental theoretical choices. Clearly, what one thinks of the semantic value of affixes depends on whether affixes have a place among the entities of a theory of language, a decision which typically rests on whether one takes words or morphemes as the minimal contentful elements. Similarly, whether or not the same conceptual tools should apply to the study of semantic phenomena inside and outside the word domain depends on one's views about what constitutes a word in the theoretical sense. Lexical and sentence-level semantics can be qualitatively different, if word meaning and sentence meaning are conceived as contrasting in their basic elements, in their combinatorics, and in the type of knowledge they involve; or alternatively they can be two salient aspects of the composition of meaningful units, along a continuous line from basic morphemes to complex texts, where the notion of morphological word may or may not have a stable semantic correlate. Even indirectly, fundamental choices about morphology can have substantial implications on such questions. For example, all approaches to morphology that share a realizational outlook (Stump 2001) are predicated of abstract semantic representations, which morphology relates to form in a complex but systematic map; however, making precise this semantic content which morphology operates on would seem to be a rather different enterprise from that of computing the content of complex syntactic structures on the basis of the value of their constituent parts and of the way they are combined. In a similar vein, one's basic perspective on the lexicon may privilege its aspect as a model of the psychologically real competence of speakers, or view it rather as a

theory-internal construct within a model of grammar, possibly split and articulated into different dimensions (cf. the comments in Fábregas and Scalise 2012: 5–8). Also the very notion of morpheme, in the classical structuralist sense of a minimal sign, by itself encapsulates a fundamental hypothesis about how linguistic form expresses meaning; therefore, the vigorous theoretical debate of recent decades, related to conceptions of morphology as word- or lexeme-centred (Matthews 1972; Aronoff 1976; Beard 1995), or ‘amorphous’ (Anderson 1992), and especially the new attention to systematic ‘morphomic’ regularities within morphological systems which cannot be reduced to form-meaning mappings (Aronoff 1994; Luís and Bermudez-Otero, *in press*), in this sense are developments that concern the proper relation of morphology to semantics.

In order to make these choices explicit, this chapter discusses, first, how theoretical assumptions about morphology determine its relation with semantics (§2); it then distinguishes various aspects in which word structure relates to word interpretation (§3); finally, it considers cross-linguistic morphological variation in connection with those aspects of semantics that are regarded as language-invariant, as an explicit theoretical hypothesis or as a basis for typological comparison and classification (§4).

A number of unifying themes run through the sections, some of which are dealt with in separate chapters: the identification of minimal signs (Chapter 3), productivity and listedness (Chapter 4), the place of morphology in grammar (Chapter 9), and the relation between word-internal and sentence structure (Chapter 10). In addition, two overarching themes require a mention here: the content of lexical knowledge, and the need for semantic atoms.

Consider first what lexical knowledge is knowledge of. Over and above grammar-internal information (which, according to approaches like that of Borer 2005a, 2005b, 2013, may account for a greater portion of lexical knowledge than is generally believed), speakers know how to use words in linguistic behaviour. A prominent part of this behaviour consists in acts of reference to mind-external entities. The formal semantic tradition which goes back to Frege is primarily concerned with this language-world relation, as is the “externalist” tradition in the philosophy of language. An alternative viewpoint privileges instead the mind-internal aspect of language viewed as the ability to express psychological content; this content can be externalized and socially shared thanks to its linguistic encapsulation, but remains at its core a property of the mind, not of the relation between language and the world. Taking morphology as the natural environment for a theory of words, we should note that the two approaches make significantly different demands on such a theory. If semantic interpretation is ultimately based on the notions of reference and truth, as in the externalist perspective, then a full specification of the semantic value of a word or of a morpheme must be framed in terms that ultimately go back to truth conditions and mind-external realities. This may seem

straightforward enough when applied to *dog*, or to inflectional categories like pluralization, or to other grammatical operators; but the task of a full truth-conditional account is far more challenging for other aspects of lexical knowledge, like the denotation of a noun like *time*, or oppositions like *boy~lad*, or *broad~wide*. As regards more specifically morphology, consider the difficulty of grounding directly in a mind-external denotation the content of word-forming elements like diminutives and other evaluatives when they convey an affective connotation about a referent, or a conversational implicature about the speaker's attitude, as instances of the phenomena falling under the rubric of "morphopragmatics" (Dressler and Merlini Barbaresi 1994; more generally Fradin and Montermini 2009; Sawada 2013); or think of the challenge of describing in truth-conditional terms the value of the German prefix *ver-* when it forms verbs interpreted as negatively oriented predicates (for example *verblühen* 'to wither, to bloom to exhaustion', *verlernen* 'to unlearn', *versehen* in the sense 'omit, miss, commit an oversight'); or finally consider the difficulty of stating the denotation of the stem *transmis-* given the two readings of *transmission* (mechanical part and abstract event nominalization). By contrast, the perspective which we may loosely qualify as "cognitive" seeks to account for these and similar aspects of lexical knowledge by mapping out their conceptual constituents, and accounting for the mutual relations of inference, similarity, and opposition, holding between words. The risk, in this case, is to simply re-label aspects of word knowledge that appear more or less prominent, in the worst-case scenario with little prospects of a predictive and falsifiable theory of what components can co-occur in a word of natural language, and of how speakers put to use this conceptual content to talk about the world in socially stable terms. In what follows it will be useful to keep in mind the different strengths and goals of the two perspectives, remembering that what counts as semantic interpretation for a lexical item or one of its components is not self-evident, and probably requires both a mind-external dimension and a "cognitive-inferential" one (as claimed, for instance, by Asher 2011; see also Marconi 1997).

The second general point concerns the need for well-defined semantic atoms. In syntactic terms, it is self-evident that any recursive account of linguistic creativity requires a vocabulary of smallest elements, which can be combined to generate an infinite number of possible sentences. But, if each of these sentences is to be interpretable on the basis of the content of a finite set of signs, we also need a precise characterization of the basic elements of semantic interpretation. Syntax in its more traditional sense, as well as most work in truth-conditional semantics, can legitimately focus on the formal mechanisms of composition for elements clearly above word level, like those that create the formal structure corresponding to the phrase *the cat* and its denotation, plus other elements that are not free forms (in English) but can be clearly segmented and interpreted as discrete grammatical formatives, like the past tense inflection on the form *sat*. When the

focus shifts to word structure, however, substantive questions arise. For example, do the word constituents *-ing* and *-er* carry different semantic values in their “transparent” productive reading, exemplified by *selling* and *seller* (both transparently derived from *to sell*), in contrast with “lexicalized” readings like that of *pusher* in the sense of “seller of drugs,” or *hiding* in the sense of “beating” (as in the phrase *a good hiding*, from *hide* ‘skin’ and not from the verb *to hide*)? Should we assume one semantic atom *PUSHER*, analogous to *CAT*, and two more for the verb *PUSH* and for the transparent nominalizing affix *-ER*? Does it make sense to treat such an affix as a semantic atom on a par with a lexical word, if the range of its possible readings is so broad as to include, beside the canonical activity-related nominalization (*X-er* ‘individual that Xs, habitually or in a salient context’), also cases like *pusher* ‘one who sells drugs habitually,’ but also *goner* ‘person doomed to be lost,’ *fiver* ‘banknote with the value of five currency units,’ *dresser* ‘kitchen sideboard with shelves’ (or ‘chest of drawers’ in American English), or even, distributing over both elements of a compound, the British *doer-upper* (American *fixer-upper*) ‘house in need of some work, house to do-up’? Inflectional morphology too can give rise to similar difficulties in segmenting the units of semantic interpretation, as in non-canonical pluralizations like *funds* with the meaning ‘funding’, distinct both from its singular *fund* and from the homophonous regularly interpreted plural, true of a plurality of funds. As Asher (2011: x) writes:

Thus, the notion of a word quickly becomes a theoretical term; the meaningful parts of the lexicon may include things that we ordinarily think of as bits of words, and basic word stems (the elements to which affixes and prefixes attach) may not end up looking like ordinary words at all.

The notion of word is indeed a theoretical term in this context, and questions relative to semantic segmentation below (morphological) word-level fall squarely within the purview of morphological theory. Still, the sustained interest in the relation between morphological and semantic structure has not always brought out the need for an explicit statement of what count as the building blocks of semantic interpretation. It is important to be clear about the question posed by the atoms of a recursive semantic characterization of natural language, because it can easily be confused with related but distinct questions about productivity, listedness, lexical access, and the structure of lexical concepts.

2 Morphology and Semantics: Theoretical Choices

This section identifies the key theoretical assumptions which have a bearing on how morphology relates to semantics. They concern the pieces of morphology, the place of morphology relative to other components of the grammar, and the nature of the lexicon.

2.1 Are there Meaningful Word-internal Elements?

Approaches to morphology differ in whether they posit word-internal elements as legitimate theoretical entities, or rather as epiphenomena resulting from paradigmatic associations between atomic words. This major divide intersects an even deeper one: the object of study of morphology may be mind-external elements of language description, or mind-internal elements of a linguistic cognitive ability. In the latter case, the items which underlie lexical and morphological knowledge may correspond to symbolic representations generated by rules and a lexicon of basic elements; or they may be construed instead as unsegmentable wholes, such that the knowledge described in terms of paradigms, affixes, templates, constructional patterns, would arise from associative implications from stored full forms, as in connectionist models. Most work in theoretical morphology attempts to model the mind-internal knowledge that underlies the linguistic behaviour of speakers; but the distinction between mind-external and psychological construal of words deserves explicit mention, because contemporary word-based approaches typically highlight their historical continuity with a tradition (rooted in Graeco-Roman antiquity) which arguably lacked the modern concept of an internalized grammar, while at the same time they emphasize the psychological plausibility of equating words with entries in the mental lexicon.

This last point relates to the more general issue of the psychological reality of the entities posited by a theory of word structure. While it is true that cognitively oriented approaches ultimately make a claim about speakers' minds, this does not mean that a theory of morphology, as part of a theory of internalized grammar, should necessarily adopt the theoretical and descriptive vocabulary of a theory of the mental lexicon in language processing. To illustrate with an uncontroversial example, it is well known that high token-frequency plurals like *eyes* are stored and accessed as units; but this does not obliterate their nature of regularly affixed forms, which is precisely the source of their interest. The complex relation between listedness in memory and use, semantic idiosyncrasy, and structural complexity is discussed in greater detail in Chapters 3 and 4, and receives special attention in models like Jackendoff's Conceptual Semantics (Jackendoff 2010, 2011); see also Rainer et al. (2014: 6–8, 10–12).

The choice whether or not to countenance word-internal semantic constituents does not coincide with the divide between morpheme-based and word-based approaches, nor with the traditional classification into item-and-arrangement, item-and-process, and word-and-paradigm. Firstly, as Blevins (2006: 533–41) argues, morphological models in each of these categories, including realizational word-based approaches like that of Stump (2001), share a “constructive” orientation insofar as they derive the full forms making up the paradigms from more basic elements, whether through operations applying to stems or roots, or through the combination of discrete morphemes. The status of such more basic elements is clearly

very different in the two perspectives, but both can countenance semantically contentful sub-word elements. Relatedly, and more generally, a word can be analyzed as containing meaningful subcomponents which do not necessarily correspond to segmentable morphemes. This applies to primitives like *BECOME* or *CAUSE* when they are posited in lexical semantics (as in the lexicalist approach overviewed in Levin and Rappaport Hovav 2011 or the non-lexicalist one of Jackendoff 2011), as well as to the content of syntactic heads like “little *v*” (cf. *FIENTIVE* in Embick 2004, or the featurally defined activity, stative, causative “flavours” of *v* in Harley 2009). To fully appreciate the relative independence between positing word-internal semantic constituents and positing contentful morphemes, consider the monomorphemic verbs *run* or *break*. They can express either an inchoative or a causative reading, and thus would incorporate semantic primitives like *BECOME* or *CAUSE* in the analyses just mentioned. However, the two readings are also available in the bimorphemic *separ-ate* ‘to become separated’ / ‘to cause to become separated,’ formed with the verbalizing suffix *-ate* (cf. the paradigmatically related *separ-able*). Yet we cannot simply say that the property of expressing one or the other reading is the content of lexical stems like *break* or of the verbalizing suffix *-ate*, because other verbs formed with the same suffix exhibit different semantic properties: *assassin-ate* is only causative (transitive), while *hesit-ate*, an activity predicate rather than a change-of-state inchoative, is only intransitive. A single coherent content for *-ate* could still be envisaged, in principle, but not on the basis of the distribution of the posited semantic primitives *BECOME* or *CAUSE*.

At least in principle, then, the question of meaningful word-internal elements is disjoint from that of meaningful morphemes. In practice, however, the main theoretical differences about the role of word-internal elements for semantics often concern morphemes, and in particular the opposition between lexicalist and non-lexicalist models stands out most clearly in connection with the role of morphemes in determining word meaning. An approach like that of Anderson (1992), at one extreme, denies that the noun *nominalization* contains the adjective *nominal*: a derivational relation arises because rules extend and manipulate word-forms, not words in a syntactic sense, and in this case no rule directly links the innermost and the outermost form. At the other extreme, for Distributed Morphology the word *nominalization* contains the syntactic ingredients that define the adjective *nominal* and the verb *nominalize* (not however those that introduce an agent and license accusative case on the internal argument: Harley 2009). In this analysis the posited syntactic structure is what creates the word’s semantic content, or at least, those aspects of it that can be modelled in structural terms. Ambiguous nouns like *collection*, which is interpreted either as a nominalization supporting frequency modifiers and requiring the expression of arguments (*the frequent collection of mushrooms by tourists*), or as a so-called result noun (*my old collection of stamps*), realize two distinct syntactic structures; the first reading, in particular, corresponds to a

complex that includes a verbal substructure, and which overall results in an eventive interpretation (see the essays in Alexiadou and Rathert 2010).

Evidently, positing a semantic articulation of words which does not find immediate justification in their form is a theoretical decision that must be empirically motivated. Morphology can provide a testing ground. For instance, Koontz-Garboden (2005) shows that adjectives denoting result states, which entail a prior causing event, crosslinguistically tend to be morphologically derived, like *broken* or *reddened*, while adjectives denoting simple states which lack the same entailment are simplex, like *red*. Note that the state of being “not whole” is a discrete atomic component of the lexical semantic representation of *break*, in Levin and Rappaport Hovav’s (1995) lexicalist analysis. The key empirical observation (subject, of course, to falsification) is that a monomorphemic form can express the property of entering into such a state (cf. *broke in the glass broke*), but not the state itself. Since there seems to be no morphologically primitive, simplex expression for such result states, a likely explanation is that the root *break*, as an unanalyzable piece of the form, is already intrinsically associated to a change-of-state predicate (for Koontz-Garboden, a causative one); in order to denote a state, it must first be modified and turned into an adjectival participle. In other words, this is an empirical argument for distinguishing roots which build change-of-state predicates by composition with root-external operators, from other roots which express this semantic information as their inherent content. As Koontz-Garboden (2010, 2011) further notes, this militates against the idea that all morphological roots have a maximally underspecified semantics, and that abstract components like CAUSE or BECOME are always freely introduced in the syntax; for if *break* was so radically underspecified, nothing would prevent it from appearing as a simple underived adjective root meaning “state of being broken,” without any CAUSE or BECOME decompositional operator.

If morphological data can allow one to compare competing theories of lexical semantic representation, still it remains important to make theoretical assumptions explicit. Part of the argument just summarized rests on the assumption that the “root” of a lexical template in a lexicalist Levin-style analysis is an abstract term (like “not-whole” as part of the template for the verb *break*) which does not necessarily correspond to a root morphologically defined; a root is instead a syntactically and morphologically individuated entity for Distributed Morphology, which, it is claimed, should predict the existence of unanalyzable morphological roots for the result state described as “broken.” This last assumption may be open to discussion, however, given that Distributed Morphology distinguishes between syntactic roots (abstract terminals) and atomic exponents (see especially Harley 2014). On the specific issue of the semantic effect of morphological derivation, Koontz-Garboden calls attention to a fundamental “monotonicity hypothesis,” whereby “word formation operations do not remove operators from lexical semantic representations” (Koontz-Garboden

2012a). This generally tacit assumption underlies different approaches across the theoretical spectrum, but it is not followed by those analyses of the causative-inchoative alternation where the inchoative (say, *open* in its change-of-state reading of *the door opens*) is semantically prior to a causative (*she opens the door*) and is derived from it by deletion of CAUSE, even when morphologically it is rather the causative that is basic (Italian *aprire* ‘to open’) while the inchoative has reflexive morphology (*aprir-si* ‘to [become] open’). Insofar as the opposite semantic analysis is justified (Koontz-Garboden 2009), which instead of deleting a CAUSE operator takes the root to be intrinsically causative and derives the inchoative reading through the meaning of reflexivization, the match between structure-building in morphology and in semantics receives support as a significant empirical hypothesis. Again, we must note that this rests on a particular view of lexical semantic representations, where semantic atoms are identifiable on the basis of their language-independent denotation, so as to permit being associated with morphological components, and being compared across languages. It is not obvious how this can be reconciled with a word-based approach in its strongest form, which would not countenance structure inside derived words (if not as an epiphenomenon deriving from paradigmatic associations); nor how it would revealingly analyse the function of affixation in ‘lexicalized’ readings of complex nouns like *transmission* (as ‘gear box,’ concrete individual object) or *transportation* (as in ‘public transportation,’ collective), especially given the (near-)synonymy between *transmission* and the morphologically equally complex *transmittal* and *transmittance* in their compositional reading as action nominalizations (see, however, the qualifications by Stump 2001: 254 about such apparent non-disjunctivity of derivations). It is phenomena of this kind which motivate Borer’s (2013, Chapter 9, Section 4) proposal that the interpretation of conceptual listemes (her “Content”) takes as input not syntactic structures, but phonologically specified word-forms.

2.2 What is the Place of Morphology in the Architecture of Grammar?

The relation of morphology with semantics depends essentially on its place in the architecture of the grammar, which is discussed in greater detail in Chapter 9. In a model of grammar (as distinct from a model of speech production or processing) in which the lexicon is a distinct component defining the building blocks manipulated by syntax, which then feeds semantic interpretation, one expects a relatively close match between units of the form and units of meaning. A greater independence is expected if the inflectional part of morphology is taken to realize the input defined by syntax, adopting a “split” approach (Perlmutter 1988). In the light of the evidence for widespread misalignment between the categories of morphology and those of syntax and semantics (linking elements, parasynthesis,

cranberry morphs, templatic morphology, cumulative and extended exponence, deponency), many have been led to reject altogether the conception of syntax operating on the output of morphology, in favour of a realizational approach where morphology spells out the abstract output of syntactic and semantic operations. This is, for instance, the architecture assumed by syntax-based approaches like Distributed Morphology and Borer's Exoskeletal model. The autonomy of morphological form from semantic structure was explicit in Beard's (1995) hypothesis of a "separation" between a side of morphological operations which deals with abstract contentful elements, and a side which spells it out; and it acquired greater prominence with Aronoff's (1994) conception of a morphology "by itself," motivated mainly by paradigmatic effects whereby morphology references as one category (an affix, a stem form, a set of paradigmatic cells) something which is not one for syntax or semantics. In this and other realizational models, therefore, what is one in morphology does not have to be one for semantics, as a consequence of grammatical architecture.

A related opposition concerns the nature of meaningful elements, regardless of whether they coincide with units of the form. In some models, typically those that conceive of morphology as an autonomous set of principles (word-and-paradigm models, Booij's (2010) *Construction Morphology*, as well as item-and-arrangement models like Lieber (2004)), what has semantic content are morphologically defined objects: morphemes, the featural complexes which define paradigms, or constructions. In others, the elements of interpretation are defined syntactically, or as abstract constituents of a semantic representation. This applies typically to models that distribute morphology across other components rather than viewing it as a self-contained module: most prominently syntax-based frameworks like Distributed Morphology (Halle and Marantz 1993) and Borer's Exoskeletal approach (2005a, 2005b, 2013), but also Jackendoff's *Parallel Architecture* (2002, 2010). Members of the former class typically envisage specific interpretive principles applying to morphology, while for members of the latter class the semantics relevant to word structure is not in principle different from that relevant to sentence structure.

Across these models, the attention devoted to interpretive phenomena varies significantly. Word-based approaches often concentrate on purely morphological properties of words and paradigms, without much consideration for the match or mismatch of formal and interpretive properties of word structure, or for the place of morphological principles within the broader context of a theory of language. Syntax-based approaches must instead address directly the questions raised by the lack of full compositionality in word formation and compounding, given the driving principle that there is only one combinatorial system ("syntax" in an extended sense), the outputs of which are subject to semantic interpretation. We have already mentioned Borer's (2013) articulated proposal as a major representative of this line of inquiry. Work in Distributed

Morphology addresses the challenge of lexicalization and opaque readings by recourse to an “Encyclopaedia” which lists idiosyncratic readings, as a semantic repository distinct from the lists of exponents and of syntactic roots. One can point to Arad (2003a, 2003b) and Marantz (2007) for a proposal to predict the occurrence of idiosyncratic readings on the basis of syntactic locality, and to Harley (2012, 2014) for a critical reappraisal in the same framework.

2.3 What is the Lexicon?

Among the morphological assumptions that determine how one views the map between word structure and semantics, some concern specifically the lexicon. One is the assumption that the lexicon constitutes a self-contained component, either as a bare list or as a more structured component, distinct from other components of the grammar. Distributed Morphology and Jackendoff’s Parallel Architecture explicitly reject this assumption, and model listed aspects of linguistic competence, respectively, in the form of separate lists (one of phonological exponents, one of syntactic roots, and one of idiosyncratic interpretations), and of interface rules linking phonological, syntactic, and semantic representations. Since entries in the mental lexicon do not necessarily correspond to minimal units in a model of grammar (see §2.1), there is a complex relation between listedness, productivity, and semantic idiosyncrasy, the delineation of which is a major concern of Jackendoff’s model. A precise delineation of what is listed and what is productive in lexical semantics is also at the forefront in Booij’s (2010) *Construction Morphology*, which programmatically foregrounds the role of morphological schemas, rather than morphemes, as bearers of meaning. Other models envisage a lexicon of meaningful signs. The smallest such signs can be full words, as in word-based approaches (especially in the strong interpretation defended by Blevins 2006), or morphemes, as in Lieber (2004), which follows the strong hypothesis that affixes and lexical bases both have the same type of semantic representation, based on a common set of features and interpretive mechanisms.

It is customary to oppose lexicalist and non-lexicalist approaches to lexical semantics, where the former associate lexical items to complex symbolic representations, while the latter aim at resolving the properties of single items and of lexical classes into syntactic configurations. The analysis of argument-structural and aspectual properties of verbs, in particular, is a traditional testing ground that brings out the differences between accounts based on lexical semantic templates (Levin and Rappaport Hovav 1995; Rappaport Hovav and Levin 1998), and accounts that read off the interpretation distinguishing the various verb classes from the syntactic structure (Halle and Marantz 1993; Hale and Keyser 2002; Borer 2005b; Ramchand 2008). This concerns morphology only insofar as lexical-semantic properties find a morphological expression (cf. the discussion on

break and *broken* in §2.1); but the divide between lexicalist and non-lexicalist analyses brings to light another morphologically relevant notion, namely that of lexeme.

In lexicalist approaches, lexemes identify lexical items independently of any syntactic context that they may appear in, and abstract over the inflectional values they can instantiate. The concept is especially fundamental in word-based theories, where a paradigm gathers the set of the forms an abstract lexeme can have (*go*, *goes*, *went*, *gone*, *going* are all instantiations of the lexeme *go*). More generally, the concept of lexeme makes precise the idea of a “lexical base” which in realizational models of morphology is spelled out by inflection (the idea is articulated in detail in Beard 1995; Beard and Volpe 2005), and therefore makes it possible to distinguish in a precise way the derivational and inflectional functions of morphology as, respectively, lexeme-forming and lexeme-manipulating (Aronoff 1994: 13–15). In sum, a theory which includes lexemes in its vocabulary can model in precise terms the notion of a lexical word, as a domain for morphological operations and possibly for semantic interpretation, discriminating word-internal from word-external semantics. Non-lexicalist approaches, instead, do not contemplate lexemes, and so necessarily reject a principled distinction between lexical and sentence-level domains, both for morphological and for interpretive operations. Interestingly, a similar conclusion may be implied if we take seriously the idea of full words as minimal signs: if $[[\text{ speak }]]$, $[[\text{past}]]$, $[[1 \text{ plural}]]$ are all aspects of an indivisible sign *spoke*, which only emerge by virtue of paradigmatic associations, there is no reason why “inflectional” components of meaning should be any more stable and paradigmatically uniform than “lexical” components. Just as there are defective or deponent verbs, for instance, there could be verbs where the first-person plural is irregularly inclusive.

3 Word Structure and Word Meaning

This section aims to organize the main phenomena, among the myriad instances of “lexicalized” or “non-compositional” readings, which raise questions about the relation between word structure and semantic structure.

3.1 The Syntagmatic Axis

Borer (2005a: 53) notes that “while the *function* of inflection is clearly regular and syntactic, no such claim can be made about its *form*” (emphasis in the original). In effect, regardless of how one views the divide between inflection and word formation, the very notion of inflectional morphology is predicated of clear-cut oppositions in grammatical values, the content of which can be defined independently of a particular choice of lexical base.

Still, in some cases an inflectional morpheme has also a semantic effect on the lexical predicate. This happens in grammatically plural nouns like the Greek *nera* ‘water(s)’ or the Arabic *ramlaat* ‘sand(s),’ which select a concrete interpretation for the mass predicate, spatially extended and delimited, and Breton plurals like *dour-ioù* (from *dour* ‘water’) glossed as ‘streams,’ or the doubly pluralized *park-ei-er* glossed as ‘countryside’ (from *park*, *park-où* ‘field,’ ‘fields’); see Acquaviva (2008) and Alexiadou (2011).

Apart from these cases, and from the more general questions raised by templatic morphology (which straddle the inflection-word formation opposition; see §4.3 below), semantic opacity mainly arises in word formation. Examples like *writer*, with a specialized occupational sense, *blackboard*, with an extended interpretation of the adjective, are very familiar and can be multiplied at will. They arise first and foremost through affixation: *capitulate* – *recapitulate*, *continent* – *incontinent*, *fish* – *fishy* ‘suspect,’ *recite* – *recital* are just a few English illustrations of the extremely common situation in which affixes which usually have a (more) predictable semantic function derive a word with a more or less idiosyncratic meaning, which cannot be entirely predicted from its lexical base (contrast the transparent *re-read*, *in-sincere*, *fatt-y*, *acquitt-al*). In addition, cases like *a bore*, *a cheat*, *a cook* show that the function typically signaled by an affix, in this case the characterization of an individual by a habitual or occupational activity, is in principle independent of the presence of that affix, or indeed of any morphological exponent. At the same time, there is evidence that derivational affixation is sensitive to semantic lexicalization, whether or not one treats affixes as signs: forms like *govern-ment-al* or **employ-ment-al* are more or less well formed according to whether the base *X-ment* is, respectively, a lexicalized entity-denoting noun or a semantically transparent nominalization from a verb (Aronoff 1976; Acquaviva 2009). A similar illustration is provided by the Italian deverbal nominalization pattern which forms event nouns from the feminine past participle form (*nuotare* ‘to swim’ → *nuotata* ‘a swim’). This operation selects verbal bases that must be actionally atelic and non-stative, specifically in the semelfactive interpretation that emerges in the periphrasis *fare una V-ata* ‘do a V-event’: *fare una nuotata* ‘have a swim’ thus contrasts with the unacceptable **fare un’arrivata* from *arrivare* ‘to arrive.’ However, many such past participle derivations have a lexicalized reading which does not respect the regular semantic pattern “controlled continuous process of V-ing → single bounded event of V-ing”; examples of various types are *offerta* ‘an offer,’ formally related to *offrire* ‘to offer,’ *difesa* ‘defence’ (*difendere* ‘to defend’), *caduta* ‘a fall’ (*cadere* ‘to fall’), or even the more opaquely related *ricevuta* (*ricevere* ‘to receive’), specialized in the concrete meaning ‘receipt’ (see Gaeta 2004). Apart from illustrating how lexicalized readings deviate from the canonical function of a word formation pattern, this example highlights the need to distinguish between a morphological operation (a theoretical hypothesis), a systematic distribution of forms (here, the exponents defining what we

call ‘past participle feminine’), and an interpretation or a cluster of related interpretations more or less regularly corresponding to those forms (here, the semelfactive event reading, among other event-related readings). In a lexicalized form like *ricevuta*, the feminine past participle morphology does not relate to the regular semelfactive reading; we can state this empirical fact by saying that the connection between form and meaning does not instantiate the very same abstract morphological operation posited for the core or ‘canonical’ cases. While the concept of morpheme as a sign takes form and meaning as two facets of a unitary linguistic object, this kind of variable overlap between form and meaning thus suggests a different perspective – unless what counts as morpheme is redefined.

The other major source of semantic opacity in complex words, especially in languages like English, is represented by compounds: *armchair*, *deadline*, *drawing room*, *hallmark*, and *strawberry* show how this rather productive word-formation strategy can produce words whose meaning is not entirely predictable from the meaning of their parts. Notice that this formulation is not theoretically innocent, as it presupposes that compounds have constituents with a meaning of their own. But, to simplify, a compound like *armchair* is opaque precisely to the degree that its non-head constituent *arm-* does *not* have the same semantic content as the lexical entry *arm*. Libben and Weber (2014) emphasize the nature of all compounds (not just the type *cranberry*) as positionally bound morphological structures, rather than assemblages of free forms. This becomes all the more plausible if one thinks of productive patterns like that exemplified by *heli-copter*, *heli-pad*, and *heli-ambulance*, or of formations like *airsick* from *seasick*. In this light, the constituents of compounds are not so different from derivational affixes, since for both the question poses itself whether they, as morphologically segmentable parts, also contribute a discrete semantic component to the overall meaning of the word. Blends like *brunch*, *smog*, or *adulescent* add another dimension to the question, because in this case one of the morphologically segmentable parts is actually *smaller* than a free or even bound form.

The questions posed by other derivational processes concern another important issue, namely the semantic relation between two derivationally related lexical items. It is well known that conversions like *a jail* – *to jail* involve not just a change of category and an abstract function (location in this example), but also semantic and encyclopedic content which characterize the action as, in some sense, “canonical.” This can lead to shifts in meaning which can be quite unpredictable without reference to a broad encyclopedic context, like those from *frame* to *to frame* (in the sense ‘pin a crime on’) or from *bed* to *to bed* (someone). But, even limiting ourselves to a few English examples, patterns vary. The one illustrated by *to invite* – *an invite* or *to listen* – (*have*) *a listen* seem to create nouns denoting bounded events without argumental structure, as opposed to action nominalizations or result objects; cf. *his frequent invitation* / **invite of undesirable*

guests; my invitation / *invite was crumpled (contrast however to drink – a drink, two drinks, with a concretely interpreted result-state noun). Like affixation, conversion too is sensitive to the semantic lexicalization of the base, given that *to audition* and *to proposition* are clearly more acceptable than **to formation* (Borer 2013). An extreme case of lexicalization which combines clipping and conversion is *to frag* ‘to kill one’s own officer,’ formally a truncation from *fragmentation* (*grenade*). Sensitivity to semantics shows itself also in the selection of one of the senses of the base. A clipping like *exam* from *examination* selects a simple event reading from the range of interpretations available to the full noun, again without argument structure: cf. *the frequent examination* / **exam of students by teachers* (Grimshaw 1990) and also, in French, *manif* ‘street demonstration,’ as distinct from *manifestation* which can mean ‘street demonstration’ or ‘act of manifesting’ (Fradin and Kerleroux 2009).

Summing up, even a small empirical sample clearly shows that the pieces of word formation do not simply correspond to the pieces of semantic interpretation, insofar as the latter can be objectively identified. Cruse (1986: 45) made the point succinctly by noting that the antonymy relation between the lexical meaning of *rise* and *fall* (both unsegmentable) is indistinguishable from that holding between *mount* and *dis-mount*, or *in-crease* and *de-crease*, where one or both members are morphologically complex. (Skeptics might wonder, however, if it is really an accident that the latter words consist of Latinate morphemes, known at least since Aronoff 1976 for *not* being contentful: cf. *con-ceive*, *per-ceive*, *re-ceive*.) Broadening the perspective, from word formation to the more general question of the homology between the morphological and the semantic constituent parts of words, the evident lack of isomorphism does not prove, by itself, that word structure has no relation to lexical semantic structure; if the relation is not isomorphic, the analytic challenge lies in making clear just how indirect it is. Beard’s (1995) Separation Hypothesis answers the question by distinguishing a spell-out component from a set of abstract lexeme-deriving functions, both internal to morphology (unlike in models where the second role is played by syntax), such that the elements of two components do not correlate one-to-one. Like Borer’s Exoskeletal syntactic approach, Distributed Morphology identifies the content-defining component with syntax, but in addition it envisages special operations on the syntactic output which can split, merge, and rearrange the terminals to be phonologically interpreted, and which are driven by language-specific morphological well-formedness constraints. Importantly, from this perspective the notion of “word” operative in word formation does not correspond to any specific syntactic unit. This relative independence of syntactic and morphological constituency means for instance, that “the classic example *transformational grammarian* can be analyzed in the syntax and at LF [Logical Form] as having the structure [[*transformational grammar*] -ian]; the fact that the element *-ian* is affixal becomes relevant only at PF [Phonetic Form]”

(Harley 2012: 2158). Such a downplaying of the role of morphological words for the identification of meaningful elements contrasts sharply with the position of word-based approaches (see Anderson 1992; Blevins 2006). For them, affixes and morphological operations have no meaning by themselves, but are epiphenomena abstracted from recurring paradigmatic oppositions between full word-forms. Others envisage contextually defined semantic values, or simply polysemous ones, or prefer to associate the pieces and operations of lexical derivation with a very general semantic content (a position that Rainer et al. (2014: 20) show was already espoused by Bréal (1868)). Especially in cognitively oriented models, these can be interpreted as radial categories, with core and peripheral senses extendable by metaphor or metonymy, and which get selected on the basis of the local context (word-internal as well as -external). Even approaches which assign to word-forming affixes or operations a well-defined semantic content, possibly mediated by syntactic structure, usually recognize a qualitative difference between the regimented, contextually variable value of such word-internal elements, and the meaning of a full word or a lexical base. Lieber's (2004) strong hypothesis that the same set of semantic features and combinatorial rules applies to both elements stands out as a notable exception.

3.2 The Paradigmatic Axis

Paradigmatically, the questions raised by the morphology-semantics misalignment concern the interpretive value of morphological categories themselves. The existence of strictly morphological classes irreducible to syntax, semantics, or phonology, and signalled by elements such as thematic vowels or by distinct paradigmatic patterns, seems an indisputable fact, although accounts vary on how to interpret them in theoretical terms. Whether a declension class is modelled by means of class diacritics marking a choice of lexical bases, or as a series of listed co-occurrence restrictions between lexical roots and class-defining morphemes (work in Distributed Morphology has made use of both), or, at the other extreme, as a paradigmatic pattern which permits us to predict the realization of word-forms in the various cells, as in Blevins's (2006) word-based morphology, this analytical choice strictly speaking has no direct bearing on the relation between morphology and semantics, because by hypothesis such classes are not definable in semantic terms. What matters is rather whether the morphological categories which do express a semantic content are aligned with semantic categories.

Consider, for example, deponency, where a subset of verbs in all or part of their paradigm carry a grammatical specification which normally has a semantic value, but for them appears to be just a formal lexical property; for example, the middle-passive morphology of the classical Greek *dunamai* 'I can' or of the old Irish *labrithir* 'he speaks.' On the face of it, this clearly

exemplifies a mismatch between semantic content and the morphological category which realizes it. However, at least in some cases, deponency might have a semantic motivation, since it seems to characterize verbs with a non-causative and non-agentive interpretation in Latin (Xu, Aronoff and Anshen 2007) and modern Greek (Zombolou and Alexiadou 2014). If that conclusion generalized, we could say that a mismatch is there, but morphology still carves at the semantic joints—or at the syntactic joints, if agentivity and causation are properties of syntactic configurations.

Features that have both a semantic and a morphological value provide a second illustration. It is natural to characterize as [past] those verbal tenses which comport a notionally past interpretation (the event denoted by the predicate holds of a time t_1 preceding the utterance time t_0). However, the formal marking that accompanies this interpretation often appears also on forms which are not notionally past, like in the counterfactual *if I was*; in addition, it can characterize whole paradigms which, as a matter of grammar, do not express a past interpretation, like the French conditional *nous aur-ions* ‘we would have’ (‘future’ stem with the ending of the imperfect), or the Irish conditional *d’ól-f-ainn* ‘I would drink’ (where *-f-* also appears in the future, *d-* also appears in the preterite and past habitual, and the ending is the same as in the past habitual; see Acquaviva 2014b). This very common scenario would seem to prove that what is ‘past’ for morphology is not ‘past’ for semantics, although the two are related. But there is an alternative, according to which the semantic value of ‘past’ as ‘before speech time’ is not primitive, but arises in a determinate context from a more abstract function, which also underlies the counterfactual reading. This is the approach of Iatridou (2000), who views formally past morphology as expressing topological non-coincidence. This derives the past reading when applied to a temporal argument, and the counterfactual when applied to a possible world argument. In short, some alignment between morphological and semantic categories can be preserved, at the cost of complicating the semantic and/or syntactic analysis. The crucial question is whether such complications are independently necessary.

Other cases provide stronger evidence for the lack of isomorphism between morphological and semantic categories. Maiden (2004) identified a cluster of verbal paradigms in Hiberno-Romance (PYTA or *Perfecto y tiempos afines*, preterite and past subjunctive in Spanish) which share the same stem allomorphy and behave as a unified class in diachrony. Although semantic perfectivity unified the Latin antecedents of these paradigms, Maiden showed that synchronically they cannot form a natural class either phonologically or semantically. In particular, the preterite and the past subjunctive do not share an aspectual value, and their past characterization does not single them out but extends to other tenses (see O’Neill 2014 for a clear summary in a broader empirical and theoretical context). Thus, the PYTA tenses clearly exemplify Aronoff’s (1994) notion of morphomic function, mapping to a single form (or set of forms) a heterogeneous set

of paradigmatic cells. Insofar as the features of these cells do not define a natural class, what is one for morphology definitely cannot be one for semantics.

Similar considerations arise from a different kind of misalignment, where what does not correspond to a unitary semantic or syntactic category is not a set of paradigmatic cells, but a set of word-form realizations. Aronoff's (1994) best-known example is the Latin stem which is systematically chosen as stem allomorph in the supine, past participle, and future participle of a verb's inflectional paradigm and in desiderative, iterative, and agentive derivations; another is the English "past participle" form, which appears in passive and analytic perfect forms of the verb. In this case, the misalignment rests on the claim that the various functions do not share a syntactic configuration or a semantic content; one could claim that the inflectional and derivational uses of a stem all involve an abstract "eventive" syntactic configuration (Remberger 2012). Alternatively, the stem that Aronoff views as a function mapping irreducibly different semantic and syntactic inputs into one form may be analysed as an extended allomorph of a root, where the augment is compatible with different syntactic environments. Soare (2007) explored this solution for the Romanian supine and past participle (an instantiation of the widespread situation in which "verbal nouns" are one morphological category but appear in heterogeneous functions). Still, in such an item-and-arrangement reinterpretation the extra augment should have some distinctive value, no matter how impoverished.

Before leaving the topic of how morphologically identified features relate to semantically identified properties, we should mention that the relation may involve a third type of feature, identified on a syntactic basis. If syntax handles phenomena of agreement and concord, then the values of categories like gender/noun class, number, case, person, tense, must be visible for syntactic operations. Other types of semantic information must be syntactically represented because they affect word order, like the "negative" *no enemy* triggers subject-auxiliary inversion in *with no enemy could I speak so frankly* (but not in *with no enemy, Jim felt safe*). Here, however, what counts as negative for syntactic purposes are not the morphologically similar n-words *no one*, *nowhere*, *no N* and the like, but the whole class of downward-entailing quantifiers, including *few N* (compare *with few enemies could I speak so frankly*). In general, the extent to which syntactic features are isomorphic to morphological and semantic ones depends in part on specific analytical choices (for instance, whether syntactic and morphological case should be distinguished), and in part also on the architecture of grammar. Purely morphological information, apparently inert for syntax, can in principle be related to semantics only in models where semantic interpretation has access to words (or morphemes) that are morphologically fully formed; and in a non-realizational model where syntax operates on words that are the output of a map between morphological form and semantic

content, one would not expect much overlap between the features relevant for the morphology that creates lexemes and the features that drive syntactic computations on these lexemes.

3.3 Morphology and the Pieces of Semantics

An assessment of the homology between word structure and semantics depends not only on the degree of lexicalisation and the relative independence between formal and interpretive categories, but also from the semantic representation itself. The various existing approaches to lexical semantics have different implications about the relation with morphological structure, some of which were reviewed in Section 1. Here we address specifically the existence and representation of semantic building blocks.

A key question is whether such constituent parts exist. The very concept of word-internal non-compositionality would suggest the contrary, to the extent that the lexicalized, entity-denoting reading of *transmission* or *government* differs from the reading as action nominalization because it is semantically simplex, rather than formed on an eventive predicate. But these two expressions, for a speaker of English, could not mean just anything: their form, and specifically their suffixes, signal that these are nouns and potentially countable, which restricts considerably the range of interpretations. Generalizing from this elementary example, we should distinguish the overall conceptual content of a lexical word from linguistically constructed meaning (the latter approaches the notion of *Wortbildungsbedeutung*; see Rainer et al. 2014: 7). The distinction is anything but clear-cut, but it helps distinguish two dimensions of lexical content which seems to justify different and possibly diverging conclusions about the atomicity of lexical concepts; see Schwarze and Schepping (1995) for an implementation in terms of two-level lexical semantics, and Acquaviva (2014a), Acquaviva and Panagiotidis (2012) for an attempt to reconcile Fodor's (1998) thesis that lexical concepts lack internal structure with the linguistic evidence for lexical decomposition. The distinction between grammatically encoded meaning and conceptual content is related, if not identical, to the often-made distinction between those aspects of lexical meaning which derive from grammatical properties (syntactic, as in Borer 2005a, 2005b, or lexical, as in Levin and Rappaport Hovav 1995, 2005 or Lieber 2004), and so define whole classes of lexical items like verbs of directed motion or of externally caused change of state, and those aspects which idiosyncratically characterize single lexical items.

Opinions differ on whether the hypothesized division between lexical-idiosyncratic and grammatical information has a base in morphology. Lieber (2004) models this opposition in very clear terms, with a "skeleton" which encodes semantic features and argument-structural information, and a "body" for encyclopaedic content, not regimented in linguistic

categories (and far more variable across speakers). Derivational affixes, she notes (p. 10), “will often have little or nothing in the way of semantic bodies,” but the presence of this type of content distinguishes the prefix *over-* from simple derivational affixes (p. 127). In *Distributed Morphology*, all listed readings appear in the list called “Encyclopedia,” and proposals like that of Arad (2003a, 2003b) unambiguously associate them to morphological roots (this is not the position of Harley 2014). Levin and Rappaport Hovav (1995, 2005) also associate the idiosyncratic information with the root, but this is defined in *semantic* terms as a primitive in the lexical semantic template. The corresponding form is called “name” in Levin and Rappaport Hovav (1995: 28), and Levin (2009: 2) explicitly states that her notion of root is “not to be confused with the notion of root used in morphology.”

Overall, it seems prudent to envisage a rather indirect map between morphology and any hypothesized “piece” of the conceptual content other than those relevant for grammatical purposes. Crosslinguistic considerations become relevant in this case. Ouhalla (2012: 56) explains that Berber lacks distinct lexical expressions meaning “come” and “go,” and resorts instead to a single root which expresses motion, and to which clitics can attach to signal movement away from and toward the speaker:

- (1) a. t-uggur=n tfrucht
 F-move=THITHER girl
 ‘the girl goes’
 b. t-uggur=d tfrucht
 F-move-HITHER girl
 ‘the girl goes’

As the example in (2) shows, the directional clitic glossed ‘thither’ can attach to a host different from the verb:

- (2) ur=n xe-s t-ggur tfruxt
 NEG=thither on-it F-move girl
 ‘the girl did not go on it’

Let us assume that the English and Berber verbs here named *come* and *go* are in fact semantically identical. This is not an innocent assumption, but it is at least implied by the use of these translations. A distinct, even less innocent assumption to make explicit is that a language-invariant semantic vocabulary *can* be defined, underlying crosslinguistic variation at least for a few basic notions that seem to be definable independently of the cultural and encyclopedic context. Granting these bases for typological comparison of lexicalization patterns, Berber would then seem to overtly morphologize as distinct morphemes the semantic atoms which also underlie the concepts *COME* and *GO* in English. If that is the case, the morphologically unanalyzable roots *come* and *go* are not semantically atomic in English

(and in countless other languages). If instead *come/go* are not semantically equivalent to *uggur=d/uggur=n*, then we should conclude that Berber cannot strictly speaking express the concept COME and GO, but only MOVE, HITHER, THITHER, and their combinations, which by hypothesis are not equivalent to COME or GO. It seems unlikely, however, that a language should lack a single discrete lexical concept just because it lexicalizes it by means of a morphologically non-atomic word. Mandarin Chinese expresses what English translates as ‘nurse’ and ‘television’ by the compounds *hùshì* and *diànshì*, which Packard (2000: 84) glosses as ‘protect-person’ (a verb root plus a noun root) and ‘electricity-see’ (a noun word plus a verb root); but it is unlikely that Chinese speakers should lack the concepts NURSE and TELEVISION. If anything, one might question what evidence is there for a concept COME as opposed to COME-HITHER, apart from the existence of the word *come* in languages like English. As can be seen, linguistic questions quickly turn into psychological and philosophical ones about semantic primitives and the relation between lexical items and lexical concepts (see Laurence and Margolis 1999 for a survey).

4. Morphology, Semantics, and Crosslinguistic Invariance

Morphology is probably the most variable aspect of language; semantics probably the least variable. The relation between the two, therefore, raises non-trivial questions about the universality of morphological categories. We will consider them under three headings: the possibility of a universal semantic vocabulary underlying morphological variation; the universality of major lexical categories; and the possible link between major typological differences in morphology and semantic parametrization.

4.1 Morphological Variation and Universal Semantic Primitives

Some morphological models explicitly attempt to provide a language-invariant semantic vocabulary to cover the typological space of what can be a lexical word in natural language: this is the case for all compositional approaches to lexical semantics, especially those of Jackendoff (1990, 2002, 2010), with functions corresponding to ontological categories (THING, PLACE, PATH) or primitive predicates (GO, CAUSE), and Levin and Rappaport Hovav (1995, 2005), with primitive predicates like CAUSE, BECOME, MANNER. Among the many more proposals which could be listed, those which most directly bear on the semantics-morphology connection set out to individuate not just such basic elements, but also the principles by which they find a morphological realization. These are above all the “lexicalization patterns” which constitute the object of a vigorous and influential tradition of studies, starting with Talmy (1985) and developed into a full-fledged lexicalist analytical framework with Rappaport Hovav

and Levin (1998) and Levin and Rappaport Hovav (1995, 2005). Other contributions target more specifically morphologically constructed semantic content: firstly Beard's (1995) inventory of L(exical)-functions and I(nflectional)-functions, which constitute the semantic side of morphology in his system; then, limited to word formation and to English data, Lieber (2004), who sets the ambitious goal of deriving the semantic properties of morphologically complex words from a very short list of basic semantic features and from a word-internal semantic combinatorial mechanism. In different ways, Hale and Keyser (2002), Borer (2005a, 2005b, 2013), and most work in Distributed Morphology (see for instance Embick 2004; Folli and Harley 2007) derive the properties of word-forms in context from the interpretation associated with syntactic structures and with the operations on them. Phenomena like the inchoative-causative alternation, the connection between argument structure and aspect, the impossibility of a lexicalization pattern like **to salt the box* as a synonym of the well-formed *to box the salt*, do not descend from properties of words but of the syntactic structures which embed and define the content of these words.

The features encoding grammatical information can also provide indications, more or less explicit, about the basic semantic categories assumed by theories of morphology. In a fully articulated paradigm-based model like Stump (2001), features represent the morphosyntactic properties to which a lexeme is associated by a paradigm function. What is basic here is the notion of paradigm function and the set of morphosyntactic properties available in one language. Interestingly, Stump explicitly argues (2001: 252–60) that paradigm functions also model the relation between a lexical base and its derivationally related forms. In such derivational paradigms, a base is mapped to a property set made up not of featurally expressed grammatical properties, but of “syntacticosemantic properties” like “privative adjective” (as in *hopeless*) or “personal noun” (as in *linguist*), which label the semantic functions associated with derivations. It is natural to view the sum total of available properties, grammatical or “syntacticosemantic,” as the total semantic range available to morphological operations, presumably universal even though no principles suggest how this space may be constrained. Formal features encode these properties in privative or binary form, like [plural] or [+plural] respectively, or as feature-attribute structures like [number: plural]. Organizational principles like feature geometries or feature ranking (Stump 2001: 239–41) are motivated by properties of exponence, like syncretism, and only secondarily by the features' interpretive value. In very different ways, Lieber (2004) and Harbour (2011a, 2011b, 2014) have defended an alternative view, in which features are not just ways to formally describe the grammatical or syntacticosemantic properties organized in a word's paradigm, but constitute these properties themselves by their semantic content and the manner of their combination; Lieber (2004: 22–35) expressly says that they are semantic atoms. For her, the combinations of such features define the ontological classes on which

semantic interpretation is based across lexical categories. For example, the two values of $[\pm\text{dynamic}]$ distinguish states from eventualities; the feature is absent from expressions denoting entities rather than eventualities, and it is present in the privative form $[\text{dynamic}]$ on expressions denoting processual or relational entities, like *author*, *parent*, *war*. Harbour's proposal focuses more on formalizing the content of grammatically relevant features, rather than on modelling basic lexical semantic categories. However, a key aspect of his approach is that features so defined find application beyond the morphosyntactic categories for which they were originally devised. The most striking example is the feature $[\pm\text{augmented}]$, which when taken in conjunction with $[\pm\text{singular}]$ models clusivity contrasts (first-person inclusive or exclusive) by opposing minimal and non-minimal elements falling under a predicate. As Harbour shows, when the content of $[\pm\text{augmented}]$ is made precise in algebraic terms, it turns out to be equivalent to the property of strict cumulativity (the property of being a predicate P such that the sum of two distinct elements in the denotation of P is still P), which underlies formal semantic accounts of aspect and aktionsart. Features, in this view, are not the organizational principles of paradigms, but substantive semantic primitives reflected in morphological oppositions, and their inventory amounts to a hypothesis about the semantic variation space of morphological systems in natural language. For this approach, in Noyer's words (1997: 154–5), "person-number *categories* are not primitives, but rather the features which define the categories are primitives. . . . Each speaker of a language constructs a system of categories composed from the features afforded by Universal Grammar."

4.2 Lexical Categories as Morphological Universals

The question of the universality of the major lexical categories (noun, verb, adjective) has several facets. It concerns morphology, first, insofar as the criteria for deciding of the category of a lexical item in a given language are usually morphological or morphosyntactic, usually revolving around the possibility of acting in a certain syntactic capacity without the support of specialized morphemes: the possibility to support tense, or to act as a predicate, an argument, or a complement to a determiner, or of being incorporated into a clausal predicate, or to head relative clauses (see Baker 2003). As an example of morphological evidence, consider one of the arguments presented by Chung (2012: 43) that a class of "multifunctional" words in Chamorro are primarily nouns. Even though words like *adåba* can be indifferently used as instrument nouns ('padlock') or instrument verbs ('to padlock'), they display a restriction typical of converted nouns: an adjunct cannot contradict the content, just like English familiar cases like *to box in a box / # in a bag*.

- (3) Hu adåba i aparadot ni adåba / ni ?# tali
 AGR padlock the cabinet OBL padlock / OBL rope

Let us suppose that the distribution of morphological patterns indeed shows that all languages partition their content words into lexical classes. An important question arises, then, about the relation of such morphological patterns and semantics: do the morphologically identified lexical classes also define a universal set of basic semantic categories? Koontz-Garboden (2012b) sharpens the question, and asks more precisely if types of meaning, definable language-independently in model-theoretic terms, should necessarily map to lexical classes; or, in his words, whether “words in different languages with the same denotations belong to the same lexical category,” and whether “there [are] denotations that must be those of words of a particular lexical category.” As Koontz-Garboden himself notes, such questions assume that we can identify a constant denotation by reference to a language-independent model (in the technical sense), which is a substantive assumption. This re-connects the issue of the universality of lexical classes and of basic semantic categories to the questions considered above in Section 1 about the language-external and language-independent character of lexical meaning.

4.3 Semantics, Morphological Typology, and Parametrization

For the most part, the semantic impact of differences between the morphological type of languages concerns compositionality and the status of words as semantic domains, as distinct from structures assembled by syntax; this topic is treated in Chapter 25. We can briefly note here that, contrary to common assumptions, some degree of non-compositionality and opacity in the interpretation of complex words seems to be attested in creole languages even at a very early stage of their development (see Braun and Plag (2003) on Early Sranan), a circumstance which strongly points to lexical semantic opacity as a constitutive aspect of linguistic competence and not as a contingent historical residue.

As regards more generally the relation between morphological typology and semantics, languages whose morphology can recapitulate productive syntactic structures into extremely complex word-forms, as in the polysynthetic or strongly agglutinating type, clearly possess a greater degree of word-internal semantic transparency than those approximating the fusional or isolating type, where a single word could never express the content of the Turkish *Avropa-lı-laş-tır-il-a-mı-yacak-lar-dan-sın-ız* ‘you are among those who will not be able to be caused to become like Europeans’ (Beard 1995: 56). In addition to the relative degree of freedom in combining meaningful affixes and stems, what affects semantic transparency is also the mutual ordering of morphemes, in particular when morphology enforces language-specific sequences between affixes or classes of affixes. Normally, the ordering of affixes reflects scopal relations, so that in the Turkish example just cited the negation *-mı-* is more peripheral than the potential morpheme *-a-*, the passive *-ıl-*, and the causative *-tır-*, reflecting

the semantic scopal relation [NEG [POTENTIAL [PASSIVE [CAUSATIVE X]]]] (where X further comprises the stem meaning ‘Europe,’ turned into adjective by *-li-* and verbalized by *-las-*):

- (4) Avrupa-li-laş-tır-il-a-mı-
 [[[[[[[Europe] ADJ] VERB] CAUS] PASS] POT] NEG] -

The much-discussed question of whether the alignment between semantic scope and relative order of affixes is a fact about morphology rooted in cognitive principles (Bybee 1985) or whether it reflects the order of syntactic composition (Baker 1988) concerns mostly the relation of morphology with syntax (Chapter 10).

In this connection, we should note that a systematic violation of semantic transparency can arise to the extent that the morphology of a language distributes the affixes into distinct positional classes, giving rise to what is known as a templatic pattern, where each position can host semantically diverse elements and semantically homogeneous elements may appear in different slots. Because languages of this type impose a fixed order on the co-occurrence of (some) affixes, systematic form-meaning mismatches can arise when two affixes A and B can be interpreted either as A modifying (“taking scope over”) B or B modifying A, even though the single fixed order mandated by morphology is constantly AB. Hyman (2003: 248) exemplifies this state of affairs with the Bantu language Chichewa. Here the applicative *-il-* (a morpheme which adds one argument to the verb’s valence, here interpreted as an instrument) co-occurs with the causative *-its-*, either with the scopal order ‘cause to [PREDICATE with INSTRUMENT],’ as in (5a), or ‘with INSTRUMENT [cause to PREDICATE],’ as in (5b) (the *-a* at the end of the complex verb form is a stem-final element):

- (5) a. alenjé a-ku-tákás-its-il-a mkází mthíko
 hunters 3PL-PROG-stir-CAUS-APPL-a woman spoon
 ‘The hunters are making the woman stir with a spoon.’
 ‘cause [woman stir with-spoon]’
 b. alenjé a-ku-líl-its-il-a mwaná ndodo
 hunters 3PL-PROG-cry-CAUS-APPL-a child sticks
 ‘The hunters are making the child cry with sticks.’
 ‘cause with-sticks [child cry]’

Both interpretations can only be conveyed by the fixed order *its-il*, where the causative morpheme appears inside the applicative. Revealingly, this remains true even in cases where the applicative morpheme gives rise to a lexicalized reading of the verbal predicate: from the verbal stem *uk-* ‘to wake up,’ Chichewa can use an applicative morpheme to derive *uk-il-* which means ‘to rebel against’; but even in this case, if this lexicalized complex is causativized, the linear order of morphemes must be *-its-il*, as in (5), even if this means that the causative morpheme must be interfixed

between stem and applicative: *uk-its-il* ‘to cause to rebel against’ is reported as the only acceptable form with this reading, while **uk-il-its* is unacceptable (Hyman 2003: 264).

Evidently, the issue of templatic morphology is a complex one, where it is important to frame questions about morphology-internal constraints in the context of explicit assumptions about how word-internal structure relates to semantic structure. If affixation is the spell-out of structured representations assembled by syntax, and it is this syntactic structure which defines semantic interpretation, then morphology-semantics mismatches are (or can be approached as) morphology-syntax mismatches. The real question, then, becomes whether affix ordering, as the reflex of syntactic operations, can reliably be predicted on the basis of independently justified syntactic evidence (Hyman (2003: 260) points to a specific difficulty for an analysis of the Chichewa facts based on Baker’s (1985) Mirror Principle). Opinions differ on whether templatic morphology can be reduced to semantic or syntactic factors: see Inkelas (1993), Rice (2000), Stump (2001: 138–68), Manova and Aronoff (2010), and Nordlinger (2010). However, this is only one facet of the issue. Other important questions concern crosslinguistic variation, the precise determination of the semantic value of affixes, possible cognitive or pragmatic bases for the attested orders, and indeed the very notion of misalignment between affix order and semantic interpretation, concerning which Gerner (2014) has recently argued for a distinction between the notions of “scopal” and “compositional” interpretation.

In addition to these differences in the makeup of morphological systems, typological variation also concerns deeper interpretive properties (but see Rijkhoff (2009) for a critical assessment of the applicability of universal semantic categories). In particular, the crosslinguistic variability in the expression of individuation on nouns has been a concern of formal semantic approaches since Link (1998) and especially Ojeda (1993, 1998). Later work developing from this tradition has specifically focused on the possible semantic values of nouns in relation to their morphology and to the morphosyntax of number across languages. A familiar typological divide opposes languages with grammatical number to languages where quantity and countability are expressed by means of classifier structures, like Mandarin Chinese:

- (6) a. *sān* *ge* *nánhái*
 three CLF boy
 ‘three boys’
- b. *jǐ* *běnn* *shū*
 a-few CLF book
 ‘a few books’

Chierchia (1998, 2010) hypothesizes that this divide does not just concern the syntax and morphology of number, but reveals a deeper semantic

parametrization in the interpretation of nouns. Languages with grammatical number interpret nouns as properties (type $\langle e, t \rangle$ in formal model-theoretic terms); they require a suitable syntactic context (the Determiner Phrase) to appear as arguments of a predicate, and they can be directly modified by numerals, assuming these to be functions from properties. For languages of this type, numerical modification and pluralization require the identification of atoms in a property's denotation; this gives rise to the divide between countable and non-countable nouns. In languages like Chinese, according to Chierchia, nouns are instead intrinsically interpreted not as properties, but as individual kinds (type e): they can appear as arguments without syntactic mediation, but need a grammatical device (classifiers) to turn them into properties and make numerical modification possible. No count-mass contrast is predicted to emerge in this case, at least not in the same morphosyntactic ways that that oppose mass and count nouns for languages where nouns denote properties. This analysis therefore links morphological aspects of typology, such as number and the expression of countability, to a classification of possible language types based on a formally precise semantic parametrization.

As Chierchia (2010) makes clear, the opposition between classifier- and number-based languages does not in fact cover the whole typological spectrum, because there are languages where a classifier system coexists with number (like Indonesian; see Chung (2000) and Dalrymple and Mofu (2012)), and others that lack both, at least as obligatory categories (like the Athabaskan language Dëne Sųłıne; see Wilhelm (2008)). Still, the hypothesis of a semantic parametrization responsible for a host of grammatical and morphological oppositions has proved very productive, if only by inspiring much comparative work on the formal semantic analysis of number systems and countability, which allows typological comparison across very different systems. It has also been productive in inspiring an alternative view, which aims at deriving the same semantic aspects of typological variation from syntactic, structurally defined parameters concerning the properties of nouns, determiners, and abstract grammatical heads inside the Determiner Phrase (Longobardi 2001; Déprez 2005). Within the formal syntactic and semantic tradition, there is in fact a body of work on number and countability which views syntax as the linchpin between morphological and semantic properties (Acquaviva (2008), Alexiadou (2011), and the essays in Massam (2012); these works can be contrasted, and integrated, with “cognitive-functional” approaches to the semantic parametrization of NPs such as Rijkhoff (2002)). For morphological typology, in particular, Wiltschko's (2008, 2012) analysis of Halkomelem Salish has developed a predictive account of crosslinguistic variability in noun countability and in the use of pluralization for inflection and derivation, based on whether an abstract plural morpheme is syntactically a modifier of a lexical root or a grammatical head.

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Affix Ordering: Motivation and Interpretation

Marianne Mithun

A focus of much work on morphology has been discovering principles governing morpheme order. One issue is just what is ordered: substantive pieces of language or the processes that build morphologically complex words. Another is whether the kinds of principles underlying morphological structure are the same as those governing other domains of structure. Still another is whether one set of principles can account for all types of morphological systems and all parts of them. If our goal is to explain the sometimes seemingly random arrays of patterns that occur, it is important to consider not only their current states, but also the processes by which structure is built up and shaped over time.

1 The Basic Nature of Morphemes and Morpheme Orders

Morphemes have traditionally been thought of as the smallest meaningful pieces of words: a noun like *hand-s* is said to have two. But what about a noun like *feet*? Should we be talking about the ordering of pieces in a word, or the ordering of the processes by which it is assembled? Types of process-based models are described in the work of Stump (1991, 1992, 1993, 1997, 2001, 2006). In some process models, words are built up much like sentences, by means of rewrite rules which create hierarchical structures. Roots, stems, and affixes, all listed in the lexicon, are then inserted into the terminal nodes. In others, inflected words consist of a root and a set of morphosyntactic features: <Buch-, {GENITIVE, PLURAL}>. Roots are listed in the lexicon but affixes are not; they emerge from sequences of inflectional operations. Both pieces and processes come into play in the search for explanations of the orders which occur.

Two basic types of morpheme order are often distinguished: position-class or templatic systems on the one hand, and layered or hierarchical

systems on the other. Templates map out the linear order of morphemes in the maximal word with a series of positions or slots and specification of the morphemes which can occur in each. Figure 7.1 shows a verb template for Murrinh-Patha, a non-Pama-Nyungan language of the Daly River region in Australia described by Nordlinger (2010). Not all positions in a template need be filled in a particular word.

CLASSIFIER.STEM	SBJ.NUM	REFLEXIVE	BODY.PART	VERB STEM	TENSE	ADV	SBJ.NUM	ADV
+SBJ+TENSE	OBJ	RECIPROCAL	APPL				OBJ.NUM	

Figure 7.1. Murrinh-Patha verbal template

Source: Nordlinger (2010: 326)

Templates may be more or less specific. A general verb template for languages of the Iroquoian family of eastern North America is in Figure 7.2.

PREPRONOMINAL	PRONOMINAL	MIDDLE	NOUN	VERB	DERIVATIONAL	ASPECT	FINAL
PREFIXES	PREFIXES	REFLEXIVE	STEM	ROOT	SUFFIXES	SUFFIXES	SUFFIXES

Figure 7.2. General Iroquoian verb template

A more specific template for just the prefixes in one Iroquoian language is in Figure 7.3. It specifies not only relative order but also mutual exclusivity. It indicates, for example, that the contrastive always precedes the translocative if the two co-occur, and also that the contrastive never co-occurs with the coincident, the partitive, or the negative.

CONTRASTIVE	TRANSLOCATIVE	FACTUAL	DUPLICATIVE	FUTURE	CISLOCATIVE	PRO	MIDDLE
COINCIDENT					OPTATIVE	REPETITIVE	PREFIXES REFLEXIVE
PARTITIVE							
NEGATIVE							

Figure 7.3. Mohawk Verb prefix template

In layered systems, words are described as built up affix by affix, each process creating a new base that can serve as input for another process. The result is a hierarchical structure. Layered morphology is illustrated in Central Alaskan Yup'ik Eskimo (Eskimo-Aleut family) below. A root may be inflected directly to form a word as in (1a), or it may serve as the input to processes which create new stems which can then be inflected.

- (1) Yup'ik layered morphology (George Charles, speaker p.c.)
- a. *Quyaunga*
 quya-u-nga
 thankful-intr.ind-1sg
 'I am thankful.'

- b. *Quyayugtua*
 quya-yug-tu-a
 thankful-want-INTR.IND-1 SG
 'I want to be thankful.'
- c. *Quyayuumiitua*
 quya-yuumir-ite-u-a
 thankful-yearn-NEG-INTR.IND-1 SG
 'I don't want to be thankful.'
- d. *Quyayuumiitellruunga*
 quya-yuumi-ite-llru-u-nga
 thankful-yearn-neg-past-intr.ind-1sg
 'I didn't want to be thankful.'
- e. *Quyayuumiitellruyugnarqua*
 quya-yuumi-ite-llru-yugnarqe-u-a
 thankful-yearn-NEG-PAST-probably-INTR.IND-1 SG
 'I guess I didn't want to be thankful.'

In hierarchical systems, affix orders can vary, with order reflecting scope. Each suffix in (2) has scope over everything to its left.

- (2) Yup'ik scope alternations (George Charles, speaker p.c.)
 - a. *Taiciqsugnarqnillruuq*
 tai-ciq-yugnarqe-ni-llru-u-q
 come-FUT-probably-claim-PAST-INTR.IND-3 SG
 'He said he would probably come.'
 - b. *Taiciqnillruyugnarquq*
 tai-ciq-ni-llru-yugnarqe-u-q
 come-FUT-claim-PAST-probably-INTR.IND-3 SG
 'He probably said he would come.'

The same suffix can occur more than once, like the past *-llru-* in (3).

- (3) Yup'ik multiple occurrences (George Charles, speaker p.c.)
Taillrunillruyunarquq.
 tai-llru-ni-llru-yugnarqe-u-q
 come-PAST-claim-PAST-probably-INTR.IND-3 SG
 'He probably said he had come.'

There is an extensive literature on templatic and layered systems. Some key features distinguishing the two are presented in Simpson and Withgott (1986). Other discussions include Muysken (1986, 1988), Spencer (1991, 2003, 2006), Stump (1991, 1992, 1993, 1997, 1998, 2001, 2006), Inkelas (1993), Mithun (1999, 2000, 2011), McDonough (2000a), Rice (2000), Hyman (2003), Good (2005, 2011), Korotkova and Lander (2010), Manova and Aronoff (2010), Nordlinger (2010), and Manova (2011a, 2011b). Commonly cited characteristics are in (4).

(4) Templatic systems

a. Zeroes

The absence of an affix in an obligatory slot may be meaningful by its contrast with other possibilities, such as an unmarked third-person subject in contrast with a first- or second-person affix.

b. Headedness

Templates specify no headedness or constituent structure. Layering produces both.

c. Adjacency and look-ahead

The choice and form of a morpheme may be conditioned by a non-adjacent morpheme. In layered systems, affixation can be sensitive only to the affix most recently attached.

d. The relative order of morphemes is invariant. In layered systems, alternative orders may be available, usually reflecting differences in scope, as in (2).

e. A given affix may occur only once per word. In layered systems, the same affix may be introduced repeatedly, as in (3).

Templatic and hierarchical patterns often coexist within a language (Hyman (2003) on Bantu; Gerdts and Kiyosawa (2007) on Salishan; Beck (2008) on Totonac; Korotkova and Lander (2010) on Adyghe; Manova (2010a) on Bulgarian). In Eskimo-Aleut languages, like Yup'ik cited above, the edges of words could be said to be templatic: all nouns and verbs begin with a root and end with an inflectional suffix. Suffixes between the two, however, generally show hierarchical ordering. Stump proposes that inflection is always templatic.

2 Models of Synchronic Morpheme Order

Templates have often been characterized as arbitrary, so more work has focused on hierarchical systems. Models described as stratal were introduced in Siegel (1974, 1977), Allen (1978), Kiparsky (1982), Selkirk (1982), Mohanan (1986), Giegerich (1999), and others. (Overviews are in Spencer (1991), Hay and Plag (2004), and Manova and Aronoff (2010).) Their point of departure, which became a cornerstone of Lexical Phonology and Morphology, was restrictions on combinability of English affixes. Siegel postulated that the affixes belong to different lexical strata, distinguished by their phonological effects and relative order.

(5) Lexical strata (Siegel 1974)

Class I suffixes: *+ion, +ity, +y, +al, +ic, +ate, +ous, +ive, +able, +ize*

Class I prefixes: *re+, con+, de+, sub+, pre+, in+, en+, be+*

Class II suffixes: *#ness, #less, #hood, #ful, #ly, #y, #like, #ist, #able, #ize*

Class II prefixes: *re#, sub#, un#, non#, de#, semi#, anti#*

Class I affixes (marked with +) are associated with phonological effects such as stress shift, resyllabification, and ablaut: *próduct* – *prodúctive* – *productivity*. Class II affixes (marked with #) are not: *prodúctive* – *productiveness*. Class I affixes appear closer to the root: *natur+al#ness* is well formed, but **hope#ful+ity* is not. Affix shape and order are determined by the sequencing of operations: Class I affixes are attached first, then phonological rules such as stress shift are applied, then Class II suffixes are applied. A third layer for compounding and a few other markers was added by Allen. Regular inflection is attached still later. The sequence of operations produces hierarchical structures like those in syntactic models. Not all morpheme order is accounted for in these models, however. There is little discussion of prefixing versus suffixing, affixes are not ordered within levels, and some affixes appear in both groups, because they show different phonological effects in different words: *cómparable* versus *compáritable*. Class I affixes are often of foreign origin [+latinate], attach to bound roots, are less productive, and are less transparent phonologically and semantically than Class II affixes.

Other work has pointed to phonological, morphological, syntactic, and semantic selectional restrictions governing possible suffix combinations (Fabb 1988; Plag 1996, 1999, 2002; Manova 2010a, 2011a, 2011b, 2014). The verb-forming suffix *-en*, for example, as in *blacken*, attaches only to monosyllables that end in an obstruent (a phonological restriction). It will thus never occur outside of a suffix that creates a new syllable, such as adjective-forming *-al*, *-ive* or *-ous*. The suffix *-ize*, which occurs only on nouns and adjectives that end in an unstressed syllable, selects only *-ation* as a nominalizing suffix, as in *colonization* (a morphological restriction). Fabb also observed that affixes vary in the complexity of the base they can attach to. Some, like *-age*, *-al*, *-ant*, *-ify*, *-ism*, *-ist*, and *-ment*, cannot normally follow a base that already contains a suffix. Plag noted that the verbalizing suffix *-ate* attaches productively only to nouns that refer to chemical substances such as *fluorinate* (syntactic and semantic restrictions), so it will never follow an adjectival or verbal suffix, or an abstract noun-forming suffix such as *-ism*. Selectional restrictions would account for ordering within strata, though opinions vary on whether they are listed in the lexicon with bases or affixes. Fabb found that of 43 English suffixes, only 50 combinations are attested, though a stratal account alone would allow 459 out of 1,849 possible pairings. Selectional restrictions also account for attested combinations ruled out by stratal approaches, such as *#ist+ic*, where Class II suffixes precede Class I suffixes. Investigating Bulgarian, Russian, and Polish, Manova postulates that the Slavic word has three domains: two derivational, non-evaluative and evaluative, and one inflectional. Each domain can accommodate more than one suffix and exhibits suffix order of its own. Both derivational domains show mirror-image ordering (XY and YX), but those in the non-evaluative domain may apply recursively only on non-adjacent cycles (YXX), while those in the evaluative domain, such as diminutives, may apply recursively only on adjacent cycles (XXX).

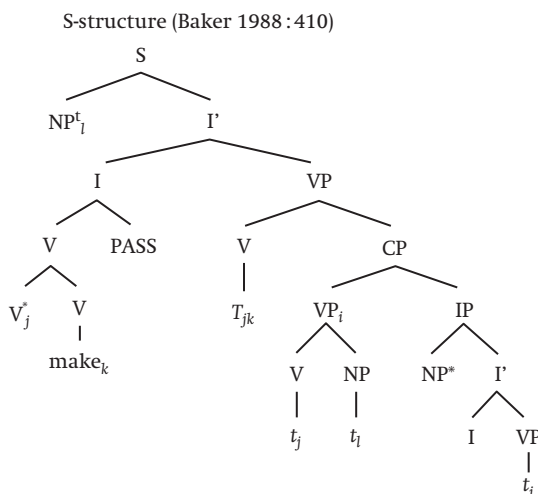
All three domains have closing suffixes, which close the word to further suffixes of the same type.

Another set of approaches has integrated morphological models largely or wholly into generative syntactic models of various periods. Working within a Principles and Parameters framework, Baker (1985, 1988) proposed what he termed the Mirror Principle: ‘Morphological derivations must directly reflect syntactic derivations (and vice-versa)’ (1985: 375). His point of departure was the relative order of affixes affecting argument structure: passives, causatives, reflexives, reciprocals, and applicatives. In his model, affixation is the result of head movement of a verb into the governing verb; the order of affixes matches the order of syntactic processes in the derivation. He provides the Chichewa example in (6) with its structure in (7).

- (6) Chichewa passive of causative (Baker 1988: 411)
- | | | | | | |
|----------|----------------------------|-----|--------|-----|---------|
| Ana | a-na-meny-ets-edw-a | kwa | buluzi | ndi | anyani |
| children | SBJ-PAST-hit-CAUS-PASS-ASP | to | lizard | by | baboons |

‘The children were made to be hit by the lizard by the baboons.’

- (7) S-structure (Baker 1988: 410)



As in Lexical Phonology, phonological rules apply each time an affix is added. Baker notes that it is unclear whether his model could account for templatic and nonconcatenative systems (1985: 401–2).

The identity of morphology and syntax is taken further in the Distributed Morphology model of Halle and Marantz 1993, developed in the context of the Minimalist Program (see Chapter 15). Overviews of the model are in Embick and Noyer (2008) and Siddiqi (2010), and a bibliography of work during the 1990s is in Harley and Noyer (1999). In Distributed Morphology, there is no independent module for word formation: words are assembled by rules of syntax. Successive applications of two operations, Merge and

Move, create hierarchical structures whose terminal nodes are either roots or abstract morphemes. Roots have syntactico-semantic features and phonological features: language-specific combinations of meaning and sound. Abstract morphemes are universal, such as [Past] or [pl]. They have no phonological features. The linear ordering of morphemes and the forms of abstract morphemes are introduced by operations in phonetic form (PF), readjustment rules that produce phonological form. (The derivation of word structure by operations in two places, the syntax and PF, is the basis for the name Distributed Morphology.) A description of complex morphology in a Distributed Morphology framework is Wojdak's (2005) account of suffix order in Nuuchahnulth, a Wakashan language of British Columbia.

Still within the generative tradition, but with a greater focus on semantic scope, is work on Athabaskan languages of western North America by Rice (1993, 1998, 2000). Athabaskan verbs are generally prefixing and can show elaborate morphological structure.

- (8) Navajo verb (Young and Morgan 1987: 281, cited in Rice 2000: 95)
chíí-b-íz-ní-t-táál
 horizontally.outward-3 OBJ-against-QUALIFIER-ASPECT.1SG.SUBJECT-
 VALENCE-kick
 'I kicked him out, threw him out, bounced him.'

Athabaskan languages have traditionally been described with templates (Young and Morgan 1943, 1987; Young, Morgan, and Midgette 1992; Kari 1989, 1992, 1993). They are characterized by zeroes (for third-person subjects and objects), relatively rigid morpheme order, no recursion, discontinuous dependencies between inner and outer morphemes, and interdigitation of derivational and inflectional markers. An account of Athabaskan morpheme order in a Lexical Phonology framework is in Hargus (1988), extended to incorporate Optimality Theory in Hargus and Tuttle (1997) with a series of alignment constraints that order morphemes. McDonough (1990, 2000a, 2000b) proposes an affix-to-base concatenation model along related lines.

Rice (2000) provides an impressive survey of morpheme orders across the languages, showing that most are the same, though order in some prefix pairs varies from one language to the next, and a few vary within languages. She proposes a model in which word formation is syntactic, and morpheme order follows largely from scope, according to the principles below.

- (9) Scope and order (Rice 2000: 78)
- a. Elements in a fixed scopal relationship occur in a fixed order with respect to each other.
 - b. Elements in which the scopal relationship can be reversed occur in variable order, with interpretation related to order.
 - c. Elements that do not enter into a scopal relationship with each other may occur in different orders, both within a particular language and across the family.

Most prefixes have everything to their left within their scope. The stem, however, occurs in the “wrong place” in terms of scope, at the end of the verb, as do the valency prefixes. Rice accounts for their order by first generating them at the beginning of the word, then moving them to the end during the derivation.

The stem raises to the voice/valence markers, and this unit in turn raises to the right edge of the verb phrase. This assumption is required to place the verb and voice/valence markers, a phonological constituent, in the correct position on the surface. (Rice 2000: 171)

3 Processing Accounts

Another line of work on morpheme order explores processing. The models discussed so far are focused on relative order within affix strings. Processing models have investigated both affix/root order and affix order.

3.1 Prefixes versus Suffixes

It has long been noticed that suffixes are more common than prefixes. Sapir famously remarked:

Of the three types of affixing—the use of prefixes, suffixes, and infixes—suffixing is much the commonest. Indeed, it is a fair guess that suffixes do more of the formative work of language than all other methods combined. (Sapir 1921: 67)

Based on a survey of thirty languages, Greenberg proposed three implicational universals which together link word order to prefixing versus suffixing.

(10) Greenberg’s universals (1957, 1963, 1966)

- a. Languages with dominant VSO order are always prepositional. (3)
- b. With overwhelmingly greater than chance frequency, languages with normal SOV order are postpositional. (4)
- c. If a language is exclusively suffixing, it is postpositional; if it is exclusively prefixing, it is prepositional. (27)

Lehmann proposed a more direct connection between verb-initial word order and prefixes on the one hand, and verb-final word order and suffixes on the other.

A number of morphological characteristics have been identified for specific language types. Prominent among these is the placement of affixes, notably

those expressing verbal qualifiers. In VSO languages these precede the central verb; in OV [object-verb] languages, on the other hand, they follow. (Lehmann 1978: 212)

These correlations have sometimes been attributed to general principles across morphology and syntax. Venneman's Natural Serialization Principle (1973, 1974a, 1974b) and Hawkins and Gilligan's Head Ordering Principle (1988) state that the order of modifier and head will be consistent within a language. Views on what constitutes the head of a word vary, but here it is the final derivational affix. Thus root-suffix morpheme order should match OV word order, and prefix-root order should match VO word order. (Work on headedness in morphology around this time includes Williams (1981), Selkirk (1982), Zwicky (1985), Hudson (1987), and Scalise (1988).)

Observing that the correlations were not perfect across their 200-language sample, Hawkins and Gilligan added a set of ordering counter-principles favoring suffixes, most with a few exceptions: noun-case (exceptionless), noun-indefinite.article (exceptionless), noun-nominalizer (3% exceptions), noun-definite.article (8%), noun-plural (2%), verb-mood (2%), verb-tense (1%), verb-aspect (2%), verb-valency (6%), and verb-causative (7%). The counter-principles are explained by processing (Cutler, Hawkins, and Gilligan 1985; Hall 1988; Hawkins and Cutler 1988). The beginning of a word is its most salient part for recognition. Since roots typically carry the most important semantic and syntactic information in the word, it is more efficient for the root to occur first. The advantage is argued to carry over to production (Hawkins and Cutler 1988).

3.2 Order among Affixes

Inflectional affixes often occur outside of derivational affixes, a tendency framed as Greenberg's Universal 28 (1963). Dressler et al. suggest a cognitive advantage.

The peripheral position of inflectional formatives facilitates their processing through the effects of psychological primacy and recency and better outward indexicality towards the other parts of the sentence. Derivational morphemes are also stored more than inflectional ones and thus should be stored together with the stem/root. (Dressler et al. 1987: 7, cited in Haspelmath 1993: 292)

More work has focused on processing complexity. It is well known that high-frequency, morphologically complex forms tend to be processed as wholes and thus tend to diverge both phonologically and semantically from their bases (Bybee 1985, 1995a, 1995b, among many others). Low-frequency forms, which are decomposed, tend to be phonologically and

semantically more transparent. Hay (2001) argues from experimental evidence that it is not the absolute frequency of derived forms that is significant, but rather their frequency relative to their bases. In dual-route processing models, direct-access and decomposed-access routes can compete. The higher relative frequency of *insane* to *sane*, for example, speeds the whole-word route, while the lower frequency of *infirm* relative to *firm* provides an advantage to the decomposed route. The path of access can in turn affect mental representation. Accessing a word via the direct route reinforces its autonomy, increasing its potential for semantic drift, while accessing it via the decomposed route reinforces semantic transparency. Relative frequency also affects perceived complexity and phonology. “Derived forms that are more frequent than their bases are rated less complex than derived forms that are less frequent than their bases, and, in speech production, they contain fewer phonetic cues to juncture” (Hay 2002: 530; Chapter 24 in this volume).

Hay proposes a parsability-based account of affix ordering in English (2002, 2003), which has come to be known as Complexity-Based Ordering. Affixes vary in their boundary strengths, which then can determine ordering, as in stratal models. But here boundary strength is a continuum. Furthermore, a given affix may have different boundary strengths in different words. Two words containing the same affix, like *discernment* and *government*, may show different degrees of decomposability. *Warmth* is more decomposable than *health*, and these two words tend towards opposite extremes of the *-th* distribution. Similarly, *tasteless* has a stronger juncture than *listless*. But no word affixed in *-th* is more decomposable than some word affixed in *-less*. The overall separability of an affix is a cumulative effect of its level of separability in all words.

The problem of restrictions on affix ordering in English can be largely reduced to one of parsability; an affix that can be easily parsed out should not occur inside an affix that cannot. The overall result is that the less phonologically segmentable, the less transparent, the less frequent, and the less productive an affix is, the more resistant it will be to attaching to already affixed words. (Hay 2002: 552)

Hay and Baayen (2002) found similar results in a study of eighty affixes.

Comparing predictions based on selectional restrictions and parsing, Hay and Plag (2004) examined 210 possible pairwise combinations of 15 English suffixes: *-dom*, *-ee*, *-en*, *-er*, *-ess*, *-ful* (adjectival), *-ful* (nominal), *-hood*, *-ish*, *-less*, *-ling*, *-ly*, *-ness*, *-ship*, *-th*.

In most cases selectional restrictions and parsing restrictions coincide. Where selectional restrictions underdetermine possible combinations, complexity-based ordering makes correct predictions. Only easily parsable combinations are possible combinations, and this range of possible combinations is then further curtailed by selectional restrictions. In sum, we

argue that both selectional restrictions and parsing constraints are instrumental in determining possible and impossible suffix combinations. (Hay and Plag 2004: 565)

Plag and Baayen (2009) added another sixteen suffixes and wider internet searches with similar results. Applying Complexity-Based Ordering to Slavic languages, Manova (2010b) found that inflectional suffix combinations are more parsable than derivational ones.

4 Making Sense of the Patterns

Work on modeling synchronic systems has uncovered important aspects of morpheme order. Morpheme order often mirrors word order in sentences, but it is often affected by selectional restrictions. It often reflects scope. Inner affixes tend to be less transparent phonologically and semantically than outer affixes, as well as less productive. It is often noted, however, that the observations are only tendencies or cover only some affixes and cannot account for templatic structures at all. Further progress can be made toward explanation by considering the processes by which morphological structure comes into being and is shaped over time.

4.1 The Diachronic Dimension

A set of processes that create morphological structure have been grouped under the term grammaticalization. Over time, the processing of highly frequent sequences of words can become routinized, so that they are stored and accessed as chunks. Boundaries between the components weaken, and their individual phonological, syntactic, and semantic identities can fade. Some words may lose stress and phonological substance, ultimately fusing with an adjacent word. Erstwhile lexical items can lose syntactic features such as definiteness, number, or case for nouns, and tense, aspect, or modality for verbs. Their meanings may become more general, abstract, and diffuse, shaped by the contexts in which they occur. Such changes are gradual, so markers may be grammaticalized to varying degrees. But it is this routinization that distinguishes morphology.

Grammaticalization processes are responsible for many of the observations incorporated into the models described above. In the most straightforward cases, the relative order of affixes matches the order of their development over time. Affixes closest to the root are among the first to have begun undergoing grammaticalization, so they often show greater reduction in phonological and semantic transparency, more abstract meanings, and less productivity. Morpheme order often matches syntactic order because affixes are often descended from words which fused with their immediate neighbors then stayed in place. The amalgamation of affixes

does not take place all at once, however; usually individual affixes are added at different moments in time, each under different synchronic circumstances.

4.2 Prefixes versus Suffixes Revisited

As noted, prefixes are more common in languages with verb-initial word order, while suffixes predominate in languages with verb-final order. Additionally, suffixes are more common crosslinguistically than prefixes. Bybee, Pagliuca, and Perkins (1990) asked whether the suffixing preference reflects i) a general preference for postposing grammatical material or ii) a greater tendency to fuse elements that are already postposed. Their survey of a set of grammatical markers in a 71-language sample showed both.

- (11) Grammatical markers (Bybee, Pagliuca, and Perkins 1990: 5)

	All	Free	Bound
Preposed	34%	48%	52%
Postposed	66%	20%	80%

Postposed markers outnumbered preposed markers two to one (66%/34%). Postposed fused markers (suffixes) outnumbered postposed free morphemes four to one (80%/20%). Preposed affixes and free morphemes were essentially equivalent (52%/48%).

They found that word order type does matter.

- (12) Word order type (Bybee, Pagliuca, and Perkins 1990)

Verb-initial	Only very slight postposing tendency, fusion
Verb-medial	Slight preposing tendency, but not fusion
Verb-final	Strong tendencies for both postposing and fusion

They concluded that the suffixing preference comes from the prevalence of verb-final over verb-initial languages in the sample: eight were verb-initial, thirty-one verb-medial, and thirty-two verb-final.

Our understanding can be sharpened by considering the histories of individual markers (Mithun 2003). In their 200-language sample, Hawkins and Gilligan (1998) found that causatives usually appeared as suffixes, as predicted by both their Head-Ordering Principle and their root-causative counter-principle. But 9 percent of the languages showed exceptions. Lakhota, with clear basic SOV order, contains a causative suffix, as predicted by both principles.

- (13) Lakhota (Siouan) causative suffix (Stanley Redbird, speaker p.c.)

<i>k^higlé</i>	<i>k^higlé-ye</i>
go.home	go.home-CAUS
'he went home'	'he sent him home'

But it also has a causative prefix *yu-*.

- (14) Lakhota (Siouan) causative prefix (Stanley Redbird, speaker p.c.)

<i>páya</i>	<i>yu-páya</i>
be.drunk	CAUS-be.drunk
‘he’s drunk’	‘he got him drunk’

The coexistence of a causative prefix and causative suffix within the same language defies explanation, until we look at their histories. Siouan languages contain robust inventories of means/manner prefixes (sometimes called “instrumental prefixes”).

- (15) Lakhota (Siouan) means/manner prefixes

<i>yu-</i>	‘involving pulling, hands or hand-held tools’
<i>pa-</i>	‘involving pushing, hands or instrument, by pressure, gravity’
<i>ka-</i>	‘involving sudden impact, striking with a tool, by blows of wind or waves’
<i>ya-</i>	‘involving the mouth, tongue, teeth, lips, beak, biting, talking’
<i>na-</i>	‘involving the foot or leg, kicking, walking’
<i>wa-</i>	‘involving a sawing motion, knife’
<i>na-</i>	‘involving inner force, heat, cold’
<i>wo-</i>	‘involving action from a distance, shooting, blowing, pounding with end of stick’
<i>pu-</i>	‘involving pressure’ (no longer productive)

These prefixes apparently originated as the initial elements of compounds. The prefix *pa-* ‘pushing,’ for example, can be traced to a verb root *pa* ‘push.’ The prefixes are now neither nominal or verbal, having lost their syntactic category status; they simply qualify the verb in a general way (Mithun 2002).

- (16) Lakhota (Siouan) means/manner prefixes (Stanley Redbird, speaker p.c.)

<i>yu-bláya</i>	‘spread out, unfold, make level, as a tablecloth or blanket, turn a page’
<i>pa-bláya</i>	‘spread out, as dough; to make level; to iron (clothes)’
<i>ka-bláya</i>	‘spread out or open, make level by beating’
<i>ya-bláya</i>	‘spread something open and level with the teeth, as a dog’
<i>na-bláya</i>	‘become relaxed, be relieved (as from worry)’
<i>wo-bláya</i>	‘spread out or level by blowing (as with a blow dryer) or punching’

The prefixes are derivational: they create lexical items which may have specialized meanings, and speakers know whether particular combinations exist in the language or not.

In addition to specifying means/manner, the prefixes often contribute a causative meaning. The verb *bláya* on its own describes a state: ‘it is spread out, opened out level or flat, unfolded, relaxed.’ Some of the most common causation involves hands or tools. Not surprisingly, the prefix *yu-* has been extended metaphorically to indicate more abstract causation, as in

yu-áokpani ‘to lessen, take away, subtract, deduct, detract’: ... *na yu-áoptetu šni yo* ‘[So do not add anything to this ceremony] and do not detract anything from it’ (*áoptetu* ‘be less, smaller, shorter’, Lakhota Language Consortium 2008: 659).

4.3 A Closer Look at Templates

Templatic systems have often been dismissed as arbitrary, but the historical processes behind them can often explain why they take the shapes they do. Genetic relationships among languages of the Athabaskan-Eyak-Tlingit family are sketched in Figure 7.4, with representative verb templates of the major branches in Figures 7.5, 7.6 and 7.7.

Representative verb templates of the major branches are below.

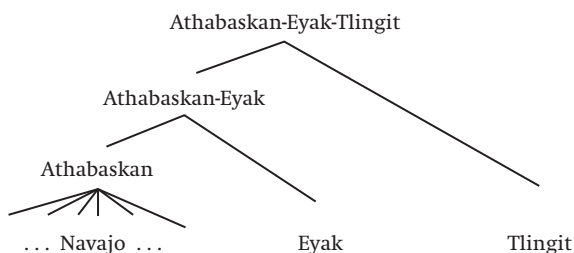


Figure 7.4. The Athabaskan-Eyak-Tlingit family (Krauss 1973)

17	16	15	14	13	12	11	10-9	8	7-4	3	2	1	0
PREVB	DISTR	PL	OBJ	AREA	NOUN		LOC	BEN	MODE/ASP	DISTR	<u>SBJ</u>	<u>CLF</u>	<u>STEM</u> SUF

Figure 7.5. Tlingit

Source: Crippen (2010: 105)

I	II	III	IV	V	VI	VII	VIII	IX	X	
OBJECT	MODE/ASP		PL	CLF	MODE/ASP	<u>SUBJECT</u>	MODE/ASP	<u>CLF</u>	<u>STEM</u>	SUFFIXES

Figure 7.6. Eyak

Source: Krauss (1965: 171)

0	Ia	Ib	Ic	Id	Ie	II	III	IV	V	VI	VII	VIII	IX	X
PP OBJ	0 PP	NOM	REFL	REV	SMI	ITR	DISTR PL	OBJ	3 SBJ	THM ADV	MODE	<u>1,2 SBJ</u>	<u>CLF</u>	<u>STEM</u>
		ADV												
		PP												

Figure 7.7. Navajo

Source: Young and Morgan (1987: 37–8)

Comparison of the languages shows the sequence in which the prefixes developed. All of the languages share a core: SUBJECT-VALENCY-STEM. The valency classifier (CLF) and subject prefixes are cognate across the three branches, indicating that this core was already in place in their common parent. Differences among the branches and within Athabaskan are primarily in the outer (leftmost) sections, indicating that those prefixes were added more recently.

The relative positions of the prefixes correlate with the kinds of features indicative of age. In Navajo, for example, the outer prefixes (0–III) have the most phonological substance and the most varied shapes. Their onsets are drawn from the full consonant inventory of the language, and their nuclei represent nearly all the vowels: *tsístʼa-* ‘cornered, trapped, blocked, baffled,’ *hashtʼe-* ‘in order, ready, prepared,’ *kʼeh-* ‘overcome.’ By contrast, most of the inner prefixes (IV–IX) consist of a single consonant, drawn from just a subset of the Navajo inventory (plain coronals, glides, laryngeals), augmented in some contexts by an epenthetic *i* descended from Proto-Athabaskan schwa: *n-/ni-* terminative, *sh-/shi-* ‘I’. The prefixes closest to the stem, the valency classifiers, consist of a single consonant, or only a phonetic effect on the following consonant, or nothing at all. Phonological substance decreases with proximity to the stem.

Outer prefixes often show quite specific meanings, many typical of lexical items in other languages: *-chʼo-* ‘support, help,’ *cha-* ‘darkness,’ *di-* ‘into or near fire,’ *ka-* ‘chronically ill, invalid,’ *ʔi-* ‘flattery, cajolery, cheating,’ *soh-* ‘hardship,’ *tii-* ‘tackle, attack,’ and so on. Inner prefixes serve more grammatical functions, such as the subject and object pronominals and the various mode/aspect markers. The valency prefixes adjacent to the stem are highly grammatical, sometimes with barely identifiable functions. While many outer prefixes have straightforward concrete meanings, many inner prefixes show effects of extension in their diffuse meanings. Young and Morgan distinguish fourteen prefixes in position VIa of the shape *d-/di-* on the basis of their meanings (1987: 38). Most definitions begin: “occurs as a component of some verb bases that involve ...,” continuing along the lines “relinquishment, relaxation, opening or closing and addition or reduction,” or “the mouth, stomach, throat, oral action, food, smell, noise,” or “holiness, faith, respect, immunity from the effects of a ceremony, prayer,” and so forth. Some *di-* prefixes have more grammatical definitions: “occurs in combination with *ni-* (VIb) in certain Neuter Imperfective Adjectivals” or “the Inceptive marker that, in combination with *yi-* (VII) Progressive mode marker produces the future paradigms.” One category is defined as “a catch-all for *di-* prefixes that, even speculatively, cannot be assigned to one of the foregoing categories.”

Not surprisingly, it is no longer possible to trace the origins of the prefixes closest to the stem. Likely sources of many outer prefixes, however, still survive as independent words. For slot Ib, Young and Morgan identify 25 prefixes with noun-like meanings, 101 with adverbial meanings, and 37 applicatives (“postpositions”). Lexical sources can be identified for all

three types. Noun-like prefixes are probably descended from incorporated nouns; incorporation is still productive in other members of the family. Some examples are the prefix *jé-* ‘carefully’ from the noun *jéi* ‘pleura, heart,’ and the prefix *le-* ‘into the ashes (to cook)’ from the noun *leezh* ‘dirt, soil.’ The prefixes already differ from their lexical noun counterparts: they are decategorized, no longer specifying a grammatical relation or appearing with possessive prefixes, and they are often reduced phonologically.

Examples of adverbial prefixes are *ada-* ‘downward from a height’ from the adverb *adah* ‘down,’ and *yá-* ‘up into the air’ from the noun *yá* ‘sky.’ It is clear how such prefixes could develop. Lexical adverbs often appear immediately before the verb. When particular adverb-verb combinations occur frequently, speakers can come to process them as chunks, and the adverbial constituent can lose its autonomy.

Applicatives add an argument to the verb. They are derivational, combining with stems to form lexical items like ‘on-look’ = ‘watch.’

- (17) Navajo applicative -*k’i-* ‘on’ (Dolly Soulé, speaker p.c.)

Awéé’ bik’idésh’íí’.

awéé’ bi-k’i-dé-sh-’íí’

baby 3SG-on-THEMATIC-1SG.SUBJECT-look.IPFV

‘I’m watching the baby.’

Though they occur at the beginning of the verb, many applicative prefixes have surprisingly grammatical meanings for recent additions: -*á-* ‘for, on behalf of,’ -*aa-* ‘to, about, concerning, on, off, by,’ -*í/-é-* ‘against,’ -*gha-* ‘away from,’ -*ghá-* ‘through,’ -*ká-* ‘for, after,’ and so on. The sources of many can still be seen in independent postpositions, which had already undergone considerable grammaticalization. Their object prefixes were pulled along with them when they became attached to verbs as applicatives.

- (18) Navajo postposition -*k’i-* ‘on’ (Dolly Soulé, speaker p.c.)

Shík’ide dahníyeeh

shi-k’i=de dah-ni-yeeh

1SG.OBJ-on=hither up-you-handle.burden.IPFV

‘Put it on me.’ = ‘Put it (a heavy sack of potatoes) up on my back.’

The view of the Athabaskan verb as the product of successive layers of development over time also explains other puzzles not addressed in synchronic treatments. One is the surprising number of prefixes with similar forms, like the Navajo iterative *ná-/né-/ní-/ń-* (slot II), the reversionary *ná-/né-/ní-/ń-* ‘returning back reverting to a previous location, state, or condition’ (Id), the continuative *na-/naa-/ni-/n-* (Ib2), the thematic *ná-/ní-/ń-* ‘sewing’ (Ib2), the adverbials *na-/naa-/ni-/n-* ‘around about, without defined direct’ (Ib2), *ná-/ní-/ń-* ‘around encircling, embracing’ (Ib2), and *ná-/né-/ní-/ń-* ‘repetition’ (Ib2), and the applicatives -*na-/naa-/ni-/n-* ‘around, around about, surrounding (it)’ (Ib1) and -*ná-/ní-/ń-* ‘around encircling, embracing (it)’ (Ib1). Such

constellations are apparently the product of successive developments from a single source. Those prefixes closest to the stem, like the iterative (part of the mode-aspect system), have the most grammatical functions and are presumably the oldest. Beyond the verb, Navajo contains a postposition *-naa* ‘around about, in the vicinity of, surrounding’: *Shighan bi-naa=góo hózhóni* ‘it’s pretty around my place’ (Young, Morgan, and Midgette 1992: 418). Its source persists in the lexical verb *na’naad* ‘move, stir, live’ (1992: 407).

Consideration of diachrony shows that the Athabaskan templates do not defy explanation after all. (Further details are in Mithun 2011.) It is no longer surprising that first- and second-person subject pronouns are prefixes rather than suffixes in these strongly SOV languages. Speaker and hearer are normally given information, consistently represented by frequent, small, unstressed pronouns adjacent to the verb, likely targets for grammaticalization. They fused with the verb early and remained in their original position. They share a slot because they were in a mutually exclusive, paradigmatic relationship. Third persons, by contrast, may be represented by lexical nouns, demonstratives, or, if given, by nothing at all, as in the modern languages. It is not surprising that inflectional and derivational prefixes are distributed throughout the verb: each new prefix was added to the existing verb as a whole, in many cases further refining such distinctions as aspect and modality, or forming new, discontinuous lexical items.

4.4 Scope

It has been proposed that scopal relations in morphology must mirror those in syntax. But scope cannot account for all orders. An explanation emerges naturally from the recognition that morphological structure is built up over time. Gerds and Koyosawa (2007) describe the verbal suffix morphology of the Salishan languages of northwestern North America. They begin with a basic template, shown in Figure 7.8.

This order can be seen in the examples below from various Salishan languages. (*-cn-* ‘mouth, talk’ is what is termed a lexical suffix for its relatively concrete meaning.)

- (19) *hec-me’-cn-mí-st-n*
 STATIVE-bother-mouth-APPL-CAUS-1SG.SUBJECT
 ‘I bothered him with my talk’

ROOT	INTRANSITIVE	APPLICATIVE	TRANSITIVE	OBJECT	SUBJECT
	LEXICAL SUFFIX		CAUSATIVE	PASSIVE	
			NON-CONTROL	REFLEXIVE	
				RECIPROCAL	

Figure 7.8. Salishan verbal suffix template
 Source: Gerds and Kiyosawa (2007: 187)

- (20) Okanagan verb (A. Mattina 1994: 219, cited in Gerdts and Kiyosawa 2007: 177)
n-ṣīl-mə-nt-s-ən
 LOC-affraid-APPL-TR-2 SG.OBJECT-1 SG.SUBJECT
 ‘I got scared of you.’
- (21) Okanagan verb (N. Mattina 1993: 265 cited in Gerdts and Kiyosawa 2007: 183)
Mary ʃac-t-t-s iʔ ttw’it iʔ kəwáp-s
 Mary tie-APPL-TR-3 ERG ART boy ART horse-3 POSS
 ‘Mary tied his horse for the boy.’
- (22) Coeur d’Alene (Doak 1997: 145, cited in Gerdts and Kiyosawa 2007: 187)
Kʷí-t-t-m xʷe s-t’ímčēʔ-s
 take-APPL-TR-PASSIVE DET NMLZ-daughter-3 SG.POSS
 ‘His daughter was taken from him.’
- (23) Columbian verb (Kinkade 1982: 59, cited in Gerdts and Kiyosawa 2007: 213)
Sc-may’-x-cút-əxʷ
 PREFIX-tell-APPL-TR.REFL-IPFV
 ‘He’s talking to himself.’

But applicatives are not restricted to the slot before the transitivity suffixes. They also occur after transitive, causative, and non-control transitive suffixes.

- (24) Columbian (Kinkade 1982: 58, cited in Gerdts and Kiyosawa 2007: 197)
K’wən-stú-t-n
 examine-CAUS-APPL-1 SG.SUBJECT
 ‘I showed it to him.’

The various Salishan languages have between two and six different applicative suffixes, which fall into two types (Kiyosawa 1999, 2002, 2006). The first (termed ‘relational’ in Gerdts and Kiyosawa) are attached to *intransitive* bases to form transitive stems, adding a grammatical object which might be a semantic recipient, beneficiary, goal, stimulus, and so forth. The second (‘redirective’) are attached to *transitive* bases, replacing the original object with an argument in one of those semantic roles. It might be posited that the two types occupy separate slots.

- (25) Kalispel (Carlson and Flett 1989: 153, cited in KY 2007: 197)
Tu-mí-st-š-t-n
 transact.business-APPL-CAUS-APPL-TR-1 SG.SUBJECT
 ‘I bought it for somebody.’

But bases ending in a passive, reflexive/middle, or reciprocal can be followed by the first set of (‘relational’) applicatives.

- (26) Comox (Watanabe 2003: 335, cited in Gerdtz and Kiyosawa 2007: 193)
təs-θut-mi-t-ul č tə qaymixʷ.
 close-REFL-APPL-TR-PAST 1 SG.SUBJECT DET native.person
 ‘I was getting closer to that person.’
- (27) Tillamook (Egesdal and Thompson 1998: 255, cited in Gerdtz and Kiyosawa 2007: 193)
 Gʷəʔ də š-ʔəha-t-əgʷəl-wi-n.
 FUT ART LOC-fight-RECP\P-APPL-TR
 ‘He is going to fight with him.’

These orders are easily explained. Derivational affixes create lexical items. Each of the suffixes described here creates a specifically intransitive or transitive stem, which becomes established in the mental lexicons of speakers. The Kalispel root *tew* ‘transact business,’ for example, always appears with the two suffixes seen in (25) when it means ‘buy, sell’: *tumist-*. The Columbian cognate *tumist* is analyzed simply as a root meaning ‘sell’ (Gerdtz and Kiyosawa 2007: 197, citing Carlson and Flett 1989: 92 and Kinkade 1981: 85). Applicatives, transitives, causatives, and non-control transitives create transitive stems, while passives, reflexives, and reciprocals (in complementary distribution with object suffixes), create intransitive stems. These established derived stems, like other stems, can then serve as bases for further derivation. Some suffixes are added only to intransitive bases (which might be derived), others only to transitive bases (which might be derived). The ordering comes about from successive processes of derivation + lexicalization, normally spread out over time. The scopal relations follow from the functions of the individual suffixes.

4.5 More Routinization

Though much morpheme order can be explained by the order of grammaticalization of affixes over time, other kinds of processes can shape morphological structure as well. One involves additional routinization. The verb below was seen earlier in (1e).

- (1e) Central Alaskan Yup’ik (George Charles, speaker p.c.)
Quyayuumiitellruyugnarqua
 quya-yuumi-ite-llru-yugnarqe-u-a
 thankful-yearn-NEG-PAST-probably-INTR.IND-1 SG
 ‘I guess I didn’t want to be thankful.’

In his Yup’ik dictionaries, Jacobson (2012) lists *-yugnarqe-* ‘probably’ as a single suffix, but he notes that it developed from a fusion of suffixes which often occurred together: *-yuke-* ‘think.or.believe.that.oneself.or.another.is.Ving’ and *-narqe-* ‘tend.to.cause.’ The second element *-narqe-* is itself a

combination of *-nar-* ‘cause’ and *-rge-* ‘time.after.time.’ The meaning is no longer compositional; it means ‘probably,’ not ‘time after time cause one to tend to cause one to think or believe that another is V-ing.’ Such routinized suffix complexes are pervasive, with varying degrees of identifiability. Though Yup’ik derivational suffixes generally show hierarchical ordering, frequent suffix sequences can come to be processed as single units, and the order of their original components fixed.

4.6 Semantic Change

Morpheme order may fail to reflect syntactic or semantic scope for other reasons. The basic verb template for Iroquoian languages was seen in Figure 7.2. More detailed views of the prepronominal prefixes in the two major branches of the family are in Figure 7.9.

The inner prefixes are cognate; the outer (leftmost) prefixes are not. Cherokee material cited here from Montgomery-Anderson (2008) is from Oklahoma; that from Cook (1979) and King (1975) is from North Carolina (Qualla Boundary).

All Iroquoian languages contain a cislocative prefix and a translocative prefix. The two seem like perfect counterparts: the cislocative indicates motion toward a point of reference (‘hither’), and the translocative motion away (‘thither’). Southern Iroquoian is represented here by Cherokee, and Northern Iroquoian by Mohawk. The cislocatives are cognate across the family.

- (28) Cherokee cislocative (Montgomery-Anderson 2008: 329)

Tvykiluhcheéli
ta-aki-luhj-eél-i
 CISLOC-1 SG.PAT-arrive-APPL-MOTION
 ‘He will come up to me.’

- (29) Mohawk cislocative (Kaia’titáhkhe’ Jacobs, speaker p.c.)

Ta-s-áti
 CISLOC-2 SG.AGT-throw
 ‘Throw it here!’

Southern Iroquoian

IRREALIS	TRANSLOCATIVE	PARTITIVE	DISTRIBUTIVE	CISLOCATIVE	REPETITIVE	NEGATIVE
RELATIVE				FUTURE		
NEG IMP						

Northern Iroquoian

CONTRASTIVE	TRANSLOCATIVE	FACTUAL	DUPLICATIVE	FUTURE	CISLOCATIVE
PARTITIVE				OPTATIVE	REPETITIVE
NEGATIVE					

Figure 7.9. Iroquoian prepronominal prefixes

The translocatives have various forms in the languages, but some are cognate across the family.

- (30) Cherokee translocative (Montgomery-Anderson 2008: 308)

Waawatéeka

wi-aki-atéeka

TRANSLOCATIVE-1 SG.PAT-throw-PRS

'I'm throwing it (away).'

- (31) Mohawk translocative (Kaia'titáhkhe' Jacobs, speaker p.c.)

le-wak-átie'-s

TRANSLOCATIVE-1 SG.PAT-throw-HAB

'I'm throwing it (away).'

The cislocative and translocative appear in different parts of the template, potentially separable by two or three other prefixes: the cislocative is an inner prefix, while the translocative is an outer prefix. If position were based on scope, this should not happen.

Their positions are easily explained by the steps by which they developed. The cislocatives can also indicate location at a place with no distinction of proximity.

- (32) Cherokee cislocative (Montgomery-Anderson 2008: 326)

Tikeèsǔ

wahya

uùthohise

ti-keès-ǔǔʔi

wahya

uu-athohis-éʔi

CISLOC-be.IPFV-NMLZ wolf

3 SG.PAT-whoop-NON.EXP.PAST

'While he was there, he whooped.'

- (33) Mohawk cislocative (Watshenní:ne' Sawyer, speaker p.c.)

T-k-ítskot-e'

CISLOC-1 SG.AGT-perch-ST

'I was sitting there.'

The cislocative is apparently older, added early in the development of the verbal morphology, with just the meaning 'at that place.' Sometime later, after several more prefixes had been added, the translocative came into being, with the meaning 'in a distant location' or, with directed motion verbs, 'thither.' This newer prefix provided a contrast with the older cislocative, resulting in its added meaning 'hither' with directed motion verbs. Though the cislocative and translocative have the same semantic scope, and they never co-occur within the same verb, the routinization of morphological structure has kept each in its original position.

Northern Iroquoian languages show another apparent scope anomaly. Among the prepronominal prefixes are a past (termed the factual), a future, and an irrealis (often termed the optative). The three are in a paradigmatic relationship: they cannot co-occur, and one of them must occur with the perfective aspect.

- (34) Mohawk perfectives
- a. Wa'*katkátho'*
wa'-k-at-kahtho-'
 FACTUAL-1SG.AGT-MIDDLE-look-PFV
 'I looked.'
 - b. En*katkátho'*
en-k-at-kahtho-'
 FUT-1SG.AGT-MIDDLE-look-PFV
 'I will look.'
 - c. A:*katkátho'*
aa-k-at-kahtho-'
 IRR-1SG.AGT-MIDDLE-look-PFV
 'I might/could/should look.'

The future and irrealis prefixes occupy the same position in the template, but the factual is not even adjacent. No synchronic account can explain their positions, but their histories can. The factual, basically *w-*, is apparently descended from a form of the translocative which survives as such in both branches of the family. A well-known pathway of semantic development crosslinguistically is from space to time; here there was an extension from 'distant location' to 'distant time.' A similar use is reported for Cherokee by Cook: "In narratives it [the translocative] can indicate that the action described occurs at a point removed from the narrative focus" (1979: 64).

- (35) Cherokee (Cook 1979: 64)
- Wihú:nv:ʔneʔi a:yo:hli hi:na wu:naki:sé:ʔi*
 'He laid the child back where he had picked it up.'
- hú:nv:ʔneʔi* 'he laid it back down'

4.7 Cycles

Accounts based only on scope are challenged by another phenomenon. Cherokee contains three negative constructions: a negative particle with outer irrealis prefix on the verb, a negative particle with an outer prefix *jii-* on the verb, and an inner prefix *ka-/ke-* on the verb, in the innermost prepronominal slot (Figure 7.9).

- (36) Cherokee negative (Montgomery-Anderson 2008: 293)
- Hla yii*ʔuulúhje*
 hla yi-ii-uu-lúhje-éʔi
 NEG IRR-ITR-3SG.PAT-arrive-NON.EXP.PAST
 'He didn't come back.'
- (37) Cherokee negative (Montgomery-Anderson 2008: 307)
- Hlesti jii*híhlvíní*
 hlesti jii-hi-hlvíní
 NEG NEG-2SG.AGT-sleep.IMM.IMP
 'Don't go to sleep!'

- (41) Cherokee negative (Feeling 1975: 137, cited in Montgomery-Anderson 2008: 339)
- | | | | |
|-------------------------|----------------------|-------------------|---------------------------------------|
| <i>Juulichv́yaâsti</i> | <i>yikéé</i> | <u><i>hla</i></u> | <u><i>yikv̄v̄wahlth́ísé?</i></u> |
| ti-uu-alichv́yaâsti | yi-kês-ééʔi | <u><i>hla</i></u> | <u><i>yi-kaa-uu-alihth́ís-éʔi</i></u> |
| DISTR-3SG.PAT-brave | IRR-be.IPFV-PAST.SUB | <u>NEG</u> | <u>IRR-NEG-3SG.PAT-TUN.PFV-PAST</u> |
- ‘If he were brave he wouldn’t have run away.’

The array of negative constructions is the product of a linguistic cycle (van Gelderen 2011). Grammaticalization resulting in the loss of phonological substance and semantic specificity can compromise the function of certain affixes, which can in turn prompt their renewal. Perhaps the best-known cycle involves negation. Negative markers develop from a variety of sources, but they can grammaticalize relatively quickly, since they are frequent in speech and tend to occupy a constant position with respect to the verb. If they are affixed early in the development of morphological structure, each added affix can further reduce their salience, displacing them from the edge of the word. But negation is often the most important information in the clause. As a result, speakers seek to reinforce it, often with another marker. This is the well-known source of the French negative *pas* ‘step,’ from ‘he doesn’t go a step.’ For a time negation may be expressed with the two forms together, like the French *Il ne va pas* ‘He doesn’t go,’ but eventually the older element may fade, as in modern colloquial French *Il va pas*.

This common phenomenon explains the multiple positions of Cherokee negative markers. The prefix *ka-* is apparently old, given its innermost position. A possible cognate is a relic in one Northern Iroquoian language, Cayuga, the rare negative particle *kaq*. The Iroquoian languages are likely distant relatives of the Caddoan languages, which contain negative prefixes of the same form: the Wichita negative prefix *ká:-* on nouns and indefinite pronouns (Rood 1976: 157), the Pawnee verb prefix *ka-* (Parks 1976: 235), and the Caddo prohibitive prefix *kaš-* ‘don’t’ (Chafe, personal communication). As the oldest Cherokee negative marker, *ka-* is now rare and confined to specific constructions, but it has been renewed with various particles. The negative particles are not cognate with those in the other Iroquoian languages and even vary across Cherokee dialects.

4.8 The Externalization of Inflection

Many counterexamples to general principles of morpheme ordering stem from the routinization that is the hallmark of morphology, the fact that affixes often maintain their positions even after their functions have changed. But affix order is not immutable. Three main types of situations have been described in which inflectional affixes appear to have moved to outer positions.

Haspelmath (1993) describes the “externalization of inflection,” where an inflectional affix is trapped in an inner position as a result of the grammaticalization and affixation of additional elements, then is reinforced with pleonastic affixation at the edge of the word, and finally disappears from its internal position. He cites the Georgian indefinite pronoun *rame* ‘anything,’ derived from the interrogative *ra* ‘what’ with the indefinite marker *-me*. All three stages of some case forms are attested.

- (42) Georgian *rame* ‘anything’ (Vogt 1971: 44–6, cited in Haspelmath 1993: 280)

	a. older pattern	b. intermediate pattern	c. newer pattern
NOM	ra-me		ra-me
DAT	ra-s-me	ra-s-me-s	ra-me-s
ADV	ra-d-me	ra-d-me-d	ra-me-d
GEN	r-is-me		ra-me-s
INS	r-iti-me		ra-me-ti

Haspelmath provides additional examples from the Icelandic indefinite pronoun *hverrge* ‘any, whichever,’ Germanic demonstrative pronouns, Latin *ipse* ‘self,’ the Greek demonstrative *hoūtos* and definite article *ho*, the Basque emphatic demonstrative *hau-xe*, the Yakut *kim eme* ‘anybody,’ the Georgian indefinite pronoun *vi(n)-ya-c* ‘somebody, anybody,’ and the Lithuanian reflexive *-s(i)*. He also cites examples from verbs in Pengo, a Dravidian language. There, a perfect clitic *=na* became a suffix, trapping the person/number inflection. Three stages of development coexist in the modern language, as in old *hurta-η=na*, hybrid *urta-η-na-η*, and new *hurta-na-η* ‘I have seen’ (cited from Burrow and Bhattacharya 1970).

Similar developments can occur in compounds. In the German *weit-gehend* ‘far reaching’ and *viel-geliebt* ‘much-loved,’ it is the initial members that are inflected as comparatives or superlatives: *weit-er-gehend* ‘further-reaching’ and *meist-geliebt* ‘most-loved.’ Non-standard forms like *weit-gehend-st* ‘most far-reaching’ and hybrid forms like *weit-est-gehend-st* are now sometimes heard, however.

Frequency can shape such developments. In the Muskogean languages of the North American southeast, first- and second-person arguments are identified by pronominal affixes on verbs. In some of the languages, all are prefixes except the first-person singular agent *-li*.

- (43) Chitimacha (Muskogean) pronominal affixes (Munro 2005: 124)

	Agent (I)	Patient (II)	
<i>Yaa-li</i>	‘I cry’	<i>Sa-kolofa</i>	‘I am cut’
<i>Ish-yaa</i>	‘You cry’	<i>Chi-kolofa</i>	‘You are cut’
<i>Yaa</i>	‘(S/he) cries’	<i>Kolofa</i>	‘(S/he) is cut’
<i>Ii-yaa</i> etc.	‘We cry’	<i>Po-kolofa</i>	‘We are cut’
<i>Hash-yaa</i>	‘You all cry’	<i>Hachi-kolofa</i>	‘You all are cut’

Synchronically this makes little sense. But there is a likely historical explanation. The Muskogean languages are rich in auxiliary constructions like that in (44), where the lexical verb ‘eat’ is followed by an inflected auxiliary ‘finish.’

- (44) Chitimacha (Munro and Willmond 2008: 213)

Apat ish-tah-tok
eat 2SG.AGT-finish-PAST
‘You ate it all up.’

The languages contain pervasive voice suffixes as well as tense, aspect, and modality suffixes, like the Chickasaw *Im-alikchi-l-a'ni* 3DAT-doctor-1SG. AGT-POT 'I can doctor him' (Munro 2005: 135). Such suffixes are likely descended from auxiliaries. Booker (1980: 112–14) notes that the modern Mikasuki present tense suffix *-om(i)* is transparently descended from the Proto-Muskogean auxiliary **o-mi* 'be.' She traces the Muskogean past tense suffix **-ta(h)* to the verb 'finish, complete' seen above (1980: 138–9). The grammaticalization of auxiliaries to suffixes, a common phenomenon crosslinguistically, would have trapped any erstwhile pronominal prefixes inside the verb. (Since third persons are zero, many auxiliary constructions have no pronominal affixes.) In some of the languages, once speakers reanalyzed the constructions as single units, they inflected them by attaching the pronominal prefixes to the whole. The most frequent prefix, however, the first-person singular agent, was the most tightly attached to the auxiliary and remains in its original position.

A related kind of change, beginning with two inflected elements, is discussed by Harris and Faarlund (2006). One inflected word undergoes grammaticalization, becoming a clitic then an affix to the other, trapping its inflectional affix. Examples are drawn from Mainland Scandinavian, Georgian, Spanish, Greek, Slavic, Zoque (Mixe-Zoquean), and Andi (North-east Caucasian). They include nouns and adjectives with case and number inflection followed by a determiner, and verbs with person and number inflection followed by an auxiliary or reflexive marker. Case inflection is illustrated with Old Scandinavian definite articles which developed into suffixes.

(45) Old Scandinavian *hest* 'horse' (Harris and Faarlund 2006: 293)

		Indefinite		Definite			
		declension		declension			
	Noun	-Case		Noun	-Case	Article	-Case
NOM	hest	-r		hest	-r	in	-n
ACC	hest			hest		in	-n
DAT	hest	-i		hest	-i	n	-um
GEN	hest	-s		hest	-s	in	-s

The suffixation of definite articles resulted in redundant case marking on definite nouns and the loss of the trapped case markers. (The nominative article underwent assimilation: **nr* > *nn*.) In mainland Scandinavian, all cases except genitive *-s* have disappeared. But in the genitive, the internal *-s* is no longer present: *hest-en-s* 'of the horse.' (The genitive *-s* has since become a clitic, but the internal *-s* was lost while it was still a suffix.) The process progressed gradually through gender classes (Norde 1997). Harris and Faarlund (2006) demonstrate with each example that the trapped inflection was lost as a unit, not by regular phonological change.

In the third kind of change, an erstwhile derivational affix develops into an inflectional affix. The derivational source may remain an inner affix,

but its inflectional descendant takes up a position among other outer inflectional affixes. Such processes are described in Eskimo-Aleut and Iroquoian in Mithun (2000). All of the modern Iroquoian languages contain cognate derivational causative/instrumental suffixes. With animate patients they contribute causative meaning; with inanimates, either causative or instrumental applicative meanings. In the Northern Iroquoian languages, they appear as *-hst*, *-ʔst*, *-st*, *-ht*, *-t*, *-hkw*, *-hw*, and *-en*. In Southern Iroquoian they show the shapes *-ihst*, *-hst*, *-ʔst*, *-vhst*, *-oʔt*, *-ʔt*, *-vht*, *-oht*, and *-ht* (where *v* = [ʌ]).

(46) Mohawk causative/instrumentals

<i>Wa'kxstátha-t-e'</i>	'I dried it.'
<i>Iohstáthen</i>	'It is dry.'
<i>Senà:nawen-ht</i>	'Moisten it!'
<i>Seneniò:kwano-hst</i>	'Freeze it!'

(47) Cherokee causative/instrumentals (Cook 1979: 138–9, King 1975: 88)

<i>K-ohwe:l-óʔt-ihsko:ʔi</i>	'He <u>makes</u> him write.'
<i>K-ohwe:l-óʔt-ihsko:ʔi</i>	'He writes <u>with</u> it.'
<i>K-ohwe:l-iʔskoʔi</i>	'He writes.'
<i>Koh-vht-ihá</i>	'He is dropping it (causing it to fall).'
<i>Atsv:ʔ-ihst-ihá</i>	'He is pouring it out (causing it to spill).'

In the northern languages, it is common for morphological verbs to function syntactically and semantically as referring expressions without further nominalizing morphology: Mohawk *rató:rats* 'he hunts' = 'hunter.' Verbs containing a causative/instrumental suffix and habitual aspect suffix *-ha* are often used to name objects by their function.

(48) Mohawk verbs as nominals

<i>iehnekihr-à:t-ha</i>	'one drinks <u>with</u> it' = 'cup'
<i>ieksokewá:ht-ha'</i>	'one wipes dishes <u>with</u> it' = 'dishcloth'
<i>iehrarhó-hst-ha'</i>	'one pulls ashore <u>with</u> it' = 'dock, wharf'

Lexical nominals are also formed from verb stems with overt nominalizers. The nominalizers have now been dropped from many words, but they remain in some and are always retained when the nouns are incorporated into verbs. Many nominalizers have exactly the same forms as causative/instrumentals.

(49) Mohawk nominalization

<i>ka-'sere-ht-t-io</i>	
N-drag-NMLZ-be.good	
'It is a nice car.'	<i>kà:sere</i> 'car, vehicle'

The causative/instrumental suffixes may have been reanalyzed as nominalizers on the basis of constructions like those in (48). It is still possible to

trace the origins of some of them. The source of the suffix *-(i)hst*, for example, is a verb root **(i)hst*: Tuscarora *k-ihst-ha* ‘I use it.’

In Cherokee, the causative/instrumentals often occur in nouns with the nominalizer *-i*.

- (50) Cherokee nominalization (Montgomery-Anderson 2008: 462)

tiihnawóóstoht

ti-a-ahnawoost-oht-i

DISTR-3SG.AGT-COVER-CAUS-NMLZ

‘one covers with it’ = ‘bed covers’

As in many languages, dependent clauses can be formed by nominalization. The construction in (50) was extended to clauses for this purpose. These constructions are termed infinitives.

- (51) Cherokee nominalized complement (Montgomery-Anderson 2008: 466)

Keekahlnoohehtóhti

uùnatuuli

keekii-ali-hnooheht-oht-i

uunii-atuuliha

3PL>2PL-MIDDLE-tell-INF-NMLZ

3PL.PAT-want.PRS

‘They want to talk to us.’

- (52) Cherokee causative complement (Montgomery-Anderson 2008: 360)

Thla uuyooostohti

yookatuuli.

thla uu-yoo-st-oht-i

yi-ookii-atuuliha

NEG 3SG.PAT-break-CAUS-INF-NMLZ

IRR-1PL.EXC.PAT-want.PRS

‘We don’t want him to break it.’

With this extension in function has come a reanalysis of the place of the suffixes in the template. In all of the Iroquoian languages, the verb templates end in a slot for inflectional aspect suffixes followed by a slot for final suffixes, though these outer suffixes are not cognate across the branches. In Cherokee, the new infinitive markers are now grouped with the aspect suffixes (with which they never co-occur), and the erstwhile nominalizer *-i* is grouped with the other final suffixes.

A similar phenomenon in Old Irish (AD 700–900) is described by García-Castillero (2013). He provides the verb template in Figure 7.10. Multiple elements may occur in slots 1 and 3. Morpheme boundaries are not always sharp, particularly between slots 3 and 4. If a verb begins with a particle or preverb in slot 1 and/or 3, it is inflected in slot 2; otherwise, it is inflected in slot 6.

1	2	3	4	5	6	7
PARTICLES/ PREVERB	PRONOMINAL AFFIX	PREVERB	VERB STEM	VERB ENDING	PRONOMINAL AFFIX	EMPHASIZING PARTICLES

Figure 7.10. Old Irish verb

Source: García-Castillero (2013: 111)

Derivational ‘lexical preverbs’ (slots 1 and 3) modify the basic lexical meaning of the stem, like *for-cain* ‘above-sing’ = ‘teach.’ The ‘particles’ (slot 1) are more grammatical in function, used in negation, yes-no questions, and perfects: *ro-cechain* ‘has sung.’ If the negative or interrogative is present, any lexical preverb appears in slot 3. The morpheme *ro-*, however, may occur in slot 1, 3, or both. García-Castillero hypothesizes that *ro-* originated as a preverb cognate with Latin and Greek *pro-* and Old Indic *pra-* ‘forward.’ In this use it occupies slot 3. It subsequently developed into an inflectional perfect, in which use it occupies slot 1 (with some variation).

The developments could be attributed to a universal preference for inflection outside of derivation, or to the processing advantages suggested by Dressler et al. (1987). But we can go further to investigate the mechanisms by which preferences are translated into structure. Functionality might lead to its increased frequency, extension to more contexts, and stability. But it is not clear how it would produce a structure. García-Castillero (2013) proposes a two-step scenario for the changes discussed here. The Georgian dative change *ra-s-me* > *ra-s-me-s* ‘anything’ might have begun with a reanalysis of the basic-derived relation, resulting in a new base *rasme*, which was inflected with final case endings by analogy to other inflected forms. A new base might come from the same case form like *rasme*, or from another form in the paradigm, perhaps an unmarked one like the nominative *rame*. A similar series of mechanisms would explain the development of the Cherokee infinitive: first reanalysis of the causative/instrumental suffixes as part of a nominalization construction, then extension of that construction to clauses, and finally reanalysis of their status as inflectional by analogy to the inflectional aspect and final suffixes.

Models of synchronic systems are often necessarily couched in terms of tendencies rather than universals. Affix order tendencies are formalized in Optimality accounts in Inkelas (1993), Hargus and Tuttle (1997), de Lacy (1999), Hyman (2003), Caballero (2010), and Ryan (2010). When the diachronic dimension is added, the absence of universals need not be seen as a failure of analysis or lack of rigor. At any point in time, numerous changes are possible, including none at all. This point is illustrated by shifts in position of the Lithuanian reflexive (Senn 1966; Geniušienė 1987; Stolz 1989; Haspelmath 1990, 1993; Nevis and Joseph 1993; Harris and Faarlund 2006). In Standard Lithuanian, the reflexive *-s(i)* appears at the end of the simplex verb: *laikaũ* ‘I consider, maintain,’ *laikaũ-si* ‘I get along’ (Nevis and Joseph 1993: 95). If the verb contains a preverb, however, the reflexive occurs after that: *iš-laikaũ* ‘I preserve, withstand,’ *iš-si-laikaũ* ‘I hold my stand.’ Nevis and Joseph show that the reflexive was a Wackernagel clitic in Proto-Balto-Slavic, occurring after the first element of the clause. It remains unchanged in several modern Slavic languages. Proto-Balto-Slavic word order was fluid, but a frequent order involved an initial verb or adverb-verb sequence. When some verbal adverbs developed into verb prefixes in Lithuanian, the reflexive remained in

place. Other Balto-Slavic languages show different developments. In certain Lithuanian dialects, Modern Standard Latvian, Old Prussian, Russian, Byelorussian, and most dialects of Ukrainian, the reflexive is now suffixed to the ends of all verbs.

In Standard Lithuanian simplex verbs, the reflexive follows the person/number suffixes: *laika-ū* 'I consider, maintain,' *laika-ū-si* 'I get along.' In some dialects, however, a copy of the person/number suffix follows the reflexive in some verb forms. The older pattern continues in *dirb-u* 'I work,' *dirb-uo-s* 'I work for myself,' but there are some hybrid dialectal forms, like *meldži-uo-si-u* 'I am praying.'

5 Conclusion

Most accounts of affix order have been framed in terms of operations or processes. Sometimes the processes proposed in different approaches parallel each other. The successive addition of affixes and phonological processes in stratal models, or the merging and readjustment rules in syntactic models, often correspond to historical changes. But there are differences. We can see how the complex morphologies of the Athabaskan-Eyak-Tlingit and Iroquoian languages were built up gradually over millennia, with the grammaticalization of one affix at a time, layers of phonological changes, semantic shifts, analogical extensions, and structural reanalyses. The complex, meandering histories explain both modern affix orders and unexpected characteristics of individual affixes. But these historical processes are not paralleled in speech production. Modern Athabaskan and Iroquoian speakers do not usually assemble their verbs morpheme by morpheme as they speak. Probably most Athabaskan and Iroquoian verbs are selected from memory as prefabricated chunks. Others are formed by substituting one affix or affix sequence for another in a familiar verb, by analogy to multitudes of other pairs of verbs differing that one element. Both diachronic and speech processing accounts differ from models of synchronic morphological systems in which operations might be viewed primarily as tools for efficient description, with such processes as the late movement of the Athabaskan verb stem from the leftmost position in the verb to the rightmost.

There was a time when it was thought, in many circles, that rigor in linguistics depended on a strict separation of synchrony and diachrony: if speakers do not know the histories of their languages, those histories must be irrelevant to universal grammar. It is now clear that a full understanding of language structure, and particularly morphological systems, depends on insights from both. Speakers inherit vast lexicons without question, vocabularies full of patterns both robust and obscure that they would never create from scratch. But this inheritance is not passed down intact. Each generation acquires language anew, perceiving patterns, forming generalizations, repairing apparent irregularities, and extending constructions to

new contexts and uses. Each innovation is a synchronic act which takes place in the context of a particular synchronic system, stimulated and governed by a wide variety of cognitive capacities. An appreciation of the interaction of synchrony and diachrony allows us not only to explain more, but also to move beyond surface patterns to the mechanisms by which speakers shape them.

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8

A Fox Knows Many Things but a Hedgehog One Big Thing

Mark Aronoff

1 Introduction

Isaiah Berlin's little book *The Hedgehog and the Fox* (1953) takes its title from a line by the Greek poet Archilochus: *πῶλλ' οἶδ' ἀλώπηξ ἀλλ' ἐχῖνος ἓν μέγα* 'many [things] knows [a] fox but [a] hedgehog one big [thing].' Since it is impossible to do justice in a paraphrase to Berlin's prose, I will quote the relevant passage in full:

[T]aken figuratively, the words can be made to yield a sense in which they mark one of the deepest differences which divide writers and thinkers, and, it may be, human beings in general. For there exists a great chasm between those, on one side, who relate everything to a single central vision, one system less or more coherent or articulate, in terms of which they understand, think, and feel—a single, universal, organizing principle in terms of which alone all that they are and say has significance—and, on the other side, those who pursue many ends, often unrelated and even contradictory, connected, if at all, only in some *de facto* way, for some psychological or physiological cause, related by no moral or aesthetic principle; these last lead lives, perform acts, and entertain ideas that are centrifugal rather than centripetal, their thought is scattered or diffused, moving on many levels, seizing upon the essence of a vast variety of experiences and objects for what they are in themselves, without, consciously or unconsciously, seeking to fit them into, or exclude them from, any one unchanging, all-embracing, sometimes self-contradictory and incomplete, at times fanatical, unitary vision. The first kind of intellectual and artistic personality belongs to the hedgehogs, the second to the foxes; and without insisting on a rigid classification, we may, without too much fear of contradiction, say that, in this sense, Dante belongs to the first category, Shakespeare to the second; Plato, Lucretius, Pascal, Hegel, Dostoevsky, Nietzsche, Ibsen, Proust are, in varying degrees, hedgehogs; Herodotus, Aristotle, Montaigne, Erasmus, Molière, Goethe, Pushkin, Balzac, Joyce are foxes.

Most of us have a little of both the fox and the hedgehog in us, and the two natures interact in complex ways. As Berlin shows in detail about the main

subject of his essay: “Tolstoy was by nature a fox, but believed in being a hedgehog.” If Berlin is right and his dichotomy applies to human beings in general, then we should find hedgehogs and foxes in any field of endeavor. In this brief chapter, I will show that we can understand a great deal about the history of modern linguistic morphology in terms of the two categories of thinkers and doers.

First a confession: I am a fox. I find it hard to understand why hedgehogs make the moves that they make. It has always been especially puzzling to me why they react with such vehemence to what strikes me, a fox, as entirely reasonable or even unremarkable. I will give just one example. Together with colleagues, I spent years working on the question of why certain Classical Latin verbs were deponent (Xu, Aronoff, and Anshen 2007). This was an arduous project. We recorded all the senses of every Latin deponent verb in a large dictionary and then categorized these senses into a pre-established set of syntactico-semantic classes. We found that the great majority fell into classes in which the object was not affected, the polar opposite of a prototypical transitive verb. Additionally, we found that deponent verbs derived from nouns or adjectives (nearly half of all deponent verbs) tend to have noncausative senses, again contrary to the prototypical derived transitive. Finally, we found that most deponent verbs not derived from nouns or adjectives contained what we called *deponent roots*, roots that only occur in deponent verbs. To my mind, at least, these results were both surprising and interesting, inviting a number of interpretations, some of which we discussed in our article. In his long review of the book in which it appeared, Müller (2013) devoted one paragraph to our article, noting only that our reluctance to provide a theoretical underpinning for the work is “defeatist.” In his summary he remarked on as “truly impressive” only those works that offer “new typological or theoretical ideas.” He appeared to have little interest in empirical results that called for theory rather than proposing one. Clearly we are at odds: I a fox, Müller a hedgehog.

2 American Structuralists

The first notable battle between hedgehogs and foxes in linguistic morphology is nicely collected with play-by-play commentary in Martin Joos’ *Readings in Linguistics* (1957), an epitome of American structuralist linguistics between 1925 and 1956. In 1947, Charles Hockett and Bernard Bloch each published an article in *Language* on morphological analysis, Hockett’s a fairly general summary of how one did “morphemic analysis” and Bloch’s a rigorous analysis of English verb inflection with little methodological content (Hockett 1947; Bloch 1947). The influence of Bloch’s analysis can still be felt today in much work on English verbs (e.g., Huddleston and Pullum 2002). Eugene Nida responded the next year

(Nida 1948). His greatest objection to both articles was that their theories had led their authors to dissatisfying conclusions. For example, Bloch had insisted on “avoiding all reference to the process by which the form is derived” and “analyzing every inflected form as a combination of morphemes in a particular order.” Bloch had asserted (without actually demonstrating his claim) that the result is a “systematization” that is “more uniform and in the long run simpler” (p. 244).¹ Thus, he famously analyzed the English verb *took* as consisting of the base verb followed by a zero past-tense suffix and a lexically conditioned morphophonemic alternation: the base has two alternants (*take* and *took*), the second of which is conditioned by the zero suffix. Nida objected strongly to such uses of zero: “it appears to me as strikingly contradictory to treat overt distinctions as meaningless and covert distinctions as meaningful” (p. 256). Nida instead posited a process morpheme in this case, one changing *take* to *took* as the expression of past tense, oblivious of the fact that what lay behind Bloch’s entire unintuitive solution was specifically his desire to avoid morphological processes and to express all morphology in terms of simple concatenation. In fact, there is nothing contradictory in Bloch’s treatment; it merely puts theory before the facts, a consummate hedgehog move. As Joos notes in his commentary (p. 254): “in principle, Bloch’s procedure is to adopt a set of axioms and then to develop the consequences of the set à outrance.” As for Nida (p. 271), Joos quipped: “If there can be any such thing as ‘common sense’ in descriptive linguistics, Nida’s work is where we may expect to find it.” In truth, hedgehogs and foxes are unlikely ever to agree on which solution is better, because they cannot agree on what is more important: the theory or the conclusion. Hedgehogs value theory above both sensibility and sensibleness. Foxes don’t like theories that lead to unenlightening or odd conclusions.

As a fox, this piece of Nida’s has always been one of my favorites. It reminds me of Oliver Hardy’s constant refrain to Stan Laurel: “Well, here’s another nice mess you’ve gotten me into!” But Nida paid dearly for facing down the theoretical juggernaut. As Terry Langendoen chronicles in his obituary of Nida (2013), this was the last piece that Nida published in *Language*, aside from his presidential address.² After 1947, he steered his course away from the community of academic linguists towards renown in the field of translation, the subject of his presidential address (Nida 1969), where he flourished for the rest of his long life. And who can blame him? His greatest legacy to linguistics, his textbook on morphology (Nida 1949), was excoriated in the pages of *Language* for its excessive reliance on semantics rather than distribution in establishing the identity of morphemes (Trager 1951). I sympathize. Having been told in print that anyone who does morphology by itself is doomed to do morphology by himself, I devoted

¹ Page numbers for these articles are from the Joos volume.

² Bloch was the editor of the journal from late 1939 until his death in 1965.

myself to sign language research and university administration for a decade. Yes, morphologists can be crueler than presidents and provosts.

Bloch's analysis of English strong verbs as having a zero suffix accompanied by a lexically conditioned morphophonemic vowel change rule persists among hedgehog morphologists to this day. Embick and Marantz (2005) invoke it without attribution as part of their analysis of the English past tense in their response to the pack of foxes assembled in Ullman et al. (2005). What leads foxes and hedgehogs to have such opposing reactions to this particular analysis? And what irks foxes, in particular, about it? Nida remarked: "It appears to me as strikingly contradictory to treat overt distinctions as meaningless and covert distinctions as meaningful" (p. 256). Certainly, *contradictory* is not the right word here, but still, there is something upside down about the analysis. It says that the readily apparent physical signal of the difference between present tense and past tense forms is a secondary by-product and that the actual linguistic signal is inaudible. The analysis hides what is apparently actually going on. There is also the matter of invoking zeroes, elements that are not just invisible for now but invisible in principle, as the heart of an explanation. For the hedgehog, though, what matters most is that the animal (or linguist) is able to solve the problem with the limited resources it has or has imposed on itself, not whether the analysis is intuitively satisfying.

To be fair, appealing to common sense is not always a reliable way of judging any analysis. Some hedgehogs instead go so far as to make a virtue of necessity by exalting the status of counterintuitiveness and downgrading common sense. After all, successful theories of physics since Newton have never borne much resemblance to the apparent physical reality of our human perceptual world, so maybe counterintuitive analyses are not so bad, maybe they are even good. Counterintuitiveness has a kind of perverse cachet: reality does not lie on the surface that the unelect naively perceive; it is hidden beneath. Robert Hoberman reminds me of the religious saying: *credo quia absurdum est* 'I believe because it is absurd.' This appeal to the occult strikes foxes as merely an excuse for refusing to use the resources at hand and for accepting odd analyses as a consequence. But hedgehogs are natural Miesians. For them, less is always more.

Not surprisingly, what hedgehogs in their turn find annoying about foxes is precisely the opposite trait from the hedgehogs' tendency to want always to make do with less: a baroque even rococo tendency to revel in the invention of all sorts of novel devices and concepts: lexemes, stems, paradigms, and morphemes, just for starters.

In the end, the lesson to be drawn from this almost seventy-year-old disagreement about which analysis of irregular past tenses in English is better is that neither side is going to convince the other of the correctness of their analysis, because the two sides have very different notions about what makes for a best analysis. The greater mystery is why some people are hedgehogs and some are foxes, but we are not trying to solve that one here.

3 Noam Chomsky: A Hedgehog and a Fox

James, MacGregor Burns opens the Preface of the second volume of his biography of Franklin Roosevelt (Burns 1970: 2) with the following sentence:

The proposition of this work is that Franklin D. Roosevelt as war leader was a deeply divided man—divided between the man of principle, of ideals, of faith, crusading for a distant vision on the one hand; and, on the other, the man of *Realpolitik*, of prudence, of narrow, manageable, short-run goals, intent always on protecting his power and authority in a world of shifting moods and capricious fortune.

In the next paragraph he notes: “This dualism between the prophet and the prince was not clear-cut.” Burns apparently felt that Roosevelt should have chosen between the two sides of his nature, leading Burns to title the first volume of his biography (Burns 1956) *The Lion and the Fox* after the two natures. He may not have read Berlin or perhaps he thought *lion* was a more dignified epithet than *hedgehog*. But Berlin was not troubled by the possibility of a person being two-faced. He argued that Tolstoy was a fox who believed he was a hedgehog, and remarked that many of us probably harbor aspects of both animals. Most politicians must be foxes, at least in part. If they were pure hedgehogs they would get very little done. The greatest of politicians, like Lincoln and Roosevelt, have balanced the two personas, deploying each side of their nature as called for. The same may be true in other walks of life. Darwin was sometimes a hedgehog and sometimes a fox. Without the mass of pure description that occupied him for most of his life his great theory would have received no support. What about linguists? Are all of us either hedgehogs or foxes or are at least some of us Janus-faced?

Noam Chomsky is usually thought of as an inveterate hedgehog and the moniker is well deserved. In one of his excursions into biology, he goes so far as to make the following suggestion:

The idea [is] that basically there’s one organism, that the difference ... between an elephant and a fly is just the rearrangement of the timing of some fixed regulatory mechanisms. It looks more and more like it. There’s deep conservation; you find the same thing in bacteria that you find in humans. There’s even a theory now that’s taken seriously that there’s a universal genome. Around the Cambrian explosion, that one genome developed and every organism’s a modification of it. (Chomsky, 2012: 53)

Of course, these notions of a single organism and universal genome fly in the face of the basic fact of speciation that Darwin’s theory of evolution was devised to address, but these are the words of an extreme hedgehog. Still, some of Chomsky’s greatest achievements, and certainly his two greatest contributions to morphology, were those of a fox.

In 1957, Chomsky published one of the most important works in twentieth-century thought, *Syntactic Structures*. At the heart of this work lay a stunning piece of morphological analysis. Chomsky is known primarily as a hedgehog theoretician but much of this book is the work of a fox, a very systematic fox. The main, purely syntactic, goal of this book is to argue a need for transformations. This is a hedgehog's vision. The book is set up as a progression of decreasingly desirable and increasingly complex theoretical frameworks for describing language. The first (and best because it is simple) purely linear Markovian framework fails quickly. Chomsky is forced to introduce a second dimension, that of phrase structure. He then shows that a two-dimensional theory cannot express certain intuitively satisfactory analyses of simple English constructions. This forces the introduction of yet a third dimension that allows for these analyses, expressed as transforming a one phrase-structure-derived string into another through movement.

What makes the entire work so powerful is the intuitive appeal of the transformations, despite their added theoretical complexity: they express clear and simple but previously unnoticed generalizations that are unstatable within a system that permits only phrase structure. While some of the transformations are purely syntactic, two of the more compelling ones involve morphology and are the creations of a very clever fox: affix hopping and subject auxiliary inversion. Both are intertwined closely with Chomsky's analysis of the English verb system, certainly the most beautiful piece of linguistic analysis of the century and rivaled in the history of the field only by that of an even younger (21-year-old) Ferdinand de Saussure in his *Mémoire sur le système primitif des voyelles dans les langues indo-européennes* (1879). Like Saussure, Chomsky will always be regarded primarily as a theoretician, but this particular achievement, like Saussure's, was analytical and descriptive.

From a theoretical point of view, the most troubling aspect of Chomsky's account is the affix-hopping transformation, because the use of transformations greatly increases the expressive power of the grammar and, all else being equal, the best theory is the least powerful one. There have been numerous assaults on the transformation, most prominently that of Gazdar et al. (1982), which explicitly sets out to demonstrate that a variety of phenomena involving English auxiliary verbs can be handled by a phrase-structure grammar. They show that the affix-hopping analysis can indeed be expressed without resort to transformations, though, at least as far as I can tell, much less perspicuously.³

The facts of the account of English verbs have sometimes been called into question (Chomsky ignores semi-auxiliaries like the very common *be going*

³ In a long footnote, Chomsky admits that it might be possible to do without transformations, but he concludes that "[t]his approach would miss the main point of level construction. . . , namely to rebuild the vast complexity of the actual language more elegantly and systematically by extracting the contribution to this complexity of several linguistic levels, each of which is simple in itself" (Chomsky 1957: 41–2). This is a fox arguing here.

to or *ought to* and double modals like *might could*, found in certain dialects), along with the need for a transformational theory. But the heart of the analysis remains intact: the marking of morphological tense (past or present) on the first member of the verbal string, the fixed sequence of auxiliary verbs, and the dependency between a particular auxiliary and the morphological form of the following word.

Ever tempted by his inner hedgehog, Chomsky finds it difficult to resist the urge to unify, even in this foxlike analysis of English verb morphology. He proposes (Chomsky 1957: 29) the morphemes *S* and $\emptyset$, “where *S* is the morpheme which is singular for verbs and plural for nouns (‘comes,’ ‘boys’), and $\emptyset$ is the morpheme which is singular for nouns and plural for verbs.” But the fox in him recoils from this solution and a sentence later he notes: “Identification of the nominal and verbal number affix is actually of questionable validity.”

Curiously, Nida had raised and quickly dismissed the possibility of this analysis of *S* (1948: 418):

Hockett considers that complementary distribution is all that fundamentally counts. But the implications of this method seem to be greater than he may have anticipated. For example, consider what could be done on that basis with number distinctions in English. Not only would it be possible to combine all the plural affixes of nouns in one morpheme (a step which we should all agree to), but one could say that these are in complementary distribution with the partly homophonous third-singular suffix of verbs. A single morpheme could then be set up with the meaning “number distinctiveness” . . .

Nida concludes, “If this were done, we should only have succeeded in changing the meaning of the word morpheme to apply to certain distributionally related forms.” I must confess that I too have claimed that this *S* is a valid entity, but that it is a morpheme rather than a morpheme. The morpheme, though, is a creature that only a fox could love, as we will see below.

A decade after *Syntactic Structures*, having conquered the field, Chomsky awoke to a rebellion among the troops, a resurgence of hedgehogs under the banner of generative semantics (Harris 1993). Though there was no organized school or single theory behind the movement, most generative semanticists sought to lump syntax and semantics together in a single system. In *Aspects of the Theory of Syntax* (1965) Chomsky had proposed that the mapping between the superficial structure of a sentence and its meaning pass through an intermediate level of deep structure. The generative semanticists sought to do away with this intermediate level in favor of a direct mapping between surface structure and meaning. Though published a few years later, a good example of this kind of thinking was Paul Postal’s article, “The best theory” (Postal 1972), in which Postal argued that a direct mapping was intrinsically better than one that involved an intermediate stage. Importantly, he did not argue that the direct mapping theory was correct, only that it was better. This is sheer hedgehogery.

Chomsky's response to the rebels was a single article on English morphology, his last major contribution on that topic (Chomsky 1970). It took a while for this subtle counterattack to take effect, but within a few years generative semantics was effectively neutralized. The article dealt with what he called "nominalization" or "derived nominals" in English, what we would now call deverbal nouns. I have discussed the article at length elsewhere (Aronoff 2013) as an example of the balance among description, analysis, and theory in accounting for a set of facts. In the context of foxes and hedgehogs, and with the hindsight of forty years, what is most striking about the article is the way in which Chomsky uses facts alone to support his basic claim, which is that verbs and nouns with the same root cannot be related by meaning-preserving transformations. This claim is entirely empirical and independent of any theory or analysis. It has never been questioned:

The idiosyncratic character of the relation between the derived nominal and the associated verb has been so often remarked that discussion is superfluous. Consider, for example, such nominals as *laughter*, *marriage*, *construction*, *actions*, *activities*, *revolution*, *belief*, *doubt*, *conversion*, *permutation*, *trial*, *residence*, *qualifications*, *specifications*, and so on, with their individual ranges of meaning and varied semantic relations to the base forms. There are a few subregularities that have frequently been noted, but the range of variation and its rather accidental character are typical of lexical structure. To accommodate these facts within the transformational approach (assuming, as above, that it is the grammatical relations in the deep structure that determine meaning), it is necessary to resort to the artifice of assigning a range of meanings to the base forms, stipulating that with certain semantic features the form must nominalize and with others it cannot. Furthermore, the appeal to this highly unsatisfactory device, which reduces the hypothesis that transformations do not have semantic content to near vacuity, would have to be quite extensive. (Chomsky 1970: 189)

Berlin says of foxes: "their thought is scattered or diffused, moving on many levels." With this characterization in mind, contrast the analysis of verbs in *Syntactic Structures* and the paragraph just cited. The first is purely distributional, worthy of Bloch or Hockett or Trager and almost morphomic in its disregard for semantics, which is completely absent from the entire analysis. Chomsky is concerned simply with getting the forms and their order right. The core of "Remarks" (Chomsky 1970), by contrast, is not an analysis at all, but a statement of facts that defy analysis. There is no consistency in method or theory between the two. As Berlin says in closing his sentence, foxes "seiz[e] upon the essence of a vast variety of experiences and objects for what they are in themselves." Of course, the ultimate goal of any science is to understand objects for what they are in themselves. The fox achieves this goal by whatever means are available. It is up to the hedgehog to try to unify such work.

4 Scylla and Charybdis

Remarks opened the door for a raft of work on morphology, both derivational and inflectional. I won't go through a history of this project, whose current state is covered elsewhere in this volume (Anderson in Chapter 21), but I will discuss the division between foxes and hedgehogs that has persisted in linguistic morphology since the publication of Chomsky's article. Central to Chomsky (1970) and everything that follows it is the tension between rules and the lexicon (Pinker 1999). The items in the lexicon, whether they are morphemes, words, phrases, sentences, or all of the above, are irregular by definition (Bloomfield 1933; DiSciullo and Williams 1987). Morphology must negotiate between the two. In this way it is very different from syntax, where the irregular lexical content is limited to collocations, idioms, and fixed phrases, which comprise a very small part of the domain of inquiry.

Morphology is filled with small and sometimes odd regularities. What to do with them? Remember what Berlin said about foxes. They "entertain ideas that are centrifugal rather than centripetal, their thought is scattered or diffused, moving on many levels." As a result, foxes do very well in this sort of ecosystem, with all its unpredictabilities. The downside is that foxes may be satisfied with smaller pickings and be less focused on or even interested in the big picture. Hedgehogs, by contrast, "relate everything to a single central vision, one system less or more coherent or articulate, in terms of which they understand, think, and feel—a single, universal, organizing principle in terms of which alone all that they are and say has significance." Hedgehogs are not so easily satisfied with a diet of many small tasty morsels, partial generalizations.

If morphological foxes are by nature willing to accept a much less unified view of language than are hedgehogs, this difference applies both within morphology itself and in how morphology relates to other aspects of language. A major tenet of Distributed Morphology, the most popular hedgehog framework, is Alec Marantz's *single engine hypothesis* (Arad 2005; Julien 2002), according to which a "single engine" is responsible for both syntactic and morphological structure. Driving this hypothesis is the exact same hedgehog impulse that lies behind Postal's Best Theory. Foxes have trouble making sense of the single engine hypothesis, because they can't fathom the unifying urge behind it. Sure, morphology and syntax share many things, say the foxes, but they are not exactly the same thing. Maybe there is a single engine driving aspects of both syntax and morphology, but there are morphological phenomena that have nothing to do with syntax, just as there are syntactic phenomena that have nothing to do with morphology. As morphologists, we are particularly interested in precisely these non-syntactic aspects of morphology. If not, we would have decided to become syntacticians.

To a fox, trying to reduce morphology to syntax is a bit like trying to reduce biology to physics and chemistry. No one would question the fact

that biology depends on physics and chemistry, that they are more basic. Nothing in biology is physically or chemically impossible but that does not mean that there are no biological phenomena or even principles that are not physically or chemically necessary. The problem is that life is not necessary but contingent by its very nature, an accidental confluence of certain physical and chemical circumstances. So too with the actual evolution of any given species. Once life gets started, the principles of evolution, combined with physics and chemistry, determine very broadly what is possible, but they have no predictive power in the face of historical accident.

Hedgehogs dislike contingency, perhaps because they are so single-minded that contingencies are just an annoyance that gets in the way. Contingencies explain nothing for a hedgehog. Foxes are flexible and versatile creatures who delight in contingency, new circumstances, and surprises, because novelties allow them to show off all their tricks. Morphology, like life, is filled with contingencies, and so it is a happy hunting ground for the ever-adaptable fox.

5 The Waste Remains and Kills

Morphological systems vary greatly in the extent and type of their complexity, making morphology a playground for foxes. For hedgehogs, this variety presents a worrisome challenge: how to reduce the riot to some semblance of generality. Both creatures search for consistencies but consistencies of very different sorts. The wildest fox comes armed with few expectations and succeeds by observing its prey and detecting the variety of patterns that emerge from its behavior. These patterns sometimes differ greatly from one language to the next. For a hedgehog, the differences are disconcerting; for a fox, they are fun. Consider systems of grammatical gender. Fewer than half the languages in the WALS sample of 258 languages (Corbett 2013) have grammatical gender at all, though all distinguish three persons and only 10 percent show no plural marking on nouns. Of the 112 languages that have grammatical gender, 50 have two genders, the rest three or more. Those with two are based on sex, humanness, or animacy, though the assignment of individual nouns to one gender or another can often be puzzling. Those with three often combine humanness, animacy, and sex (again with the usual array of oddities), but once we get beyond three, it is difficult to make any predictions. Djirbal, whose gender system has been much written about (Dixon 1972; Lakoff 1987), has four genders. One contains mostly human males and other animates; another contains most human females, water, fire, and words relating to fighting, along with a few birds and animals; a third contains most non-flesh foods; and the fourth is a catch-all residual class. Most of the languages with five or more genders are members of the Niger-Congo

family, where sex is absent from the gender system but a number of other factors have been added alongside humanness and animacy, including shape. A few of these, as well as the languages of Papua New Guinea that are known to have large numbers of genders, also add phonological criteria. Apparently, as the number of genders in a language increases, so does their variety.

The hedgehog may derive some consolation from the fact that only a tenth of the world's languages have more than four genders. But the hedgehog might also deride this seeking out and flaunting of exotic gender systems on the fox's part as the work of an eighteenth-century collector looking mostly to fill his cabinet of curiosities, rarities, and monsters. This is not science! Science seeks generalizations. And when the hedgehog does find true generalization in what appears on the surface to be a hodge-podge, even the fox applauds. Bobaljik (2012) is an example of how it is possible to explain a broad diversity of morphological facts across a wide range of languages by means of a single abstract theoretical principle. The book deservedly won an award. But an at least equally frequent strategy is to simply dismiss the curiosities as just that, to deal with "the clear cases" first.

I know of no hedgehog treatments of the diversity of gender systems, but, because person systems are better behaved, there are plenty of theories about person, some of them quite "formal" (Harley and Ritter 2002; Harbour 2011; Ackema and Neeleman 2013), others more grounded in discourse (Cysouw 2003; Wechsler 2010). Number lies between gender and person in its diversity: the values for grammatical number vary more widely across languages than do those for person, but their range is implikationally predictable for the most part (trial > dual > singular and plural). There is very little work on number by either hedgehogs or foxes. It is as if the topic is neither diverse enough nor structured enough to attract much attention from either side (Kibort and Corbett 2008).

6 His Vorpall Sword

Lewis Carroll's *Jabberwocky* is of great value to syntacticians and morphologists for its demonstration of the power of both syntax and word coinage. As Alice herself remarked upon hearing the poem:

"It seems very pretty," she said when she had finished it, "but it's rather hard to understand!" (You see she didn't like to confess, even to herself, that she couldn't make it out at all.) "Somehow it seems to fill my head with ideas – only I don't exactly know what they are! However, somebody killed something: that's clear, at any rate."

Charles Dodgson, who wrote the Alice books under a pen name, was a mathematician and logician. He spent his career as a lecturer in

mathematics at Christ Church College at Oxford and published widely, in both serious and “recreational” mathematics. The Alice books were filled with mathematical and logical allusions and, though there is no textual or other support for the idea, I like to think that the vorpal sword with which the nameless hero of the poem slew the Jabberwock was Ockham’s razor and that the Jabberwock, the Jubjub bird, the frumious Bandersnatch, and all the other nonsense terms in the poem were names for nonexistent creatures, entities multiplied beyond necessity.

Ockham’s razor is the weapon of choice of all hedgehogs and the multiplication of entities is their nemesis. Ockham never suggested that entities should never be multiplied, only that a solution with fewer entities is better than one with more, just so long as the two solutions cover exactly the same set of data. But because hedgehogs dislike multiplication in principle, they are always on the lookout. They keep their razors ready to hand, just in case.

Much of the history of linguistic morphology since the mid-1970s consists of a back-and-forth struggle between entity-multiplying foxes and razor-carrying hedgehogs. The foxes propose a new morphological concept and the hedgehogs set upon it, ready always to show how this concept can be reduced to something “simpler.” A good example is the morphological paradigm. The period since the late 1980s has seen a number of influential proposals that depend on paradigms, including Carstairs-McCarthy’s work on allomorphy and inflectional classes (Carstairs-McCarthy 1987), an influential collection edited by Franz Plank (Plank 1991), Gregory Stump’s paradigm function morphology (Stump 2001), Albright’s work on leading forms (Albright 2008), and the importance of paradigms in phonology (Downing et al. 2004), especially paradigm uniformity effects (Steriade 2000). I have cited only a single work for each of these areas, but the literature is very large.

Bobaljik (2002: 54) sets out to demonstrate that “paradigms are epiphenomenal, derived constructs.” He sees getting rid of paradigms as good, because they require “extra expressive power . . . within UG” (2002: 55). The first point might be true, but that does not mean that paradigms play no role in language, as Bobaljik concedes in his first footnote, which mentions “grammatical principles which refer directly to these structures” (2002: 78). Nowhere in his article does he attempt to refute the possibility of such principles. Bobaljik seems mostly concerned that paradigm structure might be part of U(niversal) G(rammar) and paradigms therefore *entia praeter necessitatem*. But most of those who think in terms of paradigms haven’t thought about whether they are *entia* in the strict sense of the term: irreducible elements of a theory. Few scientific concepts qualify for this status. Species certainly cannot be *entia*. That is the whole point of Darwin’s revolution. But that does not mean that species is not a useful concept for discussing evolution.

To be fair, Williams (1994), about which Bobaljik is most exercised, does call a paradigm “a real object” (1994: 22), but it is not clear that Williams meant the term *real object* to be taken quite as seriously as Bobaljik does, and even if he did, few if any other morphologists do, though they freely invoke paradigms. Why take up thirty pages of a journal arguing against this straw man? Because foxes must be stopped! Bobaljik’s second claim, about expressive power, is specious, though it tells us much about a hedgehog’s desire to make do with less. Bobaljik never produces any evidence for his assertion that positing paradigms as *entia* leads to run-away expressive power; in particular, he does not prove that paradigms lead to expressive power beyond that of a finite-state transducer, which all theories that incorporate phonological rewrite rules have (Johnson 1972), including Distributed Morphology with or without paradigms. And even if paradigms did lead to greater expressive power, that would not make it wrong to posit paradigms as basic elements if they proved to be useful, just as Chomsky did with transformations (while acknowledging their undesirability and expressive power). It would only make the theory less desirable on some meta-level that practicing scientists rarely worry about.

Another favorite target of morphological hedgehogs is the stem. Stems are among my favorite objects, real or not. The common definition of a stem, which I take here from the OED, is simple: “the theme of a word (or of a particular group of its cases or tenses), to which the flexional suffixes are attached.” Stems become interesting when we look in more detail at the particular sets of cells around which paradigms are organized. This is because, as I first argued in Aronoff (1994), not all stems can be defined cleanly in morphosyntactic terms; some stems are morphomic (Maiden 2005). Bonami and Boyé (2002) established the notion of a stem space to denote the distribution of stem types in a paradigm’s cells. For French verbs, Bonami et al. (2009) established thirteen distinct distributions (of which one is reserved for nominal derivation), each of which is a stem type: individual verbs may have a number of stems, each of which falls into one of these distributional types. Of course, no verb has thirteen stems. Regular verbs have only one and most irregular verbs have a small number, but thirteen is the theoretical maximum for French. Adjectives and nouns in French, which show little inflection, have a maximum of two stems, hence two stem types. In Aronoff (2012), I discussed a number of stem types in French verbal morphology, the most interesting and best known of which is what I called the PIPS stem, after its distribution: *present plural/imperative plural/subjunctive (plural)/imperfect/present participle stem*. The most common form of the French PIPS stems contains a –Vss- augment descended from the Latin inchoative suffix –sc-. It is the normal PIPS stem form in second-declension verbs like *finir* ‘finish.’ For these ‘semi-regular’ –ir verbs and many other verbs, the stem of plural present indicative forms (*finiss-ons*, *finiss-ez*, *finiss-ent*) is identical to the stem of all imperfect verb forms (*finiss-ais*, etc.), all forms of the subjunctive, and the present (active)

participle (*finiss-ant*). As the reader can see at a glance, the distribution of this stem type is not morphosyntactically simple but rather involves a disjunctive enumeration (and cannot therefore be subject to analyses involving impoverishment or underspecification that do not abuse the notion of morphosyntactic feature). This stem type is therefore *morphomic*, in the sense of Aronoff (1994) and in the spirit of Maiden (1992). It is defined purely in terms of distribution, which would have warmed the heart of Bloch and Hockett.

Embick and Halle question the need for “the move to stems” (2005: 1) and try to show that the same set of phenomena that calls for morphomic stem types can be accounted for by means of readjustment rules. In fact, as I argue at length (Aronoff 2012), they do no such thing. Instead, they use readjustment rules to encode suppletion, in the belief that readjustment rules are formally less powerful than suppletion, a false claim that they wisely do not bother to attempt to demonstrate. More importantly, they miss the point of what stem types are about, regardless of how the relation between a root and a stem is to be stated: stem types are *distributions*. Thus, even if one uses readjustment rules, the sets of environments in which these rules operate will recur over and over again. Stem types are thus more dangerous to the hedgehog even than paradigms, because they are by definition not *entia* but rather emergent, contingent accidents of history, as Martin Maiden has shown many times over (Maiden 2005 and elsewhere). They are like Monty Python’s Spanish Inquisition. No one expects them. That is why only a fox could love a morphome.

Embick (to appear) is couched as a response to Aronoff (2012). In fact, Embick does not address the central question of whether morphomic stem distributions exist. Though never offering any evidence, he suggests that they don’t, or at least that they shouldn’t:

Throughout the discussion, I will put to the side the question of whether the (by definition) morphomic distributions are actually found, and illustrate the main points of the argument schematically. In my view, many of the arguments for putative morphomes advanced in the literature are less than conclusive, but I will abstract away from this point here.

In place of evidence, Embick offers a complex technical solution for stem shapes involving diacritics. The basic idea is that, whenever a particular stem is called for in a given cell, say the French PIPS stem, the cell will bear a particular diacritic.⁴ This diacritic will then call whatever morphophonological rules are needed to derive the stem. This is a fine technical solution, but it has nothing to do with the central empirical claim, which is that

⁴ Since Embick eschews paradigms and cells, he expresses things a bit differently, but thinking in terms of cells is easier for me.

morphomic distributions of stems exist. All it does is substitute a morphomic distribution of diacritics for a morphomic distribution of stems. The waste remains, the waste remains and kills.

My mentor, the most formidable linguistic hedgehog I have known, used to say that when facts appear to contradict the theory one should always question the facts. This is the hedgehog's last defense against the fox: roll up into a ball and pretend that the fox is not there. This succeeds only if the fox goes away. A clever fox waits. Eventually, the hedgehog has to unroll and expose its underbelly. Then the fox will pounce.

7 Can We All Get Along?

Real hedgehogs fear real foxes, because hedgehogs are the foxes' prey. Whether they dislike them we will never know. But morphological hedgehogs have adopted, instead of fear, a profound disdain for us foxes, bordering on contempt. Marantz sets out to "dump lexicalism" (1997: 2) and his article has a section heading bearing the title "'Remarks on Nominalization' kills lexicalism to death." It's no small wonder that Edwin Williams, one of the main targets of Marantz's scorn, entitled his response (Williams 2007) "Dumping lexicalism." Lexicalism, as I commented above in my discussion of Chomsky (1970) is a fox's claim: it is entirely empirical in nature, which is why Marantz cannot understand it, and why he believes that Chomsky's article was about theory. Yes, that article contained a sketch of a theory, but one that has little bearing on the central factual claim, unless one is willing to ignore the facts by denigrating those who work to show the truth rather than figs. Foxes are not sycophants.

I noted above Müller's characterization of our work on Latin deponents as "defeatist." What evoked this response in Müller was the following line of ours, which he quotes: "Can the relation between Latin deponency and physical affectedness be deduced from any theoretical framework? We leave [this question] for more ambitious folk" (Xu et al. 2007: 143). Müller is offended by the presentation of facts outside a theory as much as by our lack of ambition. Embick's response to empirical claims about morphomic stem distribution is that "current synchronic theories of stems . . . do not hold more theoretical interest than an enumeration of the facts." Later in the same article, following in Müller's footsteps, he scolds us foxes because work on morphomic stems "does not raise any questions of theoretical significance." He contrasts this with works by other hedgehogs "that are laying the foundations for a truly integrated theoretical framework."

What raises all these hedgehogs' bristles appears to be that foxes like facts and especially factual generalizations. They do not show enough interest in theory or much respect for bristles. The hedgehogs must not

have read Berlin, who reminds us that a fox's "thought is scattered or diffused, moving on many levels, seizing upon the essence of a vast variety of experiences and objects for what they are in themselves." Hedgehogs, by contrast, "consciously or unconsciously, seek to fit [experiences and objects] into, or exclude them from, ... one unchanging, all-embracing, sometimes self-contradictory and incomplete, at times fanatical, unitary vision." Foxes don't care much for theories. What they care about are "ideas that are centrifugal rather than centripetal," things like morphomic stems. The claim that morphomes, stems and other kinds, exist has never been a theoretical claim, but rather an empirical claim and a fox delights in empirical generalizations, because, unlike the famously nearsighted hedgehog, who can find only what it is looking for, no guiding theoretical principles restrict the vulpine vision of a cunning fox.

Hedgehogs have a unitary vision. Certainly, theoretical linguistics has been dominated for over half a century by various examples of what Embick calls a truly integrated theoretical framework. Chomsky's earliest vision (Chomsky 1975)⁵ was clearly of a unified linguistic theory. But that grand vision has now been whittled down to the narrow faculty of language of Hauser et al. (2002), which encompasses only a very small aspect of syntax and nothing beyond syntax. The rest is interfaces, experience, or what Chomsky (2005) calls "third factors." On this new view, languages result from the intersection of a number of distinct factors, not necessarily integrated in the ways Embick and his fellow hedgehogs would like them to be.

Third factors are just what foxes are best at working with, precisely because a fox's thinking is more scattered and diffuse and not unitary. For example, since the mid-2000s, our sign language research group has found that the human body plays an important role in the grammatical organization of sign languages (Aronoff et al. 2005; Meir et al. 2007), including a number of constructions that are commonly found among sign languages but are peculiar to them. The human body is thus a third factor, although, unlike the ones that Chomsky enumerates, it is not a disembodied abstract principle of the sort that theoreticians prefer, but simply a fundamental biological and physical property of humans. But extra-linguistic principles of the exact sort that Chomsky has mentioned have also been shown to be third factors central to the organization of language. In recent work, Mark Lindsay and I have shown that Darwinian competition, related to what Chomsky calls **principles of efficient computation**, can be very fruitfully applied to longstanding problems involving what used to be termed **rival affixes** (Lindsay and Aronoff 2013). There is no reason to believe that any aspects of this competition are unique to language, or to biology for that matter. Competition is

⁵ The publication date of this work is deceptive. It was written in 1955. See its Preface for historical background.

simply something that drives the emergence of stable systems of all sorts, from neuronal organization to solar systems. Another very well-known factor that is independent of language but plays a role in its organization is frequency, or its Hebbian neurological correlate (Hebb 1949 and much subsequent work). I suspect that competition and frequency, together with computational efficiency, play a large role in the emergence and persistence of morphomic phenomena. If this turns out to be right, it would be of value to theoreticians, because they would no longer feel that they had to dismiss the phenomenon as improbable. The point is that any field needs hedgehogs and foxes. In the words of Rodney King, “can we all get along?”

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9

The Status of Paradigms

Gilles Boyé and Gauvain Schalchli

1 Inflectional Paradigms

The most visible aspect of paradigms is the emergence of contrasting phonological forms in different syntactic contexts. Depending on theoretical frameworks and languages, the descriptions of paradigms tend to revolve around two axes: the phonological forms and their syntactic contexts/semantic contents.

The contrasting phonological forms constitute a *form set* listing every phonologically distinct form of a lexeme independently of their conditions of emergence. The number of forms in the set might vary from lexeme to lexeme; English verbs, for example, do not all have the same number of elements in their form sets.

- (1)
- a. SET: *set, sets, setting*
 - b. TALK: *talk, talks, talked, talking*
 - c. BE: *be, am, is, are, was, were, been, being*

The description of contexts relies on syntactic features¹ such as GENDER, NUMBER, PERSON, CASE which are used to describe agreement, semantic features such as TENSE, ASPECT, MOOD, POLARITY which express content and more parochial features according to the particulars of each language. Features are used to characterize all the various dimensions relevant to the definition of contexts. The simple description of English conjugation distinguishes some basic contrasts: past tense from present, third-person singular from first-person plural, infinitive from participles. The following *feature sets* can describe the various syntactic contexts for English conjugation:

- MOOD: inf, ptcp, ind, sbjv
- TENSE: prs, pst

¹ A feature is the association of an attribute (a general property) with a specific value (e.g., PERSON: 1).

- PERSON: 1, 2, 3
- NUMBER: sg, pl

By combining features, each particular context can be described by a unique feature bundle. As the values of attributes don't cross-classify exhaustively, the number of features used to define a context may vary. For example, in English, we find three types of bundles with different numbers of features for different context types:

- non-finite contexts: only MOOD, or MOOD and TENSE
 - [MOOD: inf]
 - [MOOD: part, TENSE: prs], [MOOD: part, TENSE: pst]
- finite contexts with MOOD, TENSE, PERSON and NUMBER
 - [MOOD: ind, TENSE: prs, PERSON: 1, NUMBER: sg],
 - [MOOD: ind, TENSE: prs, PERSON: 2, NUMBER: sg], ...

As syntactic descriptions focus on contexts and their subtle contrasts, the list of appropriate feature bundles may vary from one lexeme to another, for example due to a difference in their inherent syntactic properties. Modal verbs in English such as CAN never appear in the infinitive, or in the present or past participles, so feature bundles corresponding to non-finite contexts are not appropriate for modals contrary to ordinary verbs. Stump and Finkel (2013) formally define inflectional paradigms as follows:

- (2) The paradigm of a lexeme L is a complete set of cells for L, where each cell is the pairing of L with a complete and coherent morphosyntactic property set (MPS) for which L is inflectable.

For morphological purposes, contexts are just a key to analyze the distribution of the different inflected forms. Following Stump (2006), we call the enumeration of all possible feature bundles the *content paradigm*. This paradigm can in turn be matched to a *form paradigm* where each context corresponds to a form. This makes it possible to present canonical inflectional morphology with *tabular paradigms* (see the paradigm of BE in Table 9.1).

Tabular paradigms are the most common representations of paradigms found in grammars and textbooks. When features are not orthogonal,² different types of feature bundles are separated into different tableaux (e.g., the finite and the non-finite forms in Table 9.1) and impossible combinations in each tableau are marked as non-existent.³

Since Carstairs-McCarthy (1994), it has been common practice to view these tableaux as a relation between the content paradigm (paradigm₁) relevant to the part of speech in general and the forms paradigm (paradigm₂) associated with each individual lexeme. Table 9.2 explicitly shows this interpretation of the inflectional paradigm of BE, where cells are used to associate forms with each content.

² For a detailed discussion of features typology and their relation to canonical inflection see Corbett (2012).

³ These non-existing cells are usually grayed out in tabular presentations and should not be confused with empty cells for possible combinations missing a form for a specific lexical entry (e.g., the infinitive of CAN).

Table 9.1. *The tabular paradigm of BE*

	IND		1.1.1.1	SBJV
	PRS	PST	PRS	PST
1sg	am	was	be	were
2sg	are	were	be	were
3sg	is	was	be	were
1pl	are	were	be	were
2pl	are	were	be	were
3pl	are	were	be	were
	INF		PART	
	be		PRS being	PST been

Table 9.2. *The paradigm of BE: associative perspective*

[ind, prs, 1, sg]	[ind, pst, 1, sg]	[sbjv, prs, 1, sg]	[sbjv, pst, 1, sg]	<i>am was be were</i>
[ind, prs, 2, sg]	[ind, pst, 2, sg]	[sbjv, prs, 2, sg]	[sbjv, pst, 2, sg]	<i>are were be were</i>
[ind, prs, 3, sg]	[ind, pst, 3, sg]	[sbjv, prs, 3, sg]	[sbjv, pst, 3, sg]	<i>is was be were</i>
[ind, prs, 1, pl]	[ind, pst, 1, pl]	[sbjv, prs, 1, pl]	[sbjv, pst, 1, pl]	<i>are were be were</i>
[ind, prs, 2, pl]	[ind, pst, 2, pl]	[sbjv, prs, 2, pl]	[sbjv, pst, 2, pl]	<i>are were be were</i>
[ind, prs, 3, pl]	[ind, pst, 3, pl]	[sbjv, prs, 3, pl]	[sbjv, pst, 3, pl]	<i>are were be were</i>
[inf] [part, prs] [part, pst]				<i>be being been</i>
Content: Paradigm ₁				Forms: Paradigm ₂

Abstracting away from canonical inflection (Corbett 2007), inflectional paradigms are convenient for describing a class of inflectional problems:

- (3) a. *syncretism*: forms being the same for contexts not belonging to a natural class (e.g., *was* for 1sg and 3sg in Table 9.2)⁴
- b. *defectiveness*: no form being available for certain contexts (e.g., no infinitive for CAN)⁵
- c. *overabundance*: more than one form being available for certain contents (e.g., *burnt* and *burned* as the past participles of BURN)⁶
- d. *deponency*: a mismatch between forms and content (e.g. Latin verbs such as HORTARI displaying passive-like morphology for their active content).⁷

⁴ See Baerman et al. (2005).

⁵ See Baerman and Corbett (2010).

⁶ See Thornton (2011).

⁷ In Latin, standard transitive verbs like AMARE ('to love') have an active and a passive conjugation. For a deponent verb such as HORTARI, the active forms use the same endings as the passive forms of AMARE:

		1sg	2sg	3sg	1pl	2pl	3pl
AMARE	active	<i>amo</i>	<i>amas</i>	<i>amat</i>	<i>amamus</i>	<i>amatis</i>	<i>amant</i>
	passive	<i>amor</i>	<i>amaris</i>	<i>amatur</i>	<i>amamur</i>	<i>amamini</i>	<i>amantur</i>
HORTARI	active	<i>hortor</i>	<i>hartaris</i>	<i>hortatur</i>	<i>hortamur</i>	<i>hortamini</i>	<i>hortantur</i>

See Baerman et al. (2007) for a general discussion of deponency.

Table 9.3. *The morphomic paradigm of BE*

am	[ind, prs, 1, sg]
are	[ind, prs, 2, sg], [ind, prs, 1, pl], [ind, prs, 2, pl], [ind, prs, 3, pl]
is	[ind, prs, 3, sg]
was	[ind, pst, 1, sg], [ind, pst, 3, sg]
were	[ind, pst, 2, sg], [ind, pst, 1, pl], [ind, pst, 2, pl], [ind, pst, 3, pl], [sbjv, pst, 1, sg], [sbjv, pst, 2, sg], [sbjv, pst, 3, sg], [sbjv, pst, 1, pl], [ind, pst, 2, pl], [sbjv, pst, 3, pl]
be	[sbjv, prs, 1, sg], [sbjv, prs, 2, sg], [sbjv, prs, 3, sg], [sbjv, prs, 1, pl], [ind, pst, 2, pl], [sbjv, prs, 3, pl], [inf]
being	[part, prs]
been	[part, pst]

Inflectional paradigms are also the basis for the concepts of suppletion (when originally different lexical units have fused into one with a unique inflectional paradigm; for example, the fusion of GON and WENDAN has given the modern GO) and inflectional classes (groups of lexemes sharing the same inflectional patterns; for instance, French first-conjugation verbs).

Another possible representation of inflectional paradigms would be to use the form set as a key and list the contents corresponding to each form in a dictionary-like manner as in Table 9.3 creating a *morphomic paradigm*.⁸ It starts from visible data, the forms, and is based on surface observations, making contrasts between the proper contexts for each form. It captures three of the inflectional problems in (3): (a) syncretism, more than one content for a form, (b) defectiveness, some possible content does not appear, and (c) overabundance, some content appears for several forms. One inconvenience is that the paradigm shape might vary between lexemes. We have seen, for example in (1), that this is the case for English verbs with SET (three forms), TALK (four forms), and BE (eight forms).

Tabular paradigms are content driven; morphomic paradigms are form driven. In the following, we try to establish a more balanced representation of inflectional paradigms. First, we extend the definition of *cells* to characterize them in a more general fashion.

- (4) a. A cell is a group of contents whose phonological forms never contrast for any lexeme.
- b. Two contents do not belong to the same cell only if their inflected forms contrast for at least one lexeme.

⁸ Aronoff (1994) introduces the concept of morphemes for phonological forms corresponding not to a natural class of contexts definable by features but rather an arbitrary set of contexts. Latin third radical offers a striking example as it is used both for the *active future* participle and the *passive past* participle. This type of paradigm representation is typically found in Natural Language Processing resources such as *Wiktionary*.

Table 9.4. *The cell paradigm for English verbs*

Cell ₁	[ind, prs, 1, sg]	<i>set</i>	<i>talk</i>	<i>am</i>
Cell ₂	[ind, prs, 2, sg], [ind, prs, 1, pl], [ind, prs, 2, pl], [ind, prs, 3, pl]	<i>set</i>	<i>talk</i>	<i>are</i>
Cell ₃	[ind, prs, 3, sg]	<i>sets</i>	<i>talks</i>	<i>is</i>
Cell ₄	[ind, pst, 1, sg], [ind, pst, 3, sg]	<i>set</i>	<i>talked</i>	<i>was</i>
Cell ₅	[ind, pst, 2, sg], [ind, pst, 1, pl], [ind, pst, 2, pl], [ind, pst, 3, pl], [sbjv, pst, 1, sg], [sbjv, pst, 2, sg], [sbjv, pst, 3, sg], [sbjv, pst, 1, pl], [ind, pst, 2, pl], [sbjv, pst, 3, pl]	<i>set</i>	<i>talked</i>	<i>were</i>
Cell ₆	[sbjv, prs, 1, sg], [sbjv, prs, 2, sg], [sbjv, prs, 3, sg], [sbjv, prs, 1, pl], [ind, pst, 2, pl], [sbjv, prs, 3, pl], [inf]	<i>set</i>	<i>talk</i>	<i>be</i>
Cell ₇	[part, prs]	<i>setting</i>	<i>talking</i>	<i>being</i>
Cell ₈	[part, pst]	<i>set</i>	<i>talked</i>	<i>been</i>

Table 9.5. *Short and long forms distribution in Mauritian conjugation*

Cell ₁ (SF)	briz	brije	van	amād	kōsiste	egzis	fini	vin
Cell ₂ (LF)	brize	brije	vāde	amāde	kōsiste	egziste	fini	vini
TRANS.	'break'	'mix'	'sell'	'amend'	'consist'	'exist'	'finish'	'come'

Source: Henri (2010: 125–50)

With this specification in mind, we can define *cell paradigms* as a merger between tabular paradigms and morphomic paradigms capturing all general syncretisms. In this perspective, English verbs would have an eight-cell paradigm as shown in Table 9.4.⁹

Analyses of collapsed paradigms with very multifunctional forms usually adopt this perspective. The description of short and long forms distribution in Mauritian conjugation by Henri (2010: 125–50; Table 9.5) illustrates this point perfectly. The content paradigm is intricate but it can be presented as a simple cell paradigm with only two elements: a short form (Cell₁) and a long form (Cell₂).

In the Henri (2010) analysis, Cell₁ corresponds to the contexts where the verb is followed by non-clausal complements and the verb is not under verum focus.¹⁰ On the other hand, Cell₂ is found in contexts without non-clausal complements or when the verb is interpreted as a verum focus. For some lexemes, the two cells actually contain the same phonological form but all contents in Cell₁ always use the same short form, and all contents in Cell₂ always use the same long form.

⁹ Of course, BE is the only verb warranting more than five cells for simple synthetic forms; other verbs systematically collapse cells 1, 2 and 6 into one, and cells 4 and 5 into another. The auxiliaries and the modals might justify an even larger cell paradigm according to Zwicky and Pullum (1983), who argue that synthetic negative forms such as *isn't* or *didn't* should be included in their inflectional paradigm.

¹⁰ The term *verum focus* is introduced by Höhle (1992) for constructions “introducing an epistemic operator Verum (true) into the content and requiring that the content in the scope of Verum is ‘known’ or ‘presupposed’” (Henri *et al.* 2008: 8).

Table 9.6. *The subjunctive imperfective sub-paradigm of SER*

sbjv imperf		Cell ₁	[sbjv, ipfv, 1, sg], [sbjv, ipfv, 3, sg]	<i>fuera</i> ₁ , <i>fuese</i> ₂
1sg	<i>fuera, fuese</i>	Cell ₂	[sbjv, ipfv, 2, sg]	<i>fuera</i> _{s1} , <i>fuese</i> _{s2}
2sg	<i>fueras, fueses</i>	Cell ₃	[sbjv, ipfv, 1, pl]	<i>fuéramos</i> ₁ , <i>fuésemos</i> ₂
3sg	<i>fuera, fuese</i>	Cell ₄	[sbjv, ipfv, 2, pl]	<i>fuera</i> _{is1} , <i>fuese</i> _{is2}
1pl	<i>fuéramos, fuésemos</i>	Cell ₅	[sbjv, ipfv, 3, pl]	<i>fuera</i> _{n1} , <i>fuese</i> _{n2}
2pl	<i>fuerais, fueseis</i>			
3pl	<i>fuera</i> _n , <i>fuese</i> _n			
Tabular sub-paradigm		Cell sub-paradigm		

The definition in (4) also allows for interaction between overabundance and syncretism. In Spanish, for example, there are two series of inflected forms for the subjunctive imperfective as shown in the inflectional paradigm of SER ‘to be’ in Table 9.6. In this case, each content in the sub-paradigm has two phonological forms which do not contrast syntactically. Furthermore, the 1sg and 3sg contexts share the same forms for all lexemes. According to (4), [sbjv, ipfv, 1, sg] and [sbjv, ipfv, 3, sg] belong to the same cell. Note: The form part of the cell will systematically house two forms: *form*₁ and *form*₂.

Cell paradigms change the way in which the common inflectional problems in (3) are captured. General syncretism and overabundance are part of the cells’ definition, separating these global issues from local syncretism and overabundance. Interestingly, the tabular, morphomic, and cell views of English and Spanish verb paradigms are very different while they are the same for Latin verbs.

In this section, we have looked at different conceptions of inflectional paradigms, in the following section, we look at the way inflectional paradigms are analyzed by various linguistic theories.

2 Inflectional Paradigms in Linguistic Theories

Stump (2001) distinguishes four types of linguistic theories concerned with inflectional morphology based on oppositions between operations on form and content:

- (5) a. Types of form operations:
 - *lexical* theories use lexical pieces (stems and affixes)
 - *inferential* theories use lexical pieces and operations (reduplication, ablaut, etc.)
- b. Types of content operations:
 - *incremental* theories map form to content
 - *realizational* theories map content to form.

To explore the status of paradigms, we shift from this operation-oriented classification to an opposition based on the type of lexical units and the paradigms used. We will discuss three types of frameworks:

- *syntactic frameworks*: theories without presupposed paradigms, concerned with the interpretation of morpheme arrangements as they emerge from syntax, corresponding to Stump's lexical and incremental types (e.g., Item & Arrangement/Process, Word Syntax, Distributed Morphology)
- *syntagmatic frameworks*: theories adhering to the Lexicalist Hypothesis, "syntax neither manipulates nor has access to the internal form of words" (Anderson 1992: 84) and starting from content paradigms to assemble the exponents realizing the different feature bundles into form paradigms, belonging to Stump's inferential-realizational type (e.g., A-Morphous Morphology, Network Morphology, Paradigm Function Morphology)
- *paradigmatic frameworks*: theories starting from cell paradigms to predict the missing cell forms from the existing ones (e.g., Natural Morphology, Principal Part Systems, Implicative Morphology).

2.1 Syntactic Frameworks

While syntactic theories focus on the description of sentence structures, they are also concerned with the description of inflection, especially agreement and concordance. In some cases, the interaction with the morphological component is limited to lexical insertion of whole words without any relation to paradigmatic organization.

In this section we discuss three syntactic frameworks with a focus on morphology. All three share a common view of inflectional morphology: a constituent structure relating atomic units inside words, just as syntax relates words in phrases. These approaches are particularly well suited to regular agglutinative languages where laying out paradigms bears no added value but they are ill-equipped to describe most of the inflectional problems in (3), namely: defectiveness (3b), overabundance (3c), and deponency (3d).

2.1.1 Item & Arrangement/Process

The terms Item & Arrangement, and Item & Process were coined by Hockett (1954) to describe two models of grammatical description within American Structuralism. In this section, we consider both models together (IAP) as they share the same relations to paradigms.¹¹ IAP revolves around the concept of morpheme defined for example by Bloomfield (1926):

A minimum form is a morpheme; its meaning is a sememe. Thus a morpheme is a recurrent (meaningful) form which cannot in turn be analysed into smaller recurrent (meaningful) forms. Hence, any unanalysable word or formative is a morpheme.

IAP aims to find the morphemes of a language and their possible combinations using discovery procedures. For example, the description of Swahili

¹¹ For a discussion of their differences, see Hockett (1954).

Table 9.7. *Swahili conjugation fragment*

ninasema	<i>I speak</i>	wanasema	<i>they speak</i>	wunasema	<i>you (sg) speak</i>
anasema	<i>he speaks</i>	ninanupika	<i>I hit you (pl)</i>	munasema	<i>you (pl) speak</i>
ninaona	<i>I see</i>	ninakupika	<i>I hit you (sg)</i>	ananupika	<i>he hits you (pl)</i>
ninapika	<i>I hit</i>	ninawapika	<i>I hit them</i>	nilimupika	<i>I have hit him</i>
ninamupika	<i>I hit him</i>	ananipika	<i>he hits me</i>	nitakanupika	<i>I will hit you (pl.)</i>
nilipika	<i>I have hit</i>	ninapikiwa	<i>I am hit</i>	nitakapikiwa	<i>I will be hit</i>
tunasema	<i>we speak</i>	nilipikiwa	<i>I hit (past)</i>	wutakapikiwa	<i>you (sg) will be hit</i>

Source: Nida (1949: 12–13)

conjugation in (Nida 1949: 12–13) starts from form sets and uses a discovery procedure to recursively identify phonologically contrasting parts and the bits of meaning they bring to the form (feature sets). Inflectional morphemes are organized in feature/position classes giving template descriptions as illustrated in Table 9.7 with the conjugation of Swahili.

The structuralist analysis yields four sets of morphemes arranged into five positions by the template in (6):

Agreement	1sg <i>ni</i> , subjv.2sg <i>wu</i> , obj.2sg <i>ku</i> , subjv.3sg <i>a</i> , obj.3sg <i>mu</i> , 1pl <i>tu</i> , subjv.2pl <i>mu</i> , obj.2pl <i>nu</i> , 3pl <i>wa</i>
Tense	pst <i>li</i> , prs <i>na</i> , fut <i>taka</i>
Voice	passive <i>iw</i>
Vform	finite <i>a</i>

(6) subjv.agr–tense–(obj.agr)–root–(voice)–vform

This template ensures that inflectional morphology is treated as one derivation. In this case, every position is correlated with a content feature.

The IAP approach relies on contrasts both form-wise and content-wise to define a morpheme set. There is no morphological paradigm in the analysis but one could be recovered from the cross-combination of morphemes in the different position classes with orthogonal features.

2.1.2 Word Syntax

While the IAP approach seemed agnostic about paradigms, Word Syntax (WS) is not. Lieber (1982: 119) states clearly her position: “we need no special representation of inflectional ‘paradigms’ within this system; i.e., the notion of paradigm has no theoretical status here, and will be dispensed with.” Apart from this explicit rejection of paradigms, WS can be seen as an X-bar evolution of Item & Arrangement based on similar assumptions:

- Inflectional paradigms are analyzable at large.¹²
- Inflected words are the result of morpheme combinations.

¹² Lieber considers that inflectional paradigms are predominantly regular and that inflected forms can be reduced to their morphemic parts in most cases. Irregularities should be treated as exceptions rather than part of the system.

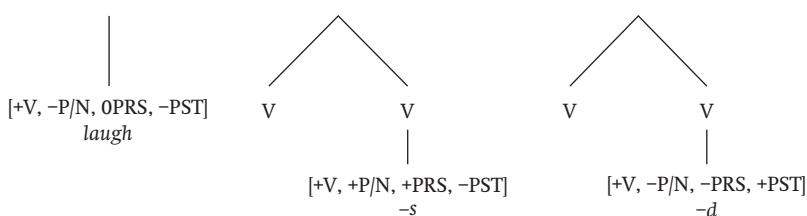
- Every morpheme comes with a category and features.
- Bound morphemes subcategorize for their base.

The combination of morphemes is constrained through category and features. For example, the conjugation of LAUGH could be described with the properties in (7a) and the morphemes in (7b):

(7) a. Category and features

- category: V
- person/number agreement: +/- P/N
- present tense marking: +/- PRS
- past tense marking: +/- PST

b. Morphemes

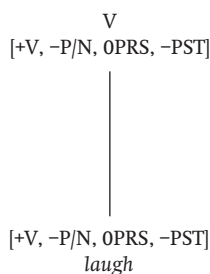


The morpheme features are percolated to the combination (Lieber 1982: 85–8):

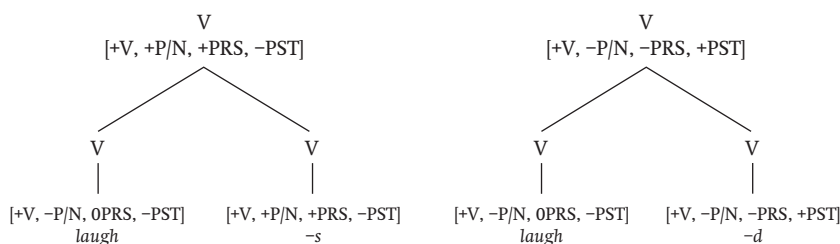
- (8)
- all features of a stem morpheme, including category features, percolate to the first non-branching node dominating that morpheme.
 - all features of an affix morpheme, including category features, percolate to the first branching node dominating that morpheme.
 - if a branching node fails to obtain features, features from the next lowest labeled node are automatically percolated up to the unlabeled branching node.

Three structures can be derived with the morphemes in (7b) and the previous conventions:

- one using the free morpheme *laugh*:



- two using *laugh* in combination with each of the bound morphemes, *-s* and *-d*:



The main difference between IA and WS lies with lexical structure. In WS, morpholexical rules can relate stems to account for morphological alternations that cannot be reduced to phonologically conditioned allomorphy. These rules introduce a paradigmatic dimension in WS, and the related items can be distinguished by diacritic features allowing inflectional affixes to select the right stem for their purpose. For Latin conjugation, Lieber (1982: 148) proposes two diacritic features T and D to discriminate between the classical stems of Latin verbs:

- AMARE ‘to love’: *am*[-T, +D]~*amā* [+T, +D]~*amāv* [+T, -D]~*amāt* [-T, -D]
- MORDERE ‘to bite’: *morde* [-T, +D]~*mordē* [+T, +D]~*momord* [+T, -D]~*mors*[-T, -D]
- CARPERE ‘to pluck’: *karp*[-T, +D]~*karpe* [+T, +D]~*carps* [+T, -D]~*carpt* [-T, -D]

This allows inflectional morphemes to select a specific stem among the morpholexically related stems of a given verb. In spite of the rejection of the notion in the preamble, morpholexical relations actually constitute a stem **paradigm** with purely morphological features.

2.1.3 Distributed Morphology

Halle and Marantz (1993) set up Distributed Morphology (DM) to describe inflectional morphology without using inflectional paradigms with an approach based on three main characteristics as defined by Noyer and Harley (1999):

- (9)
 - a. syntactic hierarchy all the way down
 - b. late insertion
 - c. underspecification of vocabulary items.

Contexts are formed directly by the arrangements of functional heads through syntactic movement and then by morphosyntactic merge and fission (9a). At the end of the syntactic phases (9b), each node contains a feature bundle (DM: *morpheme*) defining the morphological context for the lexical element (DM: *vocabulary item*) to be inserted. Lexical elements are not signs as they are only considered to be realizations for the feature bundles rather than the actual expression of their content. Furthermore, their feature bundles are not maximally specified. Each node selects the best

fitting lexical element for its own feature bundle according to Pāṇini's principle (9c).

DM uses feature sets and underspecified exponents but, contrary to IAP, one could not derive a tabular paradigm from these elements as the feature combinations are defined by syntax and an exhaustive list of possible feature bundles would depend on a review of all syntactic structures. The role of morphology is limited to the definition of the lexical items available to fit the feature bundles assembled by syntax; generalizations relate features to exponents without using paradigms, neither for content nor forms.

2.1.4 Inflectional Paradigms in Syntactic Frameworks

The syntactic frameworks share an identical view of paradigms as a superfluous notion in a linguistic theory. Their analyses rely on morphemes and syntactic rules to describe inflection. Accordingly, paradigmatic problems, such as defectiveness or deponency, are marginal subjects in their studies. Because they operate on a sub-word level, they replace inflectional paradigms with dictionary-like morpheme paradigms.

2.2 Syntagmatic Frameworks

The three syntagmatic frameworks presented in this section aim to define relations between an explicit content paradigm and the exponents used to realize the inflected forms for these contents; they differ in their details but share the Lexicalist Hypothesis and the same typical inferential-realizational assumptions about the components of inflectional morphology below:

- lexical units with indexed stems
- a content paradigm defining the *signifié* interface with inflectional morphology
- a function mapping content to exponence
- a resulting form paradigm.

The main differences between syntagmatic frameworks reside in the way they express generalizations.

2.2.1 A-morphous Morphology

The theory of inflection outlined in Anderson (1992, Chapters 4 and 5) relies on two devices: morphosyntactic representations (MSR) and word formation rules (WFR). A MSR is a feature structure describing the content of an inflected form; a WFR is a transformation rule modifying the morphophonological representation depending on context.¹³ WFRs are organized into blocks and explicitly ordered. The first applicable rule in each block

¹³ WFRs are similar to SPE rules (Chomsky and Halle 1968) where the contextual information would be the conjunction of a MSR and a phonological context.

applies. With this mechanism in mind, Anderson gives the following definition for a paradigm (1992: 134):

An item's paradigm is the complete set of surface word forms that can be projected from the members of its stem set by means of inflectional Word Formation Rules of the language.

For example, Anderson lays out a simple analysis of Georgian noun inflection (1992: 138–41) with MSRs (making up our content paradigm) made only from CASE (nom, erg, dat, acc, gen, adv) and NUMBER (sg, pl) features and the two blocks below.

MSRs [+nom, +sg], [+erg, +sg], [+dat, +sg], [+acc, +sg], [+gen, +sg], [+instr, +sg], [+adv, +sg], [+nom, +pl], [+erg, +pl], [+dat, +pl], [+acc, +pl], [+gen, +pl], [+instr, +pl], [+adv, +pl].

Block 1

$$\begin{array}{c} \left[\begin{array}{c} +N \\ +Pl \end{array} \right] \\ /X(a)/ \longrightarrow /Xeb/ \end{array}$$

Block 2

$$\begin{array}{c} \left[\begin{array}{c} +N \\ +Nom \end{array} \right] \\ /X/=Y[-Syllabic]/ \longrightarrow /Xi/ \end{array} \quad \begin{array}{c} \left[\begin{array}{c} +N \\ +Erg \end{array} \right] \\ /X/=Y[-Syllabic]/ \longrightarrow /Xm/ \\ /X/ \longrightarrow Xma/ \end{array}$$

$$\begin{array}{c} \left[\begin{array}{c} +N \\ \{+Dat, +Acc\} \end{array} \right] \\ /X/ \longrightarrow /Xs/ \end{array} \quad \begin{array}{c} \left[\begin{array}{c} +N \\ +Gen \end{array} \right] \\ /X(a)/ \longrightarrow /Xis/ \end{array} \quad \begin{array}{c} \left[\begin{array}{c} +N \\ +Instr \end{array} \right] \\ /X(a)/ \longrightarrow /Xit/ \end{array} \quad \begin{array}{c} \left[\begin{array}{c} +N \\ +Adv \end{array} \right] \\ /X(a)/ \longrightarrow /Xad/ \end{array}$$

The top part of the WFRs contains the MSR context, the bottom part describe the transformations. The WFR in Block1 describes the exponence for [NUMBER: pl]: add *eb* to the right of the current phonological representation.¹⁴ The tabular paradigm obtained with this description for the lexical item MAMA ('father', stem: /mama/) is shown in Table 9.8.

While the architecture of A-morphous Morphology clearly belongs to the syntagmatic frameworks, its general outlook is not turned toward paradigms as such. Content and form paradigms are not so much part of the

¹⁴ The +N stands for Nouns, the (a) means that final a is dropped in this transformation.

Table 9.8. *Tabular paradigm of MAMA ‘father’ in Georgian*

	NOM	ERG	DAT	ACC	GEN	INS	ADV
Sg	mama	mamam	mamas	mamis	mamis	mamit	mamad
Pl	mamebi	mamebma	mamebs	mamebis	mamebis	mamebit	mamebad

description as its by-products, making it stand apart from Paradigm Function Morphology and Network Morphology.

2.2.2 Paradigm Function Morphology

Turning unequivocally towards paradigms, Stump (2001: 32) defines Paradigm Function Morphology as a realizational framework¹⁵ starting with this basic assumption: “A word’s association with a particular set of morphosyntactic properties determines a sequence of rule applications defining that word’s inflectional form.” The model is organized around three modules:

- a feature geometry enumerating appropriate morphosyntactic property sets (MPS), the content paradigm
- a paradigm function associating a pair composed of a lexeme and an MPS $\langle L, \sigma \rangle$ to a phonological form
- a lexicon with at least one stem for every lexical item.

Following Gazdar et al. (1985: 17–42), the MPS are structured attribute value matrices where features have either an atomic value $\{\text{TNS:pres}\}$ or have a value that is itself a set of features $\{\text{AGR:}\{\text{PER:1, NUM:pl}\}\}$. The feature geometry describes exhaustively the possible structures through property co-occurrence restrictions (Stump 2001: 38–43). For example, the restriction of the imperative forms to the person 2sg is stated below in (10).

- (10) if σ is an extension of $\{\text{MOOD:ipfv}\}$, then σ is an extension of $\{\text{AGR:}\{\text{PER:2}\}\}$.¹⁶

With these property co-occurrence restrictions, PFM starts with a formal content paradigm which is then used to derive the inflected forms with various realization rules in a way similar to A-morphous Morphology. The rules are organized in blocks where rules compete. The most specific rule applies in each block.¹⁷ Every rule has a scope defined by a context, an underspecified MPS and a lexeme class. There are two types of rules:¹⁸

¹⁵ See definitions given in (5). ¹⁶ If an MPS contains $\{\text{MOOD:ipfv}\}$, it has to contain $\{\text{AGR:}\{\text{PER:2}\}\}$.

¹⁷ If no rule matches the MPS of the given lexeme, the block is passed without changing the phonological representation. According to PFM economy, there cannot be equally maximally specific rules.

¹⁸ In this presentation, we use the simplified rule format from Ackerman and Stump (2004) rather than the original one.

- rules of exponence matching a current phonological representation to a new one depending on its features

Block 2: $X_V, \sigma:\{\text{TNS:pst}\} \rightarrow X+d$ ¹⁹

- rules of referral matching a current phonological representation to a new one by getting the phonological result for a different set of features from given blocks

Block 2: $X_V, \sigma:\{\text{MOOD:subjv, TNS:pst}\} \rightarrow \langle XV, \sigma/\{\text{MOOD:ind, AGR:\{\text{NUM:pl}\}\}} \rangle:2$ ²⁰

Eventhough rules are meant to belong to a specific block, PFM uses portmanteau rules which have scope over a group of blocks and are selected over rules in the blocks. For example, in French, *nous sommes* ‘we are’ is the only indicative present 1pl not displaying the exponent *-ons* and the only form in the paradigm of ÊTRE ‘to be’ displaying a stem in *som-*, this oddity can be captured with a single portmanteau rule:

Block 1–5: $X_{\text{ÊTRE}}, \sigma:\{\text{MOOD:ind, MOOD:ind, AGR:\{\text{PER:1, NUM:pl}\}}\} \rightarrow \text{s3m}$.²¹

This very short overview of PFM²² shows that tabular paradigms are central in this framework aimed at filling content cells with inflectional forms. In this version, PFM captured two of the inflectional problems in (3): syncretism through underspecification (natural syncretism) and rules of referral (arbitrary syncretism), syntactic and semantic defectiveness through feature geometry. It excluded overabundance through its function interface (only one output per content cell), but deponency appeared only with Stump (2006) and a proposition to introduce *paradigm linkage* as a possibility to relate the syntactic content paradigm to a morphological content paradigm, allowing for deponency and heteroclisis²³ at the same time.

2.2.3 Network Morphology

Since the founding paper (Corbett and Fraser 1993), Network Morphology (NM) has concentrated on making direct generalizations about inflectional paradigms. An NM analysis starts from a content paradigm and a lexicon and states generalizations about the relations between the content paradigm and the form paradigm for lexical entries through a network of

¹⁹ The default rule for verbs past tense matching X to X+d.

²⁰ The form for past subjunctive in Block 2 is what the preterite indicative plural would be in the same block with all other features staying the same.

²¹ See Bonami and Boyé (2007a, appendix A) for an analysis of French conjugation in PFM. A more classical example of portmanteau exponent would be Swahili negative prefix for 1sg, *si-* as in *si-ku-tak-a* ‘I did not want,’ spreading over two blocks used for the other persons *ha-tu-ku-tak-a* ‘we did not want,’ one for analytic negation *ha-* and one for subject person *tu-* (see Stump (2001: 139–44) for the detailed PFM analysis).

²² The PFM version presented here is the one from Stump (2001); see Bonami and Stump (Chapter 17, this volume) for an overview of the evolutions since.

²³ In heteroclisis, a lexeme borrows sub-paradigms from different inflectional classes.

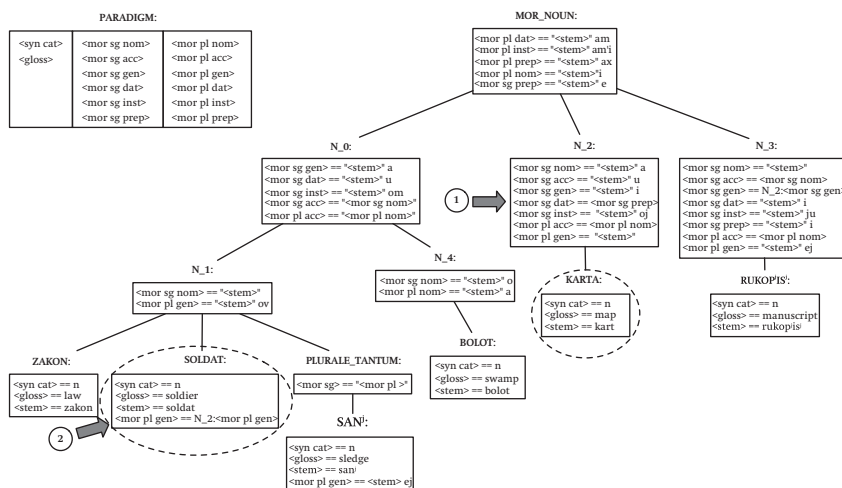


Figure 9.1. Russian noun declension outline

Source: Brown and Hippiisley (2012)

hierarchies. For example, Brown and Hippiisley (2012, Chapter 1) present the fragment in Figure 9.1 with a single hierarchy for simple Russian nouns.²⁴ The model defines the content paradigm to be realized on the left (PARADIGM) and the inflectional classes hierarchy on the right (MOR_NOUN). Hierarchies express generalizations through default inheritance. For instance, in the lexical hierarchy, the entry for KARTA stipulates only its category <syn cat>=n, its translation <gloss>=map, and its phonological stem <stem> kart. The information used to fill out the content paradigm is inherited from above. KARTA belongs to declension 2 (N_2) inside noun declension classes (MOR_NOUN). In this particular case, KARTA inherits all the information from its ancestors.

Some forms are described directly, such as the nominative singular being the stem suffixed with a (<mor sg nom>=<stem> a), others are defined through a referral ① such as the dative singular which is a copy of the prepositional singular (<mor sg dat>=<mor sg prep>). In the previous case, KARTA inherited all the information from its hierarchy because there were no contradictions in the information. The case of SOLDAT is different: <mor gen pl> is defined both at the level of SOLDAT and N_1. In this case, the most specific definition, the closest in the hierarchy, <mor gen pl>=N_2:<mor gen pl> applies. The equation notes the fact that the genitive plural of SOLDAT <mor gen pl> has the form of a second declension genitive plural N_2:<mor gen pl>. The “N_2:” marks a secondary inheritance local to the genitive plural.

²⁴ In NM, morphological feature bundles are marked by mor, separated by space and embedded in chevrons. <mor sg nom> is the equivalent of our [sg. nom].

Applying the same kind of strategies to multiple inheritance, Brown and Hippisley (2012) show that NM can model the complicated dataset of Russian noun inflection taking into account stress patterns, animacy/sex, genre and phonological shape of the root in orthogonal hierarchies.

2.2.4 Inflectional Paradigms in Syntagmatic Frameworks

Among the syntagmatic frameworks we described in this section, Amorphous Morphology and Paradigm Function Morphology put exponence front and center while Network Morphology concentrates on inflectional classes.

All three have formal paradigms but their places vary. For Anderson (1992), the analysis aims to create the right form for the right context through blocks of rules; their appearance in a paradigm is a consequence of the system. For Stump (2001), filling the content paradigm is the target of the paradigm function while in Network Morphology the description of inflectional classes presupposes paradigms.

The description of syncretism, defectiveness, and deponency figures among the principal objectives of all three. While syntactic frameworks concentrated on a sub-word level, the syntagmatic frameworks are lexeme-based and focus on the relation between content paradigms and form paradigms.

2.3 Paradigmatic Frameworks

Paradigmatic frameworks are characterized by generalizations about cell-to-cell rather than content-to-exponent relations. Most descriptions found in traditional grammars belong at least in part to this category.

Because these frameworks aim to make generalizations about cell-to-cell relations, the analyses they provided are less guided by content than the previous ones. This leads to under-analysis of exponents in general and would be particularly ill suited for radical agglutinative languages.

2.3.1 Natural Morphology

Natural Morphology (Dressler et al. 1987) aims to characterize morphology in many ways;²⁵ here we concentrate on the status of paradigms. Wurzel (1989: 112–20) introduces *paradigm structure conditions* (PSC) as a way to capture the implicative structure of inflectional paradigms. A PSC uses the inherent morphological properties and the known forms of a word to predict other forms. Wurzel gives the following examples about German nouns:

- If the nominative plural ends in *-er*, the genitive singular will end in *-s*.
- If the noun is masculine and its nominative plural ends in *-e*, the genitive singular will end in *-s*.

²⁵ See Chapter 14 for a general presentation.

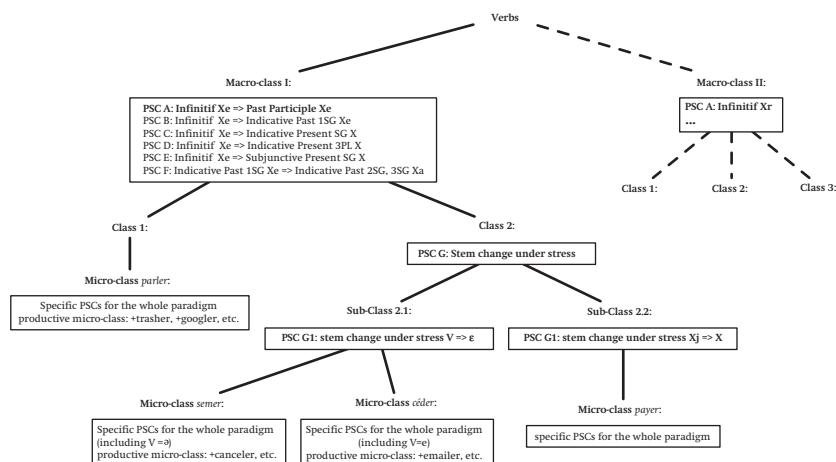


Figure 9.2. French verb classes outline

Source: Kilani-Schoch and Dressler (2005: 162–4)

While PSCs are local conditions usually relating a pair of cells, Natural Morphology uses inflectional class hierarchies to structure inflectional morphology globally. Kilani-Schoch and Dressler (2005), for instance, use two parallel classifications of inflectional classes called *dynamic morphology* and *static morphology*. The first one is based on a syntagmatic analysis of inflectional morphology in the spirit of Network Morphology while the second consists of a paradigmatic analysis based on stored lexical information. Both classifications compete in a dual-route model to produce and analyze inflection.

Natural Morphology is radically paradigm-oriented and is more concerned with paradigm stability, productivity, and regularity than syntagmatic frameworks. In Network Morphology, the network of hierarchies serves to capture multi-dimensional intricate syntagmatic constraints on exponence. In Natural Morphology, the hierarchies of inflectional classes are inheritance structures too but they also act as class types. In their description of French, Kilani-Schoch and Dressler (2005; Figure 9.2) define three types:

- micro-class: an inflectional class in the traditional sense, all lexical items belonging in the same micro-class have the same relations between their cells; micro-classes can be open (NM: productive) or closed (NM: nonproductive)²⁶
- class: inflectional classes belonging in a class share at least one common PSC
- macro-class: the most general type usually centered around a productive micro-class and characterized by at least one PSC unique to its members.

²⁶ Kilani-Schoch and Dressler (2005) distinguish these from isolated paradigms which differ in their form and content from all other paradigms and occupy arbitrary places in the hierarchies.

Microclasses are the basic elements of the classification, and one of the goals of Natural Morphology is to predict their migrations. For example, an unproductive microclass with low frequency lexical items might be attracted to a neighboring productive class.

2.3.2 Implicative Morphology

Implicative morphology is an emerging trend driven by the Paradigm Cell Filling Problem (PCFP) as defined by Ackerman et al. (2009: 54): “What licences reliable inferences about the inflected (and derived) surface forms of a lexical item?” Following the distinction proposed by Blevins (2006), this framework belongs to the abstractive approach based on relations between word-forms in cell paradigms as opposed to the constructive approaches presented in Sections 2.1 and 2.2.

In this section, we will discuss two flavours of Implicative Morphology, one concerned with predictions (Pirrelli and Battista 2000; Bonami and Boyé 2003; Boyé 2011; Stump and Finkel 2013) and another with predictiveness (Albright 2002; Ackerman et al. 2009; Bonami and Boyé 2014; Bonami and Luís 2014; Bonami and Beniamine 2015). Even though they both intend to solve the PCFP, their concrete goals seem to differ. The first group concentrates on how to derive a complete cell paradigm from known cells and revolves around the traditional concept of *principal parts*; the second group focuses on predicting one cell from a particular set of known cells using *entropy*.²⁷

Principal parts are defined by Stump and Finkel (2013: 11) as “a set of cells...from which one can reliably deduce the remaining cells.” For example, the complete paradigm of Latin verbs, its particular inflectional class, can be determined from the four following cells: *prs* 1sg, *pst* 1sg, *supine*, *inf*. In this context, implications are to be understood as logical connectives not predictions. To solve the PCFP, principal parts, static or dynamic,²⁸ have to be included in the known cells. This leads Stump and Finkel (2013: 17) to the concept of Pure Word and Paradigm Morphology and its second axiom:

- (11) The stored principal-parts hypothesis: A lexeme *L*’s entry in the lexicon includes a set of principal parts for *L*.

Bonami and Boyé (2003, 2007b) and Boyé (2011) propose a similar principle to describe French conjugation. Their principal parts, however, are not forms but stems²⁹ and they use a network of default implications to make

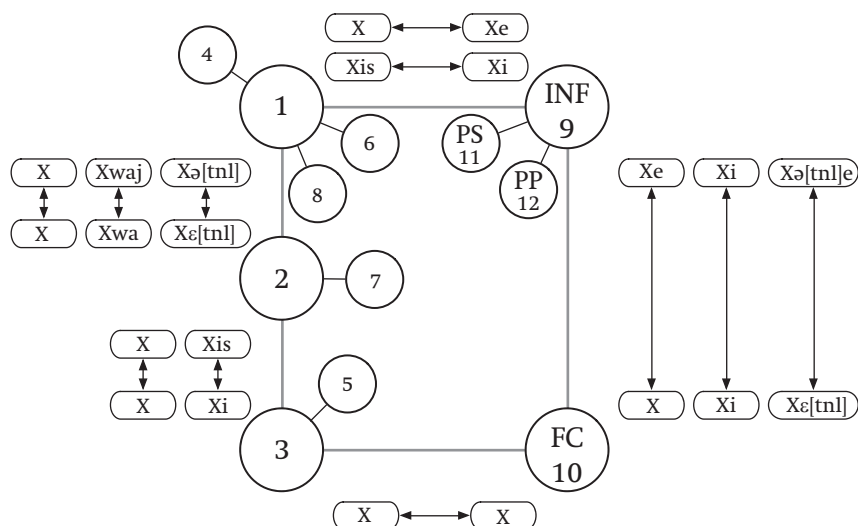
²⁷ In Information Theory, entropy measures the uncertainty as missing bits of information; in other words, it qualifies predictability. The outcome of a coin toss can be represented with one bit, so the entropy for a perfect coin toss is 1. Low entropy corresponds to high predictability.

²⁸ Static principal parts are a fixed set of cells that can be used to predict the complete cell paradigm of every lexeme, and dynamic principal parts associate a particular set of cells to each inflectional class.

²⁹ French verb inflectional classes being almost exclusively concerned with stems with very little exponent allomorphy involved, the discussion could be easily translated to forms.

Table 9.9. *Inferences from stem₉ fini using the implicative relations in Figure 9.3*

Stem ₁ : finis	$Xis_1 \leftarrow X_{i9}$	Stem ₅ : fini	$X_5 \leftarrow X_3$	Stem₉:	fini	
Stem ₂ : finis	$X_2 \leftarrow X_1$	Stem ₆ : finis	$X_6 \leftarrow X_1$	Stem ₁₀ :	fini	$Xi_{10} \leftarrow Xi_9$
Stem ₃ : fini	$X_3 \leftarrow X_{10}$	Stem ₇ : finis	$X_7 \leftarrow X_2$	Stem ₁₁ :	fini	$Xi_{11} \leftarrow Xi_9$
Stem ₄ : finis	$X_4 \leftarrow X_1$	Stem ₈ : finis	$X_8 \leftarrow X_1$	Stem ₁₂ :	fini	$Xi_{12} \leftarrow Xi_9$

**Figure 9.3.** Default implicative relations between stems

Source: Boyé (2011)

a system of dynamic principal parts. For example, in Figure 9.3, the link between stem₁ and stem₉ shows the default implicative relations:³⁰

- From stem₁ to stem₉
 - $Xis \rightarrow Xi$: if stem₁ ends in is then stem₉ ends in i
 - $X \rightarrow Xe$: stem₉ is stem₁ plus e
- From stem₉ to stem₁
 - $Xi \rightarrow Xis$: if stem₉ ends in i then stem₁ ends in is
 - $Xe \rightarrow X$: if stem₉ ends in e then stem₁ is stem₉ minus the e.

The known stems are stored in their cell and used to infer the forms of the missing stems using the compatible implicative relations. For instance, with a stem₉ *fini*, the complete stem set of FINIR ‘to finish’ can be deduced from the graph in Figure 9.3 following all the connections as shown in Table 9.9.

As much as a principal parts system can be an answer to the PCFP for lexicalized lexemes, it does not quantify the predictiveness of cells in general.

³⁰ Stem₁ is used in the indicative imperfective and for 1pl and 2pl indicative present. Stem₉ is used for the infinitive.

By opposition, Albright (2002) proposes a model of predictiveness for cell-to-cell relations based on analogy and reliability. His Minimal Generalization Learner (MGL: Albright and Hayes 2003) works in two phases:

- It calculates all the existing analogies between an input cell and an output cell within a reference lexicon and generalizes each analogy to its minimal common phonological context. Analogies are written in SPE format (Chomsky and Halle, 1968), for example in English, for the relation between [ind, prs, 1, sg] and [ind, prs, 3, sg]:
 - the input form set is matched to its output sets: $\emptyset \rightarrow s / \text{set}$ –
 - the context is reevaluated with each pair displaying the same transformation—for instance, $\text{p}^{\text{ik}}/\text{p}^{\text{iks}}$ —and minimally generalized to cover both pairs: $\emptyset \rightarrow s / X[\text{k}, \text{p}, \text{t}]$ –
 - after examining all the available pairs, the MGL obtains a list of rules relating the two cells.
- It estimates the reliability of each rule by comparing its scope, input forms potentially targeted by the analogy, to its hits, output forms correctly predicted by the analogy:
 - in Albright and Hayes (2003), for example, the regular rule affixing *-ed* after *t* and *d*³¹ could apply in 1,234 instances (scope); it is the right rule in 1,146 cases (hits) so its raw reliability is 92.9 percent.³²

Albright (2002) aimed to find the most predictive cell to use it as a single base to calculate inflectional paradigms. On one hand, this was a movement from global predictions to local predictiveness but, on the other hand, it was a move back from principal part systems to a single base hypothesis. With the emergence of the PCFP, the goal shifted from finding the optimal bases to evaluating predictiveness as such.

Building on adaptations of Albright's MGL,³³ Bonami and Beniamine (2015: 1) propose a numerical method to calculate the predictiveness of a group of known forms for a specific cell (*joint predictiveness*), thus making it possible to answer their own formulation of the PCFP: "How do speakers know how to inflect the full paradigm of a lexeme on the basis of exposure to only some of its forms?" This kind of model offers the possibility of exploring the relation between sparsely populated lexicons based on the frequency of inflectional forms and speakers' gradual competence³⁴ about inflection while making no assumptions about the relations between content and form.

2.3.3 Inflectional Paradigms in Paradigmatic Frameworks

In this section, Natural Morphology holds a place apart as a sort of hybrid between a syntagmatic framework and paradigmatic one. The dynamic

³¹ $\emptyset \rightarrow \text{ed} / X[\text{t}, \text{d}]$ –

³² Albright and Hayes make corrections according to the scope size giving an adjusted reliability of 87.2 percent.

³³ Bonami and Boyé (2014); Bonami and Luís (2014).

³⁴ Inflectional mistakes and insecurities are a common inflectional problem for some lexemes.

morphology of Kilani-Schoch and Dressler (2005) belongs to the former while their static morphology belongs to the latter.

Natural Morphology, overall, seems to consider paradigms first and foremost through inflectional classes and exponence relations. On the contrary, principal part systems as well as entropy-centric predictiveness studies take a cell view of paradigms where exponence does not occupy the center stage, the content properties only playing a role as an index for the cell content. In this respect, paradigmatic frameworks are word-based in the sense of Blevins (2006), describing relations inside a paradigm rather than the paradigm itself.

3 Paradigms in Morphology

So far, we have looked at the status of paradigms in inflectional morphology. While syntagmatic and paradigmatic frameworks agree on their being central in this field, there is no such consensus on their status in derivational morphology. In this section, we first present arguments for a paradigmatic dimension in derivational morphology starting from Van Marle (1985) and Roché (2009) and then we turn to proposals for derivational paradigms with Bauer (1997) and Bochner (1993).

3.1 The Paradigmatic Dimension of Morphological Creativity

Both the approaches presented here oppose the rule-only view of derivation as characterized by word- or lexeme-formation rules. The first one starts from a reflexion on the nature of derivation; the second one comes from studies on the organization of the lexicon. They introduce a paradigmatic dimension to the organization of derivation and the lexicon but not the derivational paradigms we will see in Section 3.2.

3.1.1 Paradigmatic Derivational Morphology: The Dutch Thread

Van Marle (1985) argues against the purely syntagmatic approach of derivational morphology proposed by Aronoff (1976) where derivations are described via Word Formation Rules as in (12) because this describes the syntagmatic relation in (13a) but misses the paradigmatic relation between the *syntactic category* of the base and the *morphological category* of the derived word in (13b).

- (12) *un-* prefixation à la Aronoff (Van Marle's version)

$[X]_{\text{Adj}} \rightarrow [\text{un}\# [X]_{\text{Adj}}]_{\text{Adj}}$

semantics (roughly) $\text{un}\#X = \text{not } X$

- (13) a. Derivation (Base) $\rightarrow$ Derived Lexeme
 b. Syntactic Category $\longleftrightarrow$ Morphological Category

Table 9.10. *Stem Allomorphy in non-native part of the Dutch lexicon*

word	non-word stem	non-native derivations
<i>drama</i> 'drama'	<i>dramat-</i>	<i>dramat-isch</i> 'dramatic' <i>dramat-iek</i> 'dramatics' <i>dramat-urg</i> 'dramatist'
<i>functie</i> 'function'	<i>function-</i>	<i>function-eel</i> 'functional' <i>function-eer</i> 'to function' <i>function-aris</i> 'functionary'

Source: Booij (1997)

He defines a morphological category (words derived with the same WFR) with two relations of similarity, a relation between words sharing the same phonological and semantic properties, and a relation between words sharing the same phonological and semantic differences with their base.

The set of possible bases for a morphological category is called its *derivational domain*. Morphological categories can in turn be related along three paradigmatic axes (Saussure 1916):

- same derivational domain
- same phonological differences with their bases
- same semantic differences with their bases.

These relations transform the isolated WFRs of Aronoff (1976) into a network of related morphological categories. These relations are oriented by derivation and not to be confused with the symmetrical relation Van Marle uses to describe non-derivational analogical coining where, for example, Dutch speakers create a [+female] counterpart for French borrowings such as *dompteur* 'animal trainer' and *rechercheur* 'detective' lacking a lexical one, as well as neutral terms for feminine borrowings.³⁵

Becker (1993) extends Van Marle's analogical coining for nonproductive word creation to back-formation (*babysit* ← — *babysitter*), cross-formation (*fascism* ← — *fascist*), replacive formation (*horsemanship* — — *airmanship*) and finally to productive morphology, proposing to consider all formations of complex words as the result of proportional analogy. In his perspective, morphological analysis should follow relations of motivation rather than syntagmatic structure.

Booij (1997) studies allomorphy in Dutch derivation and defends a similar view (Table 9.10). Many allomorphies are shared by independent WFRs and cannot be reduced to a morphophonological phenomenon or affix allomorphy. The formal variations have to be assigned to idiosyncratic stem allomorphy. The WFRs, selecting a particular stem allomorph, are

³⁵ Neutral to +female: *dompteur* → *domptrice*/*dompteuse*, *rechercheur* → *rechercheuse* and also +female to neutral: *vendeuse* → *vendeur* 'salesperson', *institutrice* → *instituteur* 'school teacher'.

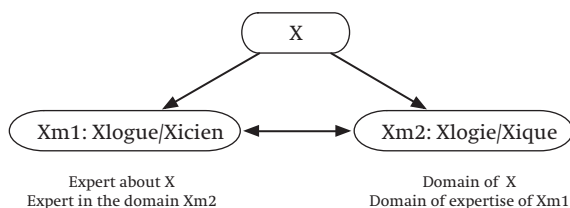


Figure 9.4. Morphological triangle

Source: Lignon et al. (2014)

paradigmatically related in a way similar to Van Marle's morphological categories sharing the same derivational domain.

3.1.2 Lexical Morphology: The French Connection

Based on empirical studies of French morphology, Roché (2004, 2009, 2011, 2015) introduces a similar paradigmatic dimension to derivational morphology in opposition to the rule-centered approach of Corbin (1987). His observations concentrate around semantic motivation and converge with Becker (1993) on the idea that relations of motivation should not guide morphological analysis in cross-formations only (*carrossier* ← → *carrosserie*).³⁶

Roché (2011) proposes a Lexical Morphology organized explicitly around two principal paradigms:

- *derivational family*: words related to the same base
- *derivational series*: words related to their base with the same derivation.³⁷

Both are extended to cover lexical relations: the *derivational family* covers words directly or indirectly related to the same base; the *derivational series* extends to words sharing the same phonological and semantic marks, irrespective of the existence of a base. For instance, *vigueur* 'vigor' belongs to the same lexical derivational series as *hauteur*, feminine property nouns ending in *-eur*, even though *hauteur* derives from *haut* and *vigueur* has no proper base in modern French.³⁸

With Lignon et al. (2014), Lexical Morphology takes a new step towards paradigmatic organization, introducing morphological triangles between a base and derived lexemes in possible cross-formation. Triangles combine to constitute a mesh network of lexical relations creating a global structure for the (derived) lexicon (Figure 9.4).

3.2 Derivational Paradigms

Paradigmatic Derivational Morphology developed from the idea that even a single derivation has a paradigmatic dimension, and Lexical Morphology

³⁶ 'car body repairer' ← → 'car body'. ³⁷ This is the same as Van Marle's (1985) morphological category.

³⁸ See Hathout (2011) for an implemented example of Lexical Morphology.

from the concept of derivational family and its place in morphology. Bauer (1997) starts directly from paradigms and examines the properties in (14), deemed typical of inflectional paradigms, and makes the parallels with derivation shown in (15).

(14) Paradigms:

- a. are a series of related forms which share a base or a base-type (lexeme-based)
- b. contain forms semantically related by more than the idiosyncratic meaning of the base (feature geometry)
- c. are generalizable patterns of forms (inflectional classes)
- d. are frequently arranged round a basic form, or a set of basic forms, from which other forms can be predicted (principal parts)
- e. are organized in such a way as to reduce the burden of memory in learning forms (low entropy)
- f. play a role in linguistic change (paradigm shift).

(15) Derivations:

- a. Sets of forms are derived from a single base (derivational family: *national*, *nationalize*, *nationalist*, ...).
- b. Sets of derived words share more than the base meaning (cross-formation: *nationalist*, *nationalism*).
- c. Corresponding derived forms create generalizable patterns (morphological triangles: *morphology*, *morphologist*, *morphological*).
- d. Lexical families generally gather around one lexical item, sometimes a few.
- e. Derivation is highly redundant with lexical families and morphological series.
- f. New derivations appear from reanalysis (paradigmatic innovations: *WaterGate*, *IranGate*, *MonicaGate*).

Bauer (1997: 251) concludes that “derivation does not behave the same way as inflection but the parallels are so close as to make it entirely appropriate to discuss derivation in terms of paradigms.” To illustrate furthermore the problematic status of paradigms in morphology, the common problems listed in (3) as inflectional problems, in fact, also affect derivational morphology but are usually labeled with a different name. This argues for more than the introduction of a paradigmatic dimension to derivation morphology, and Bochner (1993) makes an explicit proposal for a Lexical Relatedness Morphology (LRM) with global paradigms encompassing inflection and derivation (Table 9.11). His individual relations (LRM: patterns) resemble those of Becker (1993) but they are imbedded in what he calls *related patterns*. This structure is actually a derivational paradigm allowing for all sorts of sub-paradigms (inflectional, derivational, back-formation, cross-formation, etc.).

Table 9.11. *Parallel paradigmatic accidents in inflection and derivation*

inflection	$\Leftrightarrow$	derivation
syncretism	$\Leftrightarrow$	polysemy
defectiveness	$\Leftrightarrow$	partial productivity
overabundance	$\Leftrightarrow$	rivalry
deponency	$\Leftrightarrow$	affix substitution

4 Conclusion

Paradigms are a linguistic phenomenon appearing mainly with contrasting phonological forms associated with parallel differences in content. We reviewed different perspectives on inflectional paradigms that depended on the languages studied and the data covered. We presented some arguments about paradigms in derivation and their divergence from inflectional paradigms. One missing aspect of this discussion has been *paradigm uniformity*. Inflectional paradigms are canonically considered uniform: same number of cells, same number of forms for all the lexemes in a given category. This is not the case for aspiring derivational paradigms, however; does this mean they should not be considered paradigms?

Paradigm uniformity is not absolute in inflectional paradigms either. The existence of some cells might vary with individual lexical items in a category depending on syntactic properties (e.g., transitivity for passive), semantic properties (e.g., no imperative for MUST) or even inflectional class (e.g., no synthetic comparative for INTELLIGENT).

A more inclusive definition of paradigms could start with the ones proposed for derivational morphology (parallel variation between form and content) and work out a more specific definition for inflectional paradigm. From this underspecified definition of paradigms, Lexical Morphology proposed a simple organization with two paradigmatic axes: families, sharing same lexical semantic value and series, sharing peripheral abstract value. In inflectional morphology, family is the most visible paradigm while series are the center of study in derivation. In inflection, series are usually considered at the level of the complete family paradigm (inflectional classes), while global families are only marginally considered in derivation. But irregularities tend to concentrate on these less visible aspects: idiosyncratic unanalyzable forms in inflection are usually found in a limited number of cells (series) while disparities between form and meaning in derivation appear with specific lexical items and their derived lexemes (families).

Coming back to the notions defined in Section 1, the various paradigms we mentioned should in fact be seen as views on a unique object. The tabular inflectional paradigm cuts across cells (series) displaying one lexeme (family) at a time and tends to impose a uniform format to all

lexemes in a category. The morphomic inflectional paradigm starts from existing forms and associates them with content with no obligatory parallel between lexemes. Using both views to describe inflection rather than the intermediary cell view promoted by implicative morphology, we can observe a neglected aspect overlooked within the uniform paradigm point of view, the reverse Paradigm Cell Filling Problem which can be formulated in exactly the same way as the original: “What licenses reliable inferences about the inflected (and derived) surface forms of a lexical item?” Answering this question could lead to the development of a reverse PFM to make morphomic paradigms from form sets by mapping them to sets of content bringing inflection closer to derivation.

Of course, the difference in content between inflection and derivation remains. The fact that the interpretation of derivation uses the linguistic and extra-linguistic context is incomparable with the extremely regular interpretation of inflectional features. But the dual view (tabular and morphomic) shows how the status of paradigms is central to morphology in general and how the Paradigm Cell Filling Problem of Ackerman et al. (2009) should become the Paradigm Filling Problem for a global morphology.

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Part III

Morphological Principles

10

Lexicalism, the Principle of Morphology-free Syntax and the Principle of Syntax-free Morphology

Paul O'Neill

1 Introduction

Since this present chapter is in a section entitled “Morphological Principles” it should be pointed out that the word *principle* has two basic definitions relevant to the present discussion.¹ Principles can refer both to truths and also to beliefs. In the first meaning principles are synonymous with *essences* and *facts*; in the second, with *doctrines* and *tenets*. These two meanings are, at the same time, extremely different and related. Their relation is attested by both meanings being simultaneously evoked in one definition of the word *principle*: a fundamental truth that serves as the foundation of a system of belief. Lexicalism and the Principles of Morphology-free Syntax and Syntax-free Morphology are beliefs, or sets of beliefs, since they each contain subsets of additional beliefs or stipulations. They are, however, beliefs which, I contend, are based on fundamental facts or truths. In order to arrive at these truths it is important to distance oneself from the fine details of the principles in their different instantiations and focus on the generalisations which they embody. Thus, Lexicalism comes in many different guises and is involved with a number of different linguistic principles and hypotheses: Principle of Lexical Integrity (Anderson 1992: 84; Bresnan 2001: 92), Generalised Lexicalist Hypothesis (Lapointe 1980: 8), Word Structure Autonomy Condition (Selkirk 1982: 70), the Syntactic Atomicity Thesis (Di Sciullo and Williams 1987: 49), the Limited Access Principle (Lieber and Scalise 2006: 128), and also the Principle of Morphology-free Syntax (Zwicky 1987: 654) and the Principle of Syntax-free Morphology (Zwicky 1987: 654). A common assumption which underlies all these principles and hypotheses, and which is central to the theoretical stance which Lexicalism

¹ Another definition of principle is that of the phrase *a man/woman of principle*, which is related to morality, moral standards and codes of ethics.

constitutes, is that there exists a component responsible for the production of words (but not always all words) and that the rules and mechanisms of this component function differently from the rules which govern phrase structure (note that this is a belief and not necessarily a truth). This is the definition of Lexicalism that will be adopted in this chapter.²

Likewise the Principles of Morphology-free Syntax and Syntax-free Morphology have been related to a number of different beliefs: the existence of purely morphological features (Corbett and Baerman 2006); the view that syntax cannot access the internal structure of words (Brown and Hippisley 2012). However, the essence of these principles is not that morphology and syntax can never interact—since they obviously do, as attested by cases of morphosyntactic agreement and the phenomenon referred to by Zwicky (1985a, 1985b, 1990, 1992) as shape conditions³—but rather that there exist different components responsible for the production and structure of words and the production and structure of phrases. And not only do the rules and mechanisms of each component function differently, but words possess certain properties and characteristics that are wholly unrelated to phrases and vice versa.

These principles and the theoretical stance of Lexicalism are contentious issues; they have been the source of intense debates and research programmes, especially the extent to which the rules of phrase structure have access to and can manipulate the internal structure of words. The aim of this chapter is not to give a detailed overview of the debates since this has already been done (Scalise and Guevara 2005; Lieber and Scalise 2006: 128; Booij 2009). Rather, I aim to summarize the main points of contention and concord, and suggest that by distancing oneself from the details one can access the general truths which constitute the real morphological principles: that languages differentiate between words and phrases, and words display a set of properties and characteristics which are wholly and entirely unrelated to phrases and rules of phrase structure. These truths then lead

² Often, theories which advocate syntax-free morphology or Lexicalism are thought to be those which espouse that morphology exists and is independent of and subject to rules which are not the same as those of syntax. In my definition of Lexicalism, I have avoided using the words *morphology* and *syntax* since these terms are ambiguous in the present context. For example, theories can advocate Lexicalism and at the same time consider word structure and its production to be governed wholly by syntactic operations and principles (this is similar to the point made by Spencer 2005: 78). Crucially, however, these processes of syntax (below the word) need to operate in a way that is different from and independent of the syntactic operations that govern phrase structure. Likewise, morphology is generally considered to be the study of complex words, and in any standard contemporary introductory textbook on the subject will include chapters on inflection, derivation, and compounding. These 'standard' parts of morphology do not always cluster together and populate the same component of the grammar.

³ Shape conditions refer to rules which specify certain aspects of the phonological shape of words in relation to triggers which can lie outside the syntactic word. The different phonological shapes cannot be derived via general phonological rules of the language since they often only apply to limited set of lexical items (e.g., the alternation *a/an* for the English indefinite article, the spurious *se* of Spanish whereby the 3sg dative clitic *le* becomes *se* in a specific syntactic environment or the fact that the Spanish feminine definite article *la* appears as the masculine *el* when heading a NP which contains a noun that begins with a stressed */a/*). See references in the body of the text for more examples and a full discussion of this phenomenon.

us to assume other principles, this time to be classed as beliefs: that the architecture of languages distinguishes two separate components, one for the structure and realization of words, the other for the structure and realisation of phrases – let us call them morphology and syntax – and the rules and workings of each component are different.

2 Origins of Lexicalism

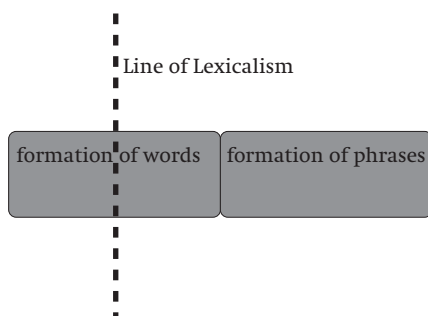
The birth of Lexicalism can be traced to Chomsky's (1970) publication *Remarks on Nominalization*. Previous to this publication, although Morphology was central to the work of both nineteenth-century European linguists and American Structuralists (Scalise and Guevara 2005), with the advent of Generative Grammar (Chomsky 1957) all complex words were constructed, along with phrases and sentences, in accordance with phrase structure rules and transformations; the rules of syntax manipulated not only simplex words but also individual morphemes. The relationship between words such as *arrive* – *arrival*, *destroy* – *destruction* was given a purely syntactic explanation whereby nominal phrases such as *The King's arrival* or *Nero's destruction of Rome* were derived from syntactic verbal phrases akin to [The King_{NP} arrive_V]_S and [Nero_N destroy_V Rome_N]_S. These phrases underwent nominal syntactic transformations and were subject to phonological rules; indeed, the fact that *destroy* did not produce the nominalization **destruction* was handled by an omnipotent phonology. The justification of deriving nominal forms from verbs was to preserve the generalization that, in syntactic constructions of both forms, the arguments of the verb performed the same function and could be substituted by appropriate nouns.

In *Remarks*, however, Chomsky reassessed this assumption and noted, among other things, the highly irregular relationship between derived nominals and their supposedly corresponding verbs (*profess* – *professor* – *profession* – *professional*; *social* – *socialist* – *socialite*) and that sometimes there did not exist a verb (*tuition* but no **tut*, *motion* but no **mote*); see Newmeyer (2009: 93–7) for a full discussion. The Lexical Hypothesis was therefore proposed whereby derivational, but not inflectional, morphological processes were not subject to the transformational rules of syntax but entered the syntax directly from the lexicon as nominal forms. The result was that the province of the lexicon was greatly expanded; it was no longer merely “an appendix of the grammar, a list of basic irregularities” (Bloomfield 1933: 274) which provided the syntax with words but could have internal computation regarding word-building; crucially, also, the rules of this computation were different from those of phrase syntax.

In its inception, the Lexical Hypothesis can be conceived as a line which was drawn between some processes of word formation and phrase formation, as diagrammatically represented in (1). The assumption was that the

rules and principles governing word formation to the left of the line did not operate in the same way as those on the right of the line. The theoretical space on the left of the line was the lexicon, which was now empowered with a possible generative component of its own. The right of the line was the domain of syntax which governed free forms, compounds, and inflectional morphology.

(1)



The publication of *Remarks* resulted in intensive research on the exact nature of the rules which operate in the lexicon, from those concerned with word-formation and their interaction with phonology (Halle 1973; Aronoff 1976; Kiparsky 1982a, 1982b, 1983) to concepts of Predicate Argument Structure and Lexical Conceptual Structure and, of course, the interactions with syntax. Much research was dedicated to where this “Line of Lexicalism” fell. That is, what phenomena, traditionally considered morphological, ought to be to the left of this line and what to the right (and subject to the rules of syntax). Inflectional morphology was at the centre of many of the debates; for Chomsky, this fell to the right of the Line of Lexicalism and was part of syntax, and this stance was adopted by many others (Aronoff 1976; Anderson 1982, 1992; Scalise 1988), and is often termed the Weak Lexical Hypothesis. For Halle (1973) inflectional morphology fell to the left of the “Line of Lexicalism” and this author stipulated that all morphological phenomena ought to take place in the lexicon and be separate from the rules governing phrase formation. This proposal has become known as the Strong Lexicalist Hypothesis and has been associated with a wide array of stipulations and restrictions.⁴ The most frequently

⁴ I list here a number of these restrictions associated with the strong and weak versions of the Lexical Hypothesis: the output of the morphology is the input to the syntax (Borer 1998: 152–3); words are built by different principles of composition than syntactic phrases (Bresnan and Mchombo 1995: 181); word formation rules never take syntactic phrases as their input (Botha 1983); the syntax neither manipulates nor has access to the internal structure of words (Anderson 1992: 84, Booij 2005); syntactic rules cannot alter the lexical meaning of words (including argument structure) (Spencer 2005: 81); no syntactic rule can refer to elements of morphological structure (Lapointe 1980: 8); syntactic rules have no access to the internal structure of XO categories. (Spencer 2005: 81); no deletion or movement transformations may involve categories of both W-structure and S-structure (Selkirk 1982: 70); words are “atomic” at the level of phrasal syntax and phrasal semantics (Di Sciullo and Williams (1987: 49); morphologically complete words are leaves of the c-structure tree and each leaf corresponds to one and only one c-structure node (Bresnan 2001: 92).

cited of these is the **Lexical Integrity Hypothesis/Principle**,⁵ which stipulates that syntax is blind to the rules governing the structure and formation of words and therefore does not have access to nor can operate on the internal structure of words, including their semantics (Lapointe 1980; Di Sciullo and Williams 1987; Anderson 1992; Ackema and Neeleman 2004).

In sum, Lexicalism evolved into much more than a line which demarcated the phenomena which were subject to the rules of phrase structure from those subject to rules of word structure. It now included a number of rules and conditions about this line and the interaction between both components. I use the analogy of the Line of Lexicalism being akin to a frontier between two countries (the different components) and the principles relating to this line as the border controls. Thus, the No Phrase Constraint (Botha 1983) necessitated that the border controls pertaining to the domain of word structure stipulate that no syntactic phrase could be the input of word-formation rules. Likewise, on the syntax side of the line, the Lexical Integrity Hypothesis required the border controls to make the internal morphological structure of words blind when they passed into syntax.

These principles were motivated by much empirical evidence. For example, the fact that *a slow composition*, in the context of music, does not refer to a piece of music which was composed slowly but rather to a composition in which the music itself is slow can be explained by the Lexical Integrity Principle: the adjective *slow* in the syntax has no access to the semantics of the base *compose* in the nominalization *composition* (Bosque 2012). The same principle also explains why parts of a word cannot be extracted out of a word via rules of syntax and cannot be moved internally in the word. This first fact is exemplified by the examples in (2) from Dutch (taken from Ackema and Neeleman 2002) in which the word *pruimen* ‘plum’ in the compound *pruimen boom* ‘plum tree’ cannot undergo WH-movement or topicalization (note also that these authors prove these restrictions cannot be explained via notions of Relativized Minimality or syntactic conditions on chain formation).

- (2) Dit is een [pruimen boom]
 this is a plum tree
 *Wat is dit een [____ boom]?
 what is this a tree
 *Pruimen is dit een [____ boom]!
 plum is this a tree

There exist various counterexamples to the principles which constitute the “border controls.” First, however, it is necessary to analyze the terminological distinction between Lexicalism and the Principles of Morphology-free Syntax and Syntax-free Morphology.

⁵ This principle was not exclusively associated with strong versions of Lexicalism.

3 Lexicalism and the Principles of Morphology-free Syntax and Syntax-free Morphology

Lexicalism is a term predominately used in theories of generative grammar for models which adhere to some version of the Lexical Integrity Hypothesis. The term *lexical*, however, is ambiguous and often misunderstood (for a full discussion see Aronoff 1994: 16–22 and Carstairs-McCarthy 2010: 38–45). Aronoff distinguishes two usages of the term *lexical*, the first related to the concept of a lexeme and synonymous with *lexemic* and the second associated with the idiosyncratic and the need to be stored and remembered. This latter usage is derived from the Bloomfieldian view of the lexicon as “a basic list of irregularities” (Bloomfield 1933: 162). Di Sciullo and Williams (1987: 3) on the nature of this conception of the lexicon state that “like a prison—it contains only the lawless, and the only thing its inmates have in common is lawlessness.” This idea of lexicalism pertaining to the idiosyncratic and irregular is clear in early works on morphology within generative grammar as attested by Anderson’s (1982) distinction between derivational morphology which is “inside the lexicon” and inflectional morphology which is “outside,” and also Aronoff’s (1976) distinction between productive processes which are “outside the lexicon” and unproductive processes which need to be lexically listed (see also Carstairs-McCarthy 2010: 42).

Morphological phenomena, however, are at the same time irregular and also regular; that, for me, is the beauty of morphology. On irregularity Carstairs-McCarthy (2010: 39) notes that “nothing allows us to predict that the adjectives *curious*, *glorious*, and *various* shall have as their corresponding nouns *curiosity*, *glory* and *variety* rather than (say) *cury*, *gloriety*, and *variosity* or that the verbs *arrive* and *derive* shall have as their corresponding nouns *arrival* and *derivation* rather than *arrivation* and *derival*.” This irregularity can be contrasted, however, with the numerous cases in which morphology is regular and predictable (e.g., plurality on nouns, the 3sg present tense suffix and the derivational suffix *-ness* in English). Indeed, many articles have been written by numerous scholars to show that morphology is not *lexical*, in the idiosyncratic sense, but corresponds to rules and can be regular; morphology is, as the title of Geert Booij’s (2007) book states, *The Grammar of Words*. Moreover, this regularity is not only present in the domain of inflection (Anderson 1992) but also in derivation as demonstrated most notably by Aronoff (1976) in his monograph on this topic or Jackendoff (1975) in his article entitled “Morphological and semantic regularities in the lexicon” (see also Carstairs-McCarthy 2010: 39–41).

Despite efforts to introduce terminological clarity (Di Sciullo and Williams 1987; Williams 2007)⁶ the word *lexical* and the concept of

⁶ These authors introduce the terms “listeme” and “storage house” to designate the items which need must be memorized and the place where these items reside respectively. These listemes are contrasted with words which do conform to rules; the collection of these rules is called the “word system.”

Lexicalism are not only ambiguous but also associated with a number of theoretical implications regarding the structure of words, the existence of morphemes as the basic units of structure, and the assumption that morphological processes take place in the lexicon and not in the morphology. Indeed, there was no component with such a nomenclature which prompted Anderson (1982) to write an article with the title: “Where’s morphology?” In response, Jensen and Stong-Jensen (1984) published a paper with the title “Morphology is in the lexicon!”⁷

Given the assumptions of Lexicalism as defined in my Introduction (the belief in a component responsible for the production of (some) words whose rules and mechanisms function differently from the rules which govern phrase structure) then it is understandable why a number of theories make a terminological distinction between the Bloomfieldian lexicon and a morphological component which is responsible for word structure and morphological realization. One such theory is Network Morphology (Brown and Hippisley 2012), an inferential-realizational theory of morphology which does not define itself as “lexicalist,” presumably due to the ambiguities and theoretical implications inherent in that term, but does adhere to the definition of Lexicalism as used in this chapter. Network Morphology advocates an autonomous morphological component which deals with all morphological phenomena and whose rules are independent of and different from the autonomous component of syntax. It is specifically stated (Brown and Hippisley 2012: 17) that “The autonomous morphological component serves the syntactic component by generating objects that are inserted into the syntax. These objects are *encapsulated* . . . they are treated as black boxes.” This notion of an autonomous morphology and words being *encapsulated* when they enter the syntax is similar to the assumptions of the Lexical Integrity Hypothesis. However, the terminology is different; no mention is made of this hypothesis but the two autonomous modules of syntax and morphology are considered to be subject to the following principles respectively: the Principle of Morphology-free Syntax and the Principle of Syntax-free Morphology (Zwicky 1992: 354–5).

Both principles, in accordance with how they were first used,⁸ relate to the nature of rules that can occur in each component and can be understood as

⁷ The answer from proponents of Distributed Morphology would be that morphology is distributed throughout the grammar (syntax and phonology) and also present in the idiosyncratic list of vocabulary items.

⁸ These terms were first proposed by Zwicky (1987: 654) in an article which aimed to explain why some verbs in English resist passivisation (e.g., resemble: she resembles her aunty versus *her aunty is resembled by her) while other verbs cannot be used actively (rumor: it has been rumored that Tracy is bald versus *someone has rumored that Tracy is bald). In this article, this author criticizes analyses of the passive within a theory of monostratal syntax which treats English passive verbs as lexically derived via a feature [vform:psp], which instructs verbs to use the past-participle (psp) form in passive constructions; this feature can have a plus or minus value which supposedly explains whether or not a lexeme can be passive. His criticism of the lexical analysis is that, based on arguments which are not seminal to the present discussion, in order to account for the data the lexical rule must not only contain the feature [vform:psp] but also the syntactic feature [+pas] (used in a passive construction). This, however, contravenes the Principle of Syntax-free Morphology since the passive construction to which the feature [+pas] refers has no relevance to the

constraints on the nature of morphological and syntactic rules. The Principle of Morphology-free Syntax prohibits any rule of syntax from making reference to the internal structure of a word or to purely morphological features (see also Corbett and Baerman 2006) and, likewise, the Principle of Syntax-free Morphology forbids morphological rules from paying attention to syntactic context or purely syntactic features. These two components interact but via an interface in which “details irrelevant outside of the module should not be part of the interface representation” (Brown and Hippisley 2012: 17). Thus, the interface follows both of the aforementioned principles.

Both Lexicalism and the Principles of Syntax-free Morphology and Morphology-free Syntax acknowledge the existence of a component which governs word structure and whose rules are different to and independent of the component which governs phrase structure; however, the principles call this former component the morphology and not the lexicon. Note also that from its first usages the Principle of Morphology-free Syntax has been associated with Lexicalism (see Zwicky 1987: 650),⁹ the Lexical Integrity Hypothesis, and stipulations and restrictions therein. Such a similarity between these terms is evident in the definition of the Principle of Morphology-free Syntax by Network Morphology via the references to words being encapsulated and syntax not having access to the internal structure of words. Note, however, that both principles have the added stipulation of prohibiting each component from referring to features which are considered purely the province of the other domain – purely syntactic and purely morphological features. If we distance ourselves from the particulars as well as the theory-specific assumptions and terminology, the important additional point of these features is that words and phrases possess certain characteristics which are wholly unrelated to one another. For example, the position of a word should not be dependent on the conjugational class of a verb, nor should the fact that some verbs are deponent and/or defective be based on whether they occur in a main or subordinate clause.

4 Developments in Lexicalism

From the proposal of the Strong Lexicalist Hypothesis to the present day, debates in the linguistic literature have been characterized by the following:

morphological system of English. He makes the point that, unlike other languages which have a dedicated synthetic morphological form for realizing passive constructions, English realizes the passive periphrastically using the verb *be* and the form of the past participle. Thus, [+pas] for English is a purely syntactic feature and the concept of [vform:psp] is a purely morphological feature since it merely instructs the morphology to use a particular verb form.

⁹ Zwicky (1987: 650) defines the principle thus: “syntactic rules cannot make reference to the internal morphological composition of words or to particular rules involved in their morphological derivation.” He goes on to note that this “fundamental assumption in grammatical theory” is sometimes referred to as the Lexicalist Hypothesis or the belief that syntax is blind to morphology.

- (a) A tug-of-war with regard to the “Line of Lexicalism” and the linguistic phenomena which fall to the left and right of this line, and are therefore subject to rules of word structure or phrase structure respectively.
- (b) The presentation of data which seemingly contradict the assumptions and stipulations of Lexicalism, and the presentation of counter-analyses of the same data.
- (c) An overall relaxing of the border controls on both sides of the morphology-syntax divide on the basis of empirical data.

Below I present a summary of each of these points.

4.1 Tug-of-war over the Line of Lexicalism

The approaches to compounding and cliticization exemplify this first point. Clitics, and especially those termed *special clitics* (Zwicky 1977), characterized by a particular positioning in the phrase, are usually considered to be subject to the rules of syntax and themselves independent syntactic items which occupy a separate terminal node (Butt and King 2005). However, Anderson (2005) in his book *Aspects of the Theory of Clitics*, offers an impressive cross-linguistic study of clitics from many different languages and argues for special clitics to be treated as phrasal affixes and subject to morphological rules and principles (see also the treatment of clitics in Portuguese by Luís (2004), Luís and Otoguro (2004), Luís and Spencer (2005) and also clitics in Udi by Luís and Spencer (2006)).

Compounding is defined as a process which creates new lexemes but via the combination of two or more elements which “can function as a lexeme independent of the other(s) in other contexts” (Bauer 2001: 695). Some linguists consider the formation of compounds to pertain to the domain of morphology (Booij (2005) and Ralli (2010), among others) while others, to varying degrees, consider it a matter of syntax (Anderson 1992; Lieber 1992; Aronoff 1994; DiSciullo 2005). Indeed, in their survey on the different perspectives of compounding in the linguistic literature, Scalise and Vogel (2010) conclude that there is no agreement as to whether compounds are to be considered as formed in the morphology or the syntax. An interesting point of view is expressed in an article by Bağrıaçık and Ralli (forthcoming) which analyses compounds predominantly in modern Greek and Turkish. Their argument is that “the locus of compounding, whether it is in morphology or in syntax, is strictly ‘compound-dependent’” and that “although compounding is ultimately a process of lexeme-formation, the output can be generated either morphologically or syntactically.” A similar argument has been advanced for nominalizations in Turkish by Kornfilt and Whitman (2011). These authors claim that there are some nominalizations in Turkish which are syntactically derived and others which are morphologically derived; the latter can display suspended affixation, which is a criterion for deciding whether the nominalization is syntactic or

morphological. Here the Lexical Integrity Hypothesis is maintained but linguistic processes such as compounding or derivational morphology are allowed to be split and be subject to the rules of either morphology or syntax according to their linguistic behaviour. Note, however, that such a conclusion contradicts claims that word formation is exclusively a morphological process (Bresnan 1997, 2001) and that syntactic rules have no access to internal word structure and hence cannot create words.

4.2 Presentation of Data against the Lexical Principles and Presentation of Counter-analyses of the Same Data

With particular reference to the Principle of Syntax-free Morphology a number of phenomena from different languages have been claimed to constitute clear counterexamples. Thus, in a variety of Italo-Romance spoken in Castrovillari (Lopocarro 2008: 167–72), in present perfect constructions of the type *I have washed the grapes*, the past participle only agrees in gender and number with the direct object when the verb belongs to the idiosyncratic morphological class which displays strong past participles (rhizotonic and morphologically irregular). Likewise, in Latvian (Holvoet 2012), normative grammars state that the occurrence of a particular irregular morphological form of the vocative in nouns, which is distinct from the nominative, determines a particular type of adjectival agreement, a special vocative ending -o. Similarly, in Serbo-Croat (the name used to refer to Serbian/Croatian/Bosnian), patterns of agreement are considered to be influenced by the inflectional class of the noun. Finally, and with reference to Syntax-free Morphology, in Dutch the choice of exponent for 2sg is argued to depend on the position of the subject with respect to the verb; when the verb precedes the subject there is no marker for 2sg as opposed to when it follows the subject and the exponent is -t (Ackema and Neeleman 2004: 192; 2007: 341; Brown and Hoppisley 2012: 19).

Such data would seem to constitute, *prima facie*, persuasive evidence to reject outright the Principles of Syntax-free Morphology and Morphology-free Syntax. However, with the exception of the data from Italo-Romance, a more detailed and careful analysis of the phenomena has indicated that other explanations are available (see references above) and that these examples may not constitute counterexamples to the aforementioned principles. With particular reference to the Serbo-Croat data, the initial generalization was that this language has three genders (masculine, feminine, and neuter) and, when nouns are conjoined, the agreement on the target differs according to the following principles: if both nouns are masculine, neuter, or of differing genders the agreement will be masculine; if both nouns are feminine the agreement on the target will be resolved in favour of feminine agreement except if one of the feminine nouns belongs to a particular inflectional class, in which case the resolution will also be masculine (Browne 1993; Corbett and Baerman 2006). Such data constitute a

clear violation of the Principle of Morphology-free Syntax since there is no reason why the syntax should be sensitive to the purely morphological notion of inflectional class membership. However, Corbett and Baerman (2006: 234) have demonstrated that the generalization is not related to matters of inflectional class but matters of semantics: feminine agreement is only the default when females are actually being denoted; in all other cases the default is masculine gender. The data which supposedly contradicted the Principle of Morphology-free Syntax are cases in which the combination of two feminine nouns, one of which belonged to a special inflectional class, produced masculine agreement. Such agreement is to be expected when non-females are referred to; the particular inflectional class in question is characterized by abstract nouns which are inanimate.

With reference to the extent to which syntax can have access to and manipulate the internal structure of words, data from Germanic languages have been advanced as possible counterexamples since these languages possess a class of verbs that have an idiosyncratic semantics and can be classed as single lexical items, but they contain a prepositional element which can be stranded syntactically from the verb (*to stand somebody up*, *to turn the light off* versus *to look after the child*). Booij (2002, 2009), however, has argued with particular reference to Dutch, that although such verbs are lexical units, they cannot be considered words; he argues for a phrasal analysis of such units and maintains that they do not contravene the Lexical Integrity Hypothesis, which he considers only applies to words. Likewise, this author (2009) argues that the insertion of a word between the syllables of another word (cases like *abso-fuckin-lutely*) constitutes a particular type of word-formation process which has recourse to the prosodic structure of the base word and does not contravene the Lexical Integrity Hypothesis. Similarly, the same author (2009) has invoked prosodic specifications to explain away the cases in which affixes can appear separated from their bases in syntactic constructions of coordination. Relevant examples are given in (3) below (for more examples and analyses see also Booij 1985; Nespor 1985; Spencer 2005: 82; Chaves 2008; Bruening 2015).

- (3)
1. The conflicts of the 1960s commonly began in confrontations of pro- and antiestablishment alignments.
 2. How “post” does “postcolonial” have to be before it ceases to be a – or the – primary determinant in the way Irish writing is read, and reads itself?
 4. pro- as opposed to anti-war
 5. hypo-but not hyper-glycemic
 6. Pre- and post-revolutionary France were very different from each other.

Such examples are not only restricted to these type of prefixes, often characterized as prefixoids (Spencer 2005: 82), but can also occur with other affixes, although by no means all affixes as examples in (4) testify (taken from Spencer 2005: 82).

- (4) 1. write- or printable
2. mouse- or rat-like
3. *un- and re-tie
4. *in- or ex-port.

Booij (2009: 88) argues that “gapping is not necessarily a form of syntactic manipulation, and there is convincing evidence that it is prosodic in nature,” and provides evidence to this effect.

4.3 Overall Relaxing of the Border Controls

The most recent rigorous assessments of Lexicalism and, in particular, the Lexical Integrity Principle (Scalise and Guevara 2005; Lieber and Scalise 2006; Booij 2009) are characterized with what I have termed the relaxing of border controls, which makes reference to the stipulations regarding the interactions between syntax and morphology. Recall that a number of versions of Lexicalism maintained that:

- (a) the morphological component could not have access to syntactic structures since the morphology fed the syntax—thus word formation processes could not involve syntactic phrases (No Phrase Constraint, Botha 1983)
- (b) syntax was blind to the morphology and thus rules of syntax could not have access to or manipulate the internal structure of words (Principle of Lexical Integrity, Anderson 1992).

The aforementioned assessments come to the consensus that (a) is incorrect and (b) needs modifying along the following lines: the syntax can have access to the internal structure of words but cannot manipulate the internal constituents. I précis this as: the syntax can see but cannot touch.

One piece of evidence to consider (a) incorrect comes from phrasal compounds,¹⁰ which are instances of whole phrases which participate in morphological processes via their incorporation into noun-headed compounds; these are attested in English, German, Dutch, and Afrikaans as shown in (5) (Booij 2002; Meibauer 2003, 2007; Spencer 2005; Trips 2012; Bruening 2015).

- (5) English the [[language-of-thought] thesis]
 a [[run-of-the-mill] film]
 a [[don't-you-dare] look]
 a [[first-in-last-out] policy]

¹⁰ Wiese (1996) and Bresnan and Mchombo (1995) have suggested that such examples are not cases of phrases within compounds but rather lexicalized quotations. Such a stance seems empirically implausible given that many of these compounds are created from novel sentences. In my English the following compound is possible: “you have an I-want-to-butt-you-in-the-nose look on your face” (see also Meibauer 2007: 240; Lieber and Scalise 2006). So the simple fact remains that this morphological process (compounding) can utilize syntactic constituents and therefore the morphology must have access to or be fed by the syntax.

	a [[slept-all-day] look]
	the [[little-and-often] principle]
	the [[recycle-at-all-costs] policy]
	a [[dog-eat-dog] world]
German	die [[Länger-leben]-Diät]
	‘the longer-live diet’
	die [[Affe-auf-Schleifstein]-Position]
	‘the ape-on-grindstone position’
	der [[Vater-und-Sohn]-Konflikt]
	‘the father-and-son conflict’
Dutch	[[lach of ik schist] humor]
	‘laugh-or-I-shoot humour’
	[[unit je bol] muziek]
	‘out-of-your-head music’
Afrikaans	[[God is dod] teologie]
	‘God-is-dead theology’
	[[uitt die ondo op die tafel] skottel]
	‘out-of-the-oven-to-the-table dish’

The morphology is responsible for the formation of the compound and the syntax for the well-formedness of the phrase, and thus either both modules must work in parallel or the syntax must feed the morphology; however, see discussions in Bağrıaçık and Ralli (forthcoming) for an interesting new proposal.

The data which prompt the conclusion that the principle in (b) needs to be modified to “the syntax can have access to but cannot manipulate the internal structure of words” are of a complex nature and come from a number of different languages (see Booij (2009) and Lieber and Scalise (2006) for a detailed overview). In what follows I will present a summary of the data in which I will abstract away the specific examples and describe the effects which motivate the conclusions.

Booij (2009) provides data from Georgian and Upper Sorbian (Corbett 1987) in which the particular morphological form of one word, which syntactically modifies another word, suggests that the former word has had access to the internal structure of the latter. Moreover, the data from Georgian prompt the conclusion that the modifying word has access to the semantics of the internal structure. More specifically, Booij (2009: 91) claims that:

As far as the semantics is concerned, the Georgian example is similar to the English phrase *transformational grammarian* in which the adjective *transformational* modifies the constituent *grammar* of the complex word *grammarian*. This is a well known example of a bracketing paradox: semantically the adjective *transformational* forms a constituent with *grammar*, but syntactically it forms a unit with *grammarian*.

Spencer (1988) in his analysis of this construction claims that such an interpretation is possible given the well-known and well-formed phrase *transformational grammar* and the relationship between *grammar-grammarians*. However, Booij (2009) provides a wealth of examples from Dutch in which there is the same restricted scope of interpretation but in the absence of any well-formed phrase of the type *transformational grammar*. His conclusion is that “these facts clearly show that word internal structure must be visible to rules of semantic interpretation. Hence, the Principle of Lexical Integrity should be phrased in such a way that it does not forbid rules for the semantic interpretation of phrasal constituents to have access to word internal structure” (2009: 96).

5 Stepping Back from the Details and Appreciating the “Big Picture”

Given the data presented in the previous section, one might be tempted to ask the following question: if morphological processes can have as their input whole phrases and syntax can have access to the internal structure of words, then what, if anything, remains of the principles of Syntax-free Morphology, Morphology-free Syntax, Lexical Integrity, and Lexicalism in general? My response to such a question would be that the essence of Lexicalism, as defined at the beginning of this chapter, remains valid: there are two distinct components in grammar which govern the ordering of smaller elements into larger meaningful ones: one is responsible for the production of words; the other is responsible for the production of phrases. And the rules and mechanisms of each component function differently.

These components obviously interact with each other in a complex way, and there are elements such as lexical items and constructional idioms (Jackendoff 1997, 2002; Booij 2009) which display characteristics of both words and phrases, but the essence is that there are two distinct systems. Indeed, Booij’s conclusion (2009) to his overview of the Lexical Integrity Hypothesis and whether this constitutes a “morphological universal” is that the hypothesis is merely a “further interpretation of the universal principle that all languages distinguish between words and phrases. The distinction between words and phrases only makes sense if the word exhibits a higher degree of cohesiveness than the phrase and hence we need the ‘no syntactic manipulation’ constraint to give substance to the distinction between words and phrases.”

This essence of Lexicalism is also expressed by Williams (2007: 17) when he states that the fundamental question is “whether there are two systems (the word system and the phrase system) with a narrow interface, or a single system, a question independent of the so far meaningless question of what structure or properties the list, or lists, of listemes might have.”

In this respect it is instructive to analyse the observations made by both Carstairs-McCarthy (2010) and Anderson (2015). Both authors note the similarities between phrase structure and word structure; that is, the rules governing the ordering of smaller elements into larger meaningful structures, be these words or phrases. They both point out that it seems to constitute a “superfluous complication” (Anderson 2015: 13) to have two extremely similar processes which are subject to different rules or principles. The fact of the matter is, however, that this is how language works; there are two systems and one cannot be derived from or subsumed under the other. Both authors exemplify this point with reference to the contrasting ordering of grammatical arguments involved in an event, when these arguments appear as morphological constituents within words as opposed to phrasal constituents in the syntax. Their data come from languages with a rich morphology and in which phrases such as *they bit him/her/it* can be expressed either as a phrase or as a single word via suffixes. The point of both authors is that when the complex event is expressed as a single word, the order of the participants in the event is markedly different than when the exact same event is expressed as a number of different words within the syntax.

Thus, Anderson (1992: 22–37; 2015) presents data from Kwakw’ala, a Wakashan language of coastal British Columbia, which has a rigid syntax whereby the verb appears in initial position followed by the subject and the object. However, when elements corresponding to a verb and its object are combined within a single word, they typically appear in the order object-verb rather than verb-object. Likewise, subjects precede objects in the syntax but this order is reversed when the participants in an event are expressed by morphological constituents. Carstairs-McCarthy (2010: 20–2) presents similar data from Zulu which demonstrate that the word order in the syntax is subject, verb, object but when complex expressions are expressed as a single word the order of the grammatical participants in an event is subject, object, verb.

These data follow from the definition of Lexicalism used in this chapter, (that there exist two different components of grammar, one dealing with the structure of complex words and the other with the structure of phrases, and that both are subject to different rules and mechanisms), a definition which Carstairs-McCarthy agrees with and claims (2010: 19) to be “The near-universal conclusion of linguists.”

It must be noted, however, that not all morphological models adhere to the existence of two independent components, as expressed by my definition of Lexicalism. In staunch opposition to lexicalist models are those models which desire to eliminate the “Line of Lexicalism” and have word-structure governed by syntax. These models must not be confused with those which propose a syntactic account of word-structure but maintain that the syntax below the word-level functions differently from that above

the word level, and that the former is not a by-product of the latter (e.g., Ackema 1995; Emonds 2002).¹¹

Distributed Morphology (Halle and Marantz 1993; Marantz 1997; Embick and Noyer 2007 among others) is most widely recognized as the theory which rejects the concept of Lexicalism. Proponents of Distributed Morphology propose a model of “syntax all the way down” in which the rules and principles that govern the structure of words are identical to those that govern the structure of phrases. They are the rules of syntax and the syntactic terminal nodes, which are referred to as morphemes, comprise bundles of morphosyntactic features which are only given phonological substance after all syntactic operations have taken place (late insertion). Thus, Baker (1985: 375) proposes the Mirror Principle whereby “Morphological derivations must directly reflect syntactic derivations (and *vice versa*)” and Marantz (1997, 2001), the Single Engine Hypothesis whereby a “single engine” is responsible for both word-structure and phrase-structure (see also Arad 2003).

If what has traditionally been considered a morphological environment is merely only a type of syntactic environment then the question remains as to why there is such a wealth of evidence from so many different languages to suggest that this particular type of environment is a special syntactic environment. Why does one particular environment display cohesion, and does not allow its constituent parts to be manipulated by the rules of syntax? Why is there so much crosslinguistic evidence that the rules governing word structure are substantially different from rules governing phrase structure? Why are the similarities not more evident?

Indeed, if we take a canonical syntactic property, such as the position of the verb in a sentence, and compare it with a canonical morphological property, such as membership of a particular conjugation class, if the same principles and rules govern word and phrase structure then why is it not the case that we do not find numerous languages in which the position of the verb in subordinate clauses depends on the conjugational class of the verb, or conversely the conjugation class which a verb takes is determinant on whether the verb appears in a particular position, perhaps governed by its appearance in a main clause or a subordinate clause? Indeed, such examples seem not to exist (however, see discussions above).

I suggest that such examples do not exist and there is so much evidence of word structure being substantively different from phrase structure because, although syntax and morphology can and do interact and the former may not, on the whole, be blind to the internal structure of the

¹¹ In this respect it difficult to classify the theory of Lieber (1992) since she claims that the mechanisms used in phrasal structure are also the ones that govern word structure and therefore no Line of Lexicalism is assumed; however, as pointed out by a number of scholars (Ackema 1995: 5–8; Borer 1998: 162–4; Carstairs-McCarthy 2010: 23–9), she modifies the theory and principles of syntax in such a way that it undermines the attempt to reduce all morphology to syntax.

latter: the basic insight and generalization of Lexicalism still remains valid: morphology and syntax obey different types of rules despite their interactions. Moreover, as expressed by the essence of the Principle of Syntax-free Morphology, there are characteristics that the morphological component displays which are wholly unrelated to matters of syntax and semantics, phenomena which are purely morphological. In what follows I will present evidence to support this claim.

6 The Purely Morphological

Within the domain of inflectional morphology and upon the assumption that the different morphological forms of a lexeme correspond to combinations of different morphosyntactic features, following Stump (2014), a canonical situation would be one in which there is a direct correspondence between morphosyntax and inflection and each different set of morphosyntactic features corresponds to a different morphological form of a lexeme. In reality, the relationship is much more complex, since morphological systems display cases in which different lexemes correspond to exactly the same set of morphosyntactic features but the exponents of these features are different, due to the inflectional class of the lexeme. Likewise, lexemes can occur in very different syntactic and semantic contexts, and thus be paired with different morphosyntactic features; however, the exponents of either these features and/or the stem allomorph for the lexeme can be identical. Such mismatches between the morphosyntactic content and the actual form of inflected words is the motivation behind Stump's distinction between content paradigms and form paradigms (Stump 2001, 2014, 2015). Indeed, this author has recently shown (Stump 2014) that the mismatches between the morphosyntactic features with which a lexeme is matched and the realized form of the word often can only be explained with reference to phenomena which are relevant exclusively to the morphological component. Such phenomena have been characterized as corresponding to *purely morphological* features (Corbett and Baerman 2006), which are listed as the following:

- inflectional class features
- morphophonological features
- stem indexing features
- syncretic indexing features.

Due to restrictions of space I will only analyze examples of the last two phenomena and I will do so in a way which relates them to Aronoff's (1994) concept of the morpheme and the morphomic level, which are often used as evidence for the autonomy of morphology and the Principle of Syntax-free Morphology.

A typical characteristic of morphological inflectional systems is that the form of the word that identifies the lexemic meaning can appear in various phonological forms. This allomorphy can at times be accounted for in purely phonological terms or, conversely, the allomorph can be correlated with a particular set of semantic or morphosyntactic properties. The most interesting cases of allomorphy, for the present purposes, however, are the cases in which sets of lexemes display recurrent allomorphy which cannot be reduced to any functional or phonological common denominator, for they consist of phonologically disparate forms whose distribution within the paradigm does not obey any semantic or syntactic criteria. The English past participle, which is used in perfective verb forms in periphrases with an auxiliary verb, and also in passives, has been suggested to constitute one such example and has been used as an example of the Principle of Syntax-free Morphology (Zwicky 1987) and Autonomous Morphology (Aronoff 1994: 24). This latter author points out that synchronically passives and analytic perfects cannot be said to share a constant significant functional property¹² since they correspond to different syntactic and semantic values; however, they always share the same phonological form, as shown in the examples in (6). Likewise Zwicky (1987: 658) points out that what he terms the base form of the verb, the form which occurs with infinitival *to*, also corresponds to no fewer than thirteen semantic and/or syntactic usages as shown in (7) for the verb *to be*.

- (6) *Present perfect* *Passive*
 he has seen it is seen
 he has bitten it is bitten
 he has sought it is sought
- (7) BASE: I need to be quiet.
 PERCEPTIVE: I saw/heard Pat *be* abusive.
 CAUSATIVE: I made/had Chris *be* polite.
 PERMISSIVE: I let Terry *be* in charge
 AFFECTIVE: I've never had anyone *be* nice to me
 MODAL: I must *be* dreaming
 SUBJUNCTIVE: I require that they *be* heard
 IMPERATIVE: *Be* still, my heart.
 EXCLAMATORY: Them *be* quiet! Never!
 INJUNCTIVE: The Gods *be* kind to you, my friend.
 HORTATIVE: Let's you and me *be* friends
 SERIAL: I want you to go/come *be* nice
 EXCLUSIVE: Rather than *be* quiet, we whistled.

Zwicky makes the point that, in a grammatical framework which does not advocate the Principle of Syntax-free Morphology, nothing would

¹² Aronoff is open to the possibility of a common functional property uniting these two cells (1994: 176), see Iatridou et al. (2001), and references therein, for a possible semantic and functional motivation.

militate against the claim that the above syntactic/semantic specifications were all associated with different but homophonous forms of the verb. He concludes, however, that “what we want to say about a list like [those in (7)], it seems to me, is that they are inventories of distinct syntactic constructions that employ, incorporate or ‘call’ the same morphological form” (1987: 659). This basic notion of multiple syntactic and semantic values being realized by the same morphological form is what Aronoff makes recourse to in order to advocate the *morphomic level* and the existence of *morphomes*, to be understood as an abstract term referring to a function which relates a set of morphosyntactic features with a possible (set of) morphophonological realization rule(s) (see Aronoff 1994: 24–5 and for a full discussion of the definition of the morphome and different usages see O’Neill 2014: 28–32).

Such “morphomes” are better illustrated with an example from Spanish and Portuguese, languages with a more complex and abundant inflectional morphology than English (note that the data set here is adapted from O’Neill 2014). These languages both contain several lexemes which display a particular stem allomorph in a number of tenses which share no coherent phonological, semantic or morphosyntactic function; these tenses will be referred to as the PYTA tenses.¹³ In Table 10.1 I give the inflectional paradigm for the Spanish verb *saber* ‘know’ and in Table 10.2 for the same verb in Portuguese; the PYTA tenses, which display the particular allomorph, are shaded. In Spanish there are approximately fifteen verb roots¹⁴ (not counting their prefixal derivatives) that display a particular type of allomorphy exclusively in the PYTA tenses,¹⁵ the preterite (“past perfective indicative”), and the imperfect subjunctive (“past subjunctive”) – two alternative paradigms.¹⁶ In Portuguese the PYTA tenses are four in number (the preterite, the imperfect subjunctive, the pluperfect, and the future subjunctive) and there are twelve verbs which display this allomorphy.¹⁷

¹³ PYTA is an acronym of the phrase *perfecto y tiempos afines* ‘perfect and related tenses’ employed by Spanish grammarians in referring to the paradigmatic distribution of the allomorphy.

¹⁴ I list the verbs which display particular allomorphs in the Spanish PYTA tenses; in order to appreciate the allomorphic differences in the lexemes I provide for each lexeme the forms of the 3sg preterite, the 3sg present indicative, and the infinitive: *condujo* – *conduce* – *conducir* ‘drive’; *cupo* – *cabe* – *caber* ‘fit’; *dijo* – *dice* – *decir* ‘say’; *estuvo* – *está* – *estar* ‘be’; *fue* – *es* – *ser* ‘be’; *fue* – *va* – *ir* ‘go’; *hizo* – *hace* – *hacer* ‘do’; *hubo* – *ha* – *haber* ‘have’ (auxiliary verb); *pudo* – *puede* – *poder* ‘be able’; *puso* – *pone* – *poner* ‘put’; *quiso* – *quiere* – *querer* ‘want’; *supo* – *sabe* – *saber* ‘know’; *trajo* – *trae* – *traer* ‘bring’; *tuvo* – *tiene* – *tener* ‘have’; *vino* – *viene* – *venir* ‘come’.

¹⁵ In medieval Spanish there also existed another PYTA tense, the future subjunctive, which was a continuant of both the Latin future perfect indicative and the perfect subjunctive paradigms. This tense was used in the protasis of conditional sentences, usually to highlight that the situation was hypothetical and possible. From the fourteenth century onwards the use of this verb form declined and although many grammarians recommended its use at the onset of the twentieth century, in present-day Spanish it is no longer used in spoken speech. In written documents its use is limited to legal documents and formulaic phrases.

¹⁶ *Imperfect subjunctive* is the term used in traditional grammar, but no aspectual distinction is encoded.

¹⁷ Unlike the Spanish PYTA tenses, which always share the same root, in Portuguese only half of the verbs display an identical root in all of the PYTA cells; four verbs display the same root in all forms except the 3sg preterite and two verbs in all forms except the 1sg (see O’Neill 2014 for details). These “aberrant allomorphs” most likely correspond to

Table 10.1. *Paradigm for the Spanish verb saber 'know' in which the PYTA tenses are shaded*

	Present indicative	Present subjunctive	Future	Conditional
1sg	sé	sepa	sabré	sabría
2sg	sabes	sepas	sabrás	sabrías
3sg	sabe	sepa	sabrá	sabría
1pl	sabemos	sepamos	sabremos	sabríamos
2pl	sabéis	sepáis	sabréis	sabríais
3pl	saben	sepan	sabrán	sabrían
	<i>Imperfect subjunctive (ra)</i>	<i>Imperfect subjunctive (se)</i>	<i>Preterite</i>	<i>Imperfect indicative</i>
1sg	supiera	supiese	supie	sabía
2sg	supieras	supiese	supiste	sabías
3sg	supiera	supiese	supo	sabía
1pl	supiéramos	supiésemos	supimos	sabíamos
2pl	supierais	supieseis	supisteis	sabíais
3pl	supieran	supiesen	supieron	sabrían
	<i>Imperative</i>	<i>Infinitive</i>	<i>Gerund</i>	<i>Participle</i>
2sg	sabe	saber	sabiendo	sabido
2pl	sabed			

Source: Adapted from O'Neill (2014)

Table 10.2. *Paradigm for the Portuguese verb saber 'know' in which the PYTA tenses are shaded*

	Present indicative	Present subjunctive	Future	Conditional	Conjugated infinitive
1sg	sei	saiba	saberei	saberia	saber
2sg	sabes	saibas	saberás	saberias	saberes
3sg	sabe	saiba	saberá	saberia	saber
1pl	sabemos	saibamos	saberemos	saberíamos	sabermos
2pl	sabeis	saibais	sabereis	saberíeis	saberdes
3pl	sabem	saibam	saberão	saberiam	saberem
	<i>Imperfect indicative</i>	<i>Preterite</i>	<i>Pluperfect</i>	<i>Imperfect subjunctive (se)</i>	<i>Future subjunctive</i>
1sg	sabia	soube	soubera	soubesse	souber
2sg	sabias	soubeste	souberas	soubesses	souberes
3sg	sabia	soube	soubera	soubesse	souber
1pl	sabíamos	soubemos	soubéramos	soubéssemos	soubermos
2pl	sabíais	soubestes	soubéreis	soubésseis	souberdes
3pl	sabiam	souberam	souberam	soubessem	souberem
	<i>Imperative</i>	<i>Infinitive</i>	<i>Gerund</i>	<i>Participle</i>	
2sg	sabe	saber	sabendo	sabido	
2pl	sabei				

Source: Adapted from O'Neill (2014)

For these distributions both Maiden (2001 for Spanish and Portuguese) and O'Neill (2014 for Spanish and Portuguese, 2011b for Spanish, 2011a for Asturian) have provided extensive evidence that the distribution of the

common forms cannot be determined on the basis of morphosyntax/semantics/phonology. It is otiose to repeat such justifications here and I refer readers to the different published works. Suffice to say, however, that there is no conceivable phonological or semantic label nor any morphosyntactic semantic feature which can exclusively subsume the various usages of the PYTA tenses in both Spanish and Portuguese. Moreover, the distribution cannot be explained via recourse to impoverishment or underspecification without rendering invalid the very notion of a morphosyntactic feature (see also Aronoff 2012 for French).

The point about the distribution of such allomorphy for these verbs is that it is not coincidental but systematic and forms part of the speaker's grammar. Maiden (2001 for Spanish and Portuguese) and O'Neill (2011b for Spanish, 2011a for Asturian) provide a wealth of evidence to justify what they term the "psychological reality" of this distribution for speakers. Maiden's evidence is based on comparative diachronic data and takes the form of what this author terms the *principle of coherence*,¹⁸ which is given below:

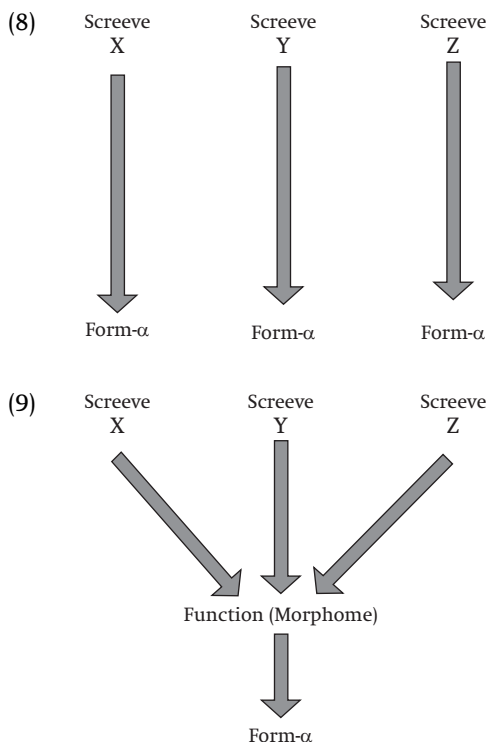
Coherence: [the forms which are in a morpheme] show persistent resistance to any morphological change liable to disrupt their peculiar paradigmatic distribution. If an analogical change affects one "cell" of the paradigm in which the relevant allomorph occurs, it affects all the others in the same way. The relationship of mutual implication between "cells" always survives intact. (Maiden 2004: 139)

Thus, in the history of Spanish when an irregular root allomorph is lost in favour of the regular root of the present/infinite (e.g., *escrito* > *escribió* for the 3sg preterite of *escribir* 'write') this change does not only occur in one particular cell of the PYTA tenses or in a particular tense (e.g., just the preterite forms) but affects all of the PYTA cells. Furthermore, when as a result of a following high vowel the root vowel of a PYTA form was metaphonically raised to /i/ such as with *FĒCĪ* > Old Spanish *fize* (1sg preterite of *fazer* 'do') this high vowel then spread to the rest of the forms of the PYTA forms: *fezo* > *fizo*, *fezieron* > *fizieron*, *feziese* > *fiziese*. In fact, almost none of the allomorphy of the modern verbs which display this allomorphy in Spanish is etymological; the roots have undergone a number of analogical and phonological changes. However, crucially, the same root appears in all of the PYTA cells (see O'Neill 2011b for more details). That is, a change adopted by one verbal form spread to all of the PYTA forms.

What these data suggest is that each cell/ individual screeve is not coincidentally aligned with separate realization rules which select for the same stored allomorph, as depicted graphically in (8). Rather, the cells act as a

¹⁸ There also exists another principle, the principle of convergence which states the following: Convergence: "[the set of paradigmatic cells in the morpheme] tend over time to acquire certain common phonological characteristics across all verbs in which they occur—a development akin to classic analogical levelling of the 'one meaning—one form' type, except here there is no 'meaning' outside the morphomic pattern itself" (Maiden 2004: 139).

group and map onto the exact same rule, and thus a change in the form of the root allomorph in one cell is either blocked or spreads to all cells. This intermediate level, which mediates between the morphosyntax/semantics and the morphophonological instructions of how to build complex words, is what Aronoff called the *morphomic level* with the functions at this level *morphemes*; this is represented in (9). Without this level it is difficult to envisage how to ensure the consistency in the distribution and account for the diachronic data.



Embick and Halle (2005), in response to Aronoff's morphomic analyses of stem types in French, question the need for stems and derive the different allomorphs via readjustment rules. As noted by Aronoff (Chapter 8, this volume) these authors "miss the point of what stem types are about . . . stem types are *distributions*. Thus, even if one uses readjustment rules, the sets of environments in which these rules operate will recur over and over again." The Spanish and Portuguese data exemplify this point nicely since the same distribution of stem-allomorphy is exhibited by a number of lexemes. Moreover, O'Neill (2014) has suggested that the distribution itself must be recognized as a grammatical entity/reality for the grammar since the cells of this distribution can act as a domain in which morphophonemic alternations are leveled not only in verbs which display stem allomorphy in the PYTA tenses but for all verbs of the language, including "regular verbs" which display an invariant root across the verbal inflectional

Table 10.3. *Desinences of the PYTA tenses for regular -ar conjugation verbs in a number of Ibero-Romance varieties*

	PIR	OCast. OPort	Astur. 1	Astur. 2	Astur. 3	Astur. 4	Tras-os-Montes
1sg	-ái	-é ~ -éi	-éi	-é	-éi	-é	salté
2sg	-asti	-aste	-éiste	-ásti	-éisti	-ísti	saltéste
3sg	-aut	-ó ~ -óu	-óu	-ó	-ó	-ó	saltóu
1pl	-amus	-amos	-ámos	-émos	-éimus	-émos	saltémos
2pl	-astis	-astes	-ásteis	-ástis	1.1.1.3 -éistis	-éste	saltéste
3pl	-arunt	-aron	-ánun	-ánon	-ánun	-óren	salteram
Continuant of Latin pluperfect indicative							
3sg	-ára	-ara	-ára	-ara	-ara	-ára, -éra	saltéra
Continuant of Latin pluperfect subjunctive							
3sg	-ase	-áse	-áse	-áse	1.1.1.4 —	1.1.1.5 —	saltése
Continuant of Latin future perfect indicative and perfect subjunctive							
3sg	-ári	-are	1.1.1.6 —	1.1.1.7 —	1.1.1.8 —	1.1.1.9 —	saltér

paradigm. His data (O'Neill 2014, a selection of which is reproduced here) come from diachronic and dialectal developments from other varieties of Romance which also display a PYTA distribution of allomorphy in a number of lexemes (distributions differ from varieties).

In Table 10.3, under the heading of PIR I give the probable endings of the PYTA tenses for regular *ar* verbs in proto-Ibero-Romance and a number of other varieties which will be important to illustrate my point. Given the proto-endings, both the old Castilian and old Galician-Portuguese forms (OCast.-OPort.) can be explained via regular sound change.¹⁹ The Asturian dialectal data, however, cannot be explained via regular sound change, but rather via the extension of the vowel /e/ of the 1sg to other forms of the preterite. Thus, in some varieties²⁰ it passes to the 2sg (Astur. 1) where it could also have been etymological (Wheeler 2012), in other varieties²¹ it passes only to the 1pl (Astur. 2), while in other varieties²² it is present in all the forms of the preterite save the third-person forms, in which the 3pl is the only person to retain the etymological theme vowel /a/ (Astur. 3). Common to all these paradigms is that the theme vowel for the other PYTA tenses is still what is considered to be the conjugation vowel /a/. However, in those varieties²³ in which there is no longer any /a/ in the preterite (Astur. 4),

¹⁹ The diphthong in the 3sg being reduced to /o/ and the diphthong in the 1sg being reduced to /e/ in old Castilian while in old Galician-Portuguese, the diphthongs were changed to [ej] and [ow] respectively.

²⁰ El Cuarto de los Valles (Menéndez García 1963).

²¹ Meres (Grossi Fernández 1962), Cabranes (Canellada 1944), Cándamo (Díaz González 1986), Vegadeo (Fernández Vior 1997), El Franco (García García 1983), Valledor (Muñiz 1978), Santianes de Pravia (García Valdés 1979), Villacidayo (Millán Urdiales 1966), Tudanca (Penny 1978).

²² Sistema (Fernández 1960), Teberga (García Arias 1974), Cabo Peñas (Díaz Castañón 1966), Lena (Neira Martínez 1955), Babia y Laciana (Álvarez Álvarez 1949), Somiedo (Cano González 1981), Parres (Vallina Alonso 1985).

²³ Alto Aller (Rodríguez Castellano 1952), Ancares (Fernández González 1981), certain varieties of Tras-os-Montes (Moura Santos 1967), and Mirandes (Nunes 1930).

Table 10.4. *A partial paradigm for the verb cantar 'sing' in Gascon (Romieu and Bianchi 1995: 278–81)*

	Present indicative	Imperfect indicative	Future indicative	Preterite	Imperfect subjunctive	Past conditional
1sg	canti	cantavi	cantarèi	cantèi	cantèssi	cantèri
2sg	cantas	cantavas	cantaràs	cantès	cantèsses	cantèras
3sg	canta	cantava	cantarà	cantè(c)	cantèsse	cantèra
1pl	cantam	cantàvam	cantaram	cantèm	cantèsem	cantèram
2pl	cantatz	cantàvatz	cantaratz	cantètz	cantèssetz	cantèratz
3pl	cantan	cantavan	cantaràn	cantèn	cantèssen	cantèran

the vowel /e/ has passed to the other PYTA paradigms. This phenomenon is most prominent in Miranda.²⁴ Note that the domain for the spread of /e/ is exclusively to the PYTA tenses; outside the PYTA tenses the theme vowel is /a/, and the lexemic root is invariable throughout the paradigm.

Similar developments are also attested in the varieties of central and southern Gascon as illustrated in Table 10.4 in which I give a selection of tenses for *cantar* 'sing,' a regular first-conjugation verb. Witness that the thematic vowel /e/ is exclusive to the PYTA tenses (the preterite, imperfect subjunctive, and past conditional,²⁵ which do not form a semantic natural class).²⁶

The origin of this stem vowel /e/ in the first-conjugation verbs can be explained²⁷ as a regular outcome of sound change only in the 1sg preterite;

²⁴ This is captured in the following quote from Nunes (1930: 319) (whose data are corroborated by Leite de Vasconcellos (1900: 110–15)): "Na fronteira de Tras-os-Montes, Norte e Centro como aliás o pratica também o dialecto mirandês, igualmente por analogia com a mesma pessoa [1sg pret], mantêm o e na 2ª do mesmo número e 1ª e 2ª do plural dizendo *salteste*, *saltemos* e *saltestes*, e, como consequência, nos tempos derivados do mesmo tema, assim: *saltera*, *saltese*, *salter*."

²⁵ Medieval varieties of Occitan, and a selection of modern varieties, some of which are referred to as Gascon, present two conditionals: the first is common to other varieties of Romance and is derived from periphrases of the infinitive and the continuants of the Latin verb HABEBAM; the second conditional is derived from the Latin pluperfect indicative.

²⁶ The preterite exclusively indicates past time, perfect aspect, and indicative mood while the past subjunctive is neutral regarding aspect and indicates subjunctive mood. The second conditional has a variety of uses: it expresses potential and counterfactual conditions, as was true in medieval times (Henrichsen 1955; Jensen 1994; Quint 1997) and can, depending on the variety, express futurity in the past (Esher 2012: 106–7, 2013: 105–6) and therefore its usage overlaps with that of the first conditional, although its stem form does not. Thus, although some PYTA tenses possess certain common functional features there is no single and semantic generalization which is exclusive to these tenses.

²⁷ The presence of /e/ in the theme vowel is common in other southern Gallo Romance varieties and is considered by some authors (for old Occitan, Anglade 1921: 272; Bourciez 1927: 3) to be due to analogy with the forms *estei* and *dei*, continuants of the Latin perfects STETĪ and DEDĪ. This desinential /e/ then entered the preterite forms of late Latin perfects of the type *perdēdi* > *perdēi*, *vendēdi* > *vendēi*. In the dialects in question, however, the presence of the /e/ seems to be etymological in the case of the 1sg preterite in which ai > ei as demonstrated by those eastern varieties (see Table 10.5) in which the theme vowel is /a/ in all persons except this person of the preterite. This particular sound change is also corroborated by the 1sg present indicative of the verb *aver* 'to have,' *ei* < **ayo* < HABEO as well as the future form *cantarèi* and words which are continuants of late Latin -*ai*- and which display -*ei*- in Gascon: *heit* 'fact' < FACTUM and *leit* 'milk' < LACTE (Bourciez 1927: 39). Therefore it seems clear in these varieties that thematic vowel /e/ in the PYTA tenses is due to the analogical extension of the /e/ from the 1sg preterite. This hypothesis is further corroborated by Lespy's late nineteenth-century *Grammaire béarnaise* (1880: 346) which gives

Table 10.5. *Preterite forms of the verb cantar 'sing' for eastern and western varieties of Gascon*

	1 conj. eastern	1 conj. western
1sg	cantèi	cantèi
2sg	cantàs	cantès
3sg	cantà	cantè
1pl	cantam	cantèm
2pl	cantatz	cantètz
3pl	cantàn	cantèn

witness the preterite forms in eastern and western varieties in Table 10.5. In the former the vowel /e/ is only present in the 1sg preterite, but in the latter this formative has spread to all forms of the preterite **and** the other PYTA tenses (only the preterite forms are given here but crucially it has extended to all PYTA tenses but not beyond the domain of these tenses).

The synchronic, diachronic, and dialectal data in this section prompt the conclusion that, in the varieties analyzed, the PYTA distribution constitutes a psychological reality for speakers and not only does it synchronically determine the allomorphy in a number of lexemes but, due to these tenses being the locus of a special type of allomorphy in a limited number of verbs, this group of tenses also acts as a morphological domain and can condition morphological change in verbs which display no root allomorphy in the paradigm. Such a group effect of these paradigmatic cells cannot be explained by recourse to morphosyntax or semantics since the cells share no common morphosyntactic feature. The distribution is purely morphological.

The same need to recognize a purely paradigmatic distribution is attested for patterns of whole-word syncretism. Syncretism is described as cases in which “the morphology lets down the syntax” (Baerman et al. 2005: 1), and occurs when different morphosyntactic properties are realized by exactly the same form. In this section I will focus only on what has been termed stable or systematic syncretism as opposed to accidental or spontaneous cases of homonymy (Plank 1991; Zwicky (1991); Baerman et al. 2005: 9; Olivier-Hinzelin 2012.²⁸

Regarding systematic syncretism, the important point lies in the distributional patterns which themselves, independent of the form expressed in these cells, can form part of the grammatical knowledge of the

the forms *cantey, cantas, canta, cantem, cantetz, cantan* in which the /e/ has only managed to pass into the 1pl and 2pl preterite.

²⁸ A good example of whole word systematic syncretism is the realization of both ablative and dative forms in the plural of Latin nouns, which, depending on the inflectional class of the noun, is realized via the suffixes *-is* or *-ibus*. However, in the plural, the whole word-forms are always syncretic for these two cases in all lexemes. Baerman makes the point that “if we did not treat this as morphologically systematic, we would have to assume the chance coincidence of two instances of accidental homonymy.”

Table 10.6. *Noun declensions in different varieties of Russian*

		I-stem class			a-stem class		
			Standard type		Southern type		Western type
Nom sg	grjaz'-Ø	žen-a	žen-a		žen-a		žen-a
Acc sg	grjaz'-Ø	žen-u	žen-u		žen-u		žen-u
Gen sg	grjaz'-i	žen-y	žen-e		žen-e		žen-y
Dat/loc sg	grjaz'-i	žen-e	žen-e		žen-e		žen-y

Source: Baerman (2004: 810)

morphological system. Evidence to this effect is that such distributional patterns can be extended diachronically; thus Baerman (2004: 810) gives examples of dialects of Russian in which a pattern of syncretism in one inflectional class has spread to another inflectional class. Note that what was extended was the pattern of syncretism of case forms and not the particular case form itself. The data is the following (adapted from Baerman 2004: 810): in standard Russian there is an inflectional class of nouns, termed *a-stem* nouns, which consistently distinguish the genitive singular from the dative locative. This class of nouns contrasts with what are termed the *i-stem* class in which these two forms are syncretic; witness the forms in Table 10.6, taken from Baerman (2004: 810). In southern and western dialects *a-stem* nouns have adopted the pattern of syncretism in the *i-stem* class but the morphological exponent of both cases varies diatopically; in some varieties the form is that of the original dative/locative while in others it is the form of the genitive. Such developments cannot be attributed to sound change.

Likewise, Olivier-Hinzelin (2012) shows how the Valdôtain variety of Franco-Provençal attests a diachronic spread of 1pl = 3pl syncretism. This pattern of syncretism evolved due to regular sound change and came to characterize the majority of tense and mood combinations. Crucially, it was **not** historically expected in the future and conditional tenses. In neighbouring varieties, however, there has been a tendency to have the different forms of the 1pl and 3pl in the aforementioned tenses correspond to the general pattern of syncretism. Thus in one variety the syncretism is attested in the future, in another variety in the conditional, while in another variety both tenses adhere to the pattern of syncretism. As with the Russian data, we are dealing with a case in which a distributional pattern of syncretism, independent of the particular phonological exponent, can extend to paradigms in which it has no historical justification.

Moreover, such patterns of syncretism can oust more traditional and historically attested patterns of suppletion when they are conflicting. Thus, for the present indicative forms of the verb *to go* Gallo-Romance is characterized by a suppletive paradigm in which the 1sg, 2sg, 3sg, and 3pl forms display a root allomorph which is a reflex of the Latin verb *vadere* 'to go' and which is distinct from the 1pl and 2pl forms, which are historically reflexes

Table 10.7. *The present indicative of Standard French and the Valdôtain variety of Franco-Provençal*

Present indicative	Standard French	Valdôtain Franco-Provençal
1sg	vais [vɛ]	(v)ó
2sg	vas [va]	va(t)
3sg	va [va]	va(t)
1pl	allons [a'lø]	allèn
2pl	allez [a'le]	allade
3pl	vont [võ]	van
Infinitive	aller [a'le]	allé

Table 10.8. *The present indicative of two varieties of Gallo-Romance*

Present indicative	Lorrain	Northern Limousin
1sg	[ve:]	[vaw]
2sg	[ve:]	[va:]
3sg	[ve:]	[va/ve]
1pl	[vã]	[vã]
2pl	[a'le:]	[va:]
3pl	[vã]	[vã]
Infinitive	[na'le]	allé

of another verb (usually identified as *ambulare*/**ambitare*/*amnare* ‘to walk’); this pattern is termed the N-pattern by Maiden (2004). Standard French and also the Valdôtain variety of Franco-Provençal exemplify this type of allomorphy (Table 10.7).

Olivier-Hinzelin (2012: 72–6) points out that in Lorrain and northern Limousin varieties such a distribution of stems conflicts with patterns of systematic syncretism attested elsewhere in these varieties and consequently, in some dialects, the traditional pattern of allomorphy has been altered to conform to the patterns of syncretism. Thus in Lorrain, which exhibits syncretism between the 1pl = 3pl, these forms are also syncretic for the verb *to go*, as they are also in northern Limousin varieties, which display syncretism not only between 1pl = 3pl, but also separately between 2sg = 2pl. The result, in the latter case, has been the total elimination of the reflexes of *ambulare*/*amnare* from the present indicative (note, however, that reflexes of this form still persist outside the present, e.g. the infinitive (*a*)*nar*). The relevant data are given in Table 10.8.

It must be stressed once again that it is the pattern of syncretism which is being extended, as opposed to any particular form which wins out or a particular cell which imposes its form on the other.²⁹ These data suggest

²⁹ Indeed, the author demonstrates this point nicely with evidence from neighbouring varieties; for example, it is the reflex from AMBULARE that is the form which spreads ([a' lõ] in the Lorrain variety of Aubure (Urtel 1902: 683)). Also

that stable syncretism is not a mere surface phenomenon whereby a number of different morphosyntactic rules coincide on exactly the same form but rather there is a group effect, expressed graphically in (9) with reference to the morphomic level. Moreover, this group effect/distribution can condition and steer morphological change and therefore must form part of the grammar of speakers.

7 Conclusion

Lexicalism and the Principles of Morphology-free Syntax and Syntax-free Morphology have in common the assumption that there exist two separate components of grammar, one which governs the structure of words and the other the structure of phrases. And these components are subject to rules which function differently. The exact name of the component which governs the structure of words (morphology, morphological component, or lexicon), the linguistic phenomena which pertain to this component (compounding, inflectional morphology, cliticization), and the extent of the interactions between this component and that which governs phrase structure (discussions around Lexical Integrity Hypothesis) have been a matter of intense debate. At the beginning of this chapter I emphasized the importance of appreciating the essence of principles instead of becoming entangled, ensnared, embroiled, and encumbered by details, often theoretically motivated/theoretic-specific, or formed on the basis of a limited data set (e.g., the No Phrase Constraint (Botha 1983)). My motivation was to reach what I termed the real morphological principles, as opposed to the beliefs; emphasis on the fine-grained details of principles can produce the effect summarized in the constructional idiom “not to be able to see the wood for the trees.”

With reference to Lexicalism and the Principles of Morphology-free Syntax and Syntax-free Morphology I contend that the truths are the following:

- Languages have some type of distinction between words and phrases and generally the properties and structures of the former are different from the latter.
- Words, and their structure and formation display a number of properties which are wholly unrelated to concepts of syntax.

These truths therefore form the basis of a belief about the organization of language, which is that the rules governing the structure and formation of

note that, as the author states (Olivier-Hinzelin (2012: 72–6), “an established syncretism pattern does not always automatically lead to a change in stem distribution ... although a future change seems very likely.” Thus, while the pattern of syncretism for the Valdôtain variety of Franco-Provençal is for 1pl = 3pl, this has not affected the verb *to go* as attested by the forms in Table 10.7.

words and phrases are each different and they belong to different components of what is termed grammar. These two components can interact and overlap but they are not one and the same component.

Indeed, a discussion of these principles is tantamount to a discussion of the place of morphology within theories of language. This topic has been covered by Aronoff in Chapter 8 of this volume and I would like to conclude by quoting the pithy generalization which Aronoff makes regarding the relationship between morphology and syntax, since it captures the essence of my argument in this chapter:

Sure, morphology and syntax share many things, say the foxes, but they are not exactly the same thing. Maybe there is a single engine driving aspects of both syntax and morphology, but there are morphological phenomena that have nothing to do with syntax, just as there are syntactic phenomena that have nothing to do with morphology.

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11

Defaults and Overrides in Morphological Description

Dunstan Brown

Defaults play an important role in modern theories of morphology. This chapter starts by considering how they relate to notions such as regularity and productivity. Discussing briefly earlier derivation-based conceptions that arose in phonology, it moves on to look at declarative inheritance-based approaches to morphology. It also illustrates where defaults can be used both to account for what is exceptional and, in contrast, what is the normal case. We then turn to an area which has received much less attention, namely overrides. We conclude by noting the value of defaults for extracting generalizations, while emphasizing the importance of computational implementation.

1 Introduction

The notion “default” has been applied widely both within and outside of linguistics. It has been used for different levels of linguistic analysis, such as semantics and syntax, as well as morphology. Given the focus of this volume, we will be looking at its application to morphology, in particular concepts and ideas that are default-like in their application in morphology, as discussed in Section 2. A first broad characterization would be that defaults are used to represent what is, in some sense, regular, while overrides are used for what is irregular or exceptional. However, as we shall see in Section 3, there are different ways in which defaults can be understood, from a rule that can be used in extremis, even if rarely so, to one that generally applies to the majority of lexical items within its purview.

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Regularity is itself a slippery notion, because we can formulate a rule for most things. Another notion that is associated with regularity is productivity, but this is typically investigated in relation to word-formation rather than inflectional morphology. In Bauer (1988: 69) productivity can be defined in terms of the relevant bases to which it can apply. This naturally depends on how one defines “relevant.” A key idea is that morphological productivity is associated with a lack of, or reduced set of, conditioning factors. The more conditioning factors that there are, the less productive a word-formation rule will be (Booij 1977; Baayen 1992: 110). Plank (1994: 1676) contrasts derivation and inflection in terms of the “applicability” of the category, with inflection being unlimited in contrast to derivation. He makes the point that a newly coined English verb can be given a third-person singular form. Other categories, he argues, will be less productive. It should be noted here that the contrast between inflection and derivation is being made on the basis of categories (i.e., features), rather than the forms that realize them. This is important, because when we discuss defaults and inflection, if the notion of productivity is used, it will be a slightly different use of the idea; namely, it will be talking about the exponent or choice of allomorph, rather than the feature that is being realized.

An important reason why linguists should care about defaults is that they allow us to arrive at a characterization of what the standard properties of a fully inflected word are. Morphology is notorious for the exceptionality that can arise, but we need some way of understanding what the core part of the system is. We contend that it is always possible to arrive at generalizations about inflection, although this may be particularly challenging for some languages. This is why default inheritance, discussed in Section 4, is particularly useful, because we do not need to know in advance all of the possible exceptions to a rule, as the default inheritance system allows us to override the default generalizations without having to restructure the system of inheritance and revise the set of rules each time we come across an exception. Default inheritance can be used to model systems with inflectional classes to good effect, picking out what is shared between them, and allowing for one class to have more of the default realizations than another. The question naturally arises whether we can always treat inflectional classes in terms of defaults, an issue that we address in Section 5.

In Section 6 we consider defaults from the other end: that is, which types of morphosyntactic information are more likely to be overridden. We discuss two different types of default, exceptional and normal case, in Section 7 and conclude in Section 8. We now turn to the history of defaults within morphology.

2 The History of Defaults in Morphology

Defaults can be understood in the more general context of how rules interact. That is, which rules take precedence, which are specific, and

(1) $k \rightarrow C_i / \text{-----} \# C_i$
 Examples: *menek#pois* $\rightarrow$ *mene* *pois* 'go away' (Kiparsky 1973:95)

(2) $k \rightarrow \phi / \text{-----} \#$
 Examples: *menek#alas* $\rightarrow$ *mene* *alas* 'go down' (Kiparsky 1973:95)
menek# $\rightarrow$ *mene* 'go' (Kiparsky 1973:95)

So the Elsewhere Condition is a general constraint that regulates the application of rules, so that the more specific rule will apply where it can, while the less specific one applies elsewhere. In the formulation of Kiparsky (1973) the specificity of the rule is expressed in terms of the sets of strings (see (a) earlier). The Elsewhere Condition is therefore about rules (in particular, phonological rules). But the rule that applies more generally could also be interpreted as a default, while the more specific one is the override in a certain sense, although the conceptual basis for the distinction is different in many respects from the theoretical innovations that led to the notion of defaults in other disciplines, such as computer science and artificial intelligence. Furthermore, the Elsewhere Condition is formulated to address the important question of when competing rules may apply, and it fits into a theoretical universe in which phonological rules are serial and derivational in nature, rather than declarative. As we shall see, this distinction is important for our understanding of defaults, as will be discussed in Section 3.2.

¹ As can be seen from the examples, word-final *-k* does not actually appear on the surface. The imperative form for each of the examples given is written as *mene*. The expression “go away” is written as *mene pois*, but the consonant in the second word is lengthened, so that the whole is pronounced [menep:ois] (Suomi et al. 2008: 44). Suomi et al. (2008: 45) refer to this phenomenon as “boundary lengthening.” See Ogden (1996: 216–36) for a declarative treatment of inter-word junctions in Finnish such as this. While Kiparsky’s (1973) analysis is not contemporary, we present it to illustrate the original argumentation for the Elsewhere Condition.

Table 11.1. *German weak adjective inflection*

	M-sg	N-sg	F-sg	Pl
nom	-e	-e	-e	-en
acc	-en	-e	-e	-en
gen	-en	-en	-en	-en
dat	-en	-en	-en	-en

Table 11.2. *German weak adjective inflection*

	M-sg	N-sg	F-sg	Pl
nom	-e	-e (ZR2)	-e	-en
acc	-en (ZR1)	-e (ZR2)	-e	-en
gen	-en	-en	-en	-en
dat	-en	-en (ZR3)	-en	-en

morphology we might also understand the interaction of the elements of morphology as constrained according to the specificity of the information encoded by those morphological elements. Zwicky (1985) is an important illustration of this. He shows how inflectional systems can be properly described by making appeal to mechanisms of default and override, illustrating with German weak adjective inflection, given in Table 11.1.

Zwicky (1985) argues that these inflections can be accounted for by assuming the following rules.

- (3) (Zwicky's rule 1):
In the context of [CAT:adj, CLASS:wk], [CASE:acc, GEND:m, NUM:sg] is realized by suffixation of /en/.
- (4) (Zwicky's rule 2):
In the context of [CAT:adj, CLASS:wk], [CASE:nom/acc, NUM:sg] is realized by suffixation of /e/.
- (5) (Zwicky's rule 3):
In the context of [CAT:adj, CLASS:wk], any bundle of CASE, GEND, and NUM values is realized by suffixation of /en/.

Zwicky (1985: 374) makes appeal to a version of the Elsewhere Condition to deal with the interaction of his rules (3)–(5). Rules (3) and (4) cannot apply to the plural, but rule (5) can. Rule (5) could apply in the nominative or accusative singular, but rules (3) and (4) take precedence, as they are more specific.

So the distribution of the rules that we observe in Table 11.2 is mediated by a version of the Elsewhere Condition that allows the less specific to apply only when the more specific cannot. Stump (2001: 22–5) refers to this concept of the elsewhere as Pāṇini's principle and argues for the Pāṇinian Determinism Hypothesis, namely that competition between morphological

rules is always resolved by Pāṇini's principle (see Chapter 17, §2.5). In Paradigm Function Morphology, following Anderson's (1992: 129) approach in A-morphous Morphology, the rules are ordered into rule blocks. Pāṇini's principle mediates the application of rules within the same block. Pāṇinian determinism is relevant within a given rule block, as these are more likely to contain multiple rules that are compatible with each other.

Within morphology an elsewhere-based approach can be associated with the notion of underspecification. For instance, in the example we discussed for Table 11.2 the more general rule (Zwicky's rule 3) is underspecified for case, gender and number, while Zwicky's rule 2 is underspecified for gender. (We gloss over the issue of case here, which is dealt with by a referral in Zwicky's analysis.) Although this is not necessarily how it is usually presented, there is an implicit layering of defaults here, with one very specific rule, one more general, and one even more general.

It is tempting to associate the potential layering of these rules with some kind of hierarchy with regard to the features involved. The most specific rule gives information about number, case, and gender. The most general underspecifies all of these, while the "middle" rule (Zwicky's rule 2) underspecifies gender, and specifies number (here singular). Network Morphology is a default-inheritance-based framework for morphology, something we discuss in Section 4. Brown and Hippisley (2012: 57–64) show how feature ordering in this framework is treated as a matter of **path extension** (see Chapter 18, §3.3). Paths, represented using angle brackets, are used to define the morphosyntactic combinations that are realized by morphology. Consider the paths in (6).

- (6) a. <>
 b. <mor>
 c. <mor sg>
 d. <mor sg dat>

The path in (6a) is the "empty path." It is maximally underspecified. Any kind of information associated with this path can be used, if there is nothing more specific provided. The path in (6b) is more specific, this time providing information that is specific to morphology. But it is still completely underspecified regarding morphosyntactic information. The path in (6c) provides information about singular forms. The path (6d) provides information about a specific case form (dative) in the singular. The paths in (6) stand in a relation of extension. (6b) is an extension of (6a). (6c) is an extension of (6b), and therefore of (6a). (6d) is an extension of (6c), and therefore of (6b) and (6a). Put the other way round (6a) is a sub-path of (6b), and therefore also of (6c) and (6d). In a Network Morphology analysis if a form is required, but there is no rule that contains the required path specification, then the morphology will resort to the next most specific matching sub-path for that specification. This is a kind of Pāṇinian determinism that is quite strict, because of the ordering imposed on the features.

Table 11.3. *Locative singular forms of Russian nouns*

I	II	III	IV
<i>zakon</i> 'law'	<i>karta</i> 'map'	<i>rukopis'</i> 'manuscript'	<i>boloto</i> 'swamp'
<i>zakon-e</i>	<i>kart-e</i>	<i>rukopis-i</i>	<i>bolot-e</i>

However, as Brown and Hippisley (2012: 164–85) state, while the ordering is associated with cross-linguistic tendencies, it is insufficient to describe the totality of morphological systems, showing that other mechanisms are required, in particular **generalized referrals** that involve both reference of sets of paradigm cells to other sets of paradigm cells. Generalized referrals allow one path to refer to another, combining this with the properties of path extension we illustrated for (6a–d). Baerman et al. (2005: 113–24), in their cross-linguistic analysis of syncretism, found that there is some evidence for patterns that fit the treatment of features as ordered in some way. That is, within the nominal domain, gender is more likely to syncretize than case, and case is more likely to syncretize than number, while syncretism of agreement morphology is more likely than syncretism of TAM in the verbal domain. These are, however, just tendencies. One cannot account for the full range of syncretisms if one uses underspecification alone, nor is it the case that what cannot be accounted for by underspecification can be dismissed as unsystematic (see, for instance, Baerman et al. 2005: 171–204). While there is a relationship between the ordering of features associated with path extension and crosslinguistic tendencies, many default properties associated with morphology cannot be regulated by the feature structure that is relevant for syntax.² For instance, when we consider the locative singular of Russian nouns in Table 11.3 the exponent *-e* is the default form that applies across three out of four inflectional classes. There is no syntactically relevant feature that we can pick out to account for the distribution of the two different forms (*-e* and *-i*). Nouns belonging to classes II and III are typically assigned feminine gender, so gender would fail to distinguish the different exponents for these items. Instead, the most natural thing is to treat the exponent *-e* as the default and to associate the exponent *-i* with its inflectional class (i.e., morphological information). Inflectional classes can be modeled using default inheritance networks

² Another concept that often comes up in relation to underspecification is that of “markedness.” The claim is that there tend to be a reduced number distinctions in the presence of a “marked” feature value, however that may be defined. For those sympathetic to markedness as an explanatory concept the idea is that the loss of distinctions (i.e., underspecification) is in some sense a way of avoiding too many “marked” values (McCarthy 2002: 81). There are, however, a number of interpretations of what being “marked” means in relation to morphosyntactic features. One might be related to frequency; another might be to do with overt expression in form. See Haspelmath (2006) for discussion of the different ways in which the notion of markedness is used.

(see Section 4). (See Müller (2004) for an account of morphology-internal inflectional classes using feature decomposition.)

Pāṇini's principle is one type of default notion, as it serves to mediate rule interaction so that one rule can apply when another cannot. The underlying principle treats this in terms of informational content, so that the more informative rule appears to win out. "Blocking" is a related notion, first introduced by Aronoff (1976: 43) in his highly influential work on word formation. This relies on the idea of lexical listing (i.e., the existence of another form) to block the application of a particular word-formation rule. The concept of "blocking" is also developed further to account for the interaction of synthetic and analytic (i.e., periphrastic) structures in realizing similar information (see Poser 1992; Sells 2011). We now turn to other related conceptions of default.

3 Different Conceptions of the Default

In the previous section we discussed work that was originally developed in phonology and was later applied in morphology. This dealt with the mediation of rule application. So we have to be careful to distinguish between the notion of default as a system and default in terms of the particular rule, or set of rules, that may apply in virtue of the way that the system works. A further important distinction is that in the example in Table 11.2 Pāṇinian determinism mediated the application of rules as defined in relation to the morphosyntactic paradigm of a defined set of lexical items. Another function of defaults is to mediate the application of rules when inflectional allomorphy (i.e., different sets of lexical items) comes into play, something that we discuss in more detail in Section 4. We turn now to one understanding of default as that which defines the "regular" form in relation to other possible realizations.

3.1 The Default versus the Rest

While our purpose here is to discuss the role of defaults in morphological description, it is worthwhile considering how the rules and operations associated with morphology are understood in psycholinguistics (discussed in Chapter 28). Clahsen (2006: 2) outlines three basic types of model:

- i) associative single-mechanism models
- ii) rule-based single-mechanism models
- iii) dual-mechanism models.

In associative single-mechanism models there is no explicit representation of morphological structure. Instead, the relationship between word-forms arises from associative links tied to their orthographic, phonological, or semantic information. In contrast, rule-based single-mechanism models reduce the role of associative links and rely on rule-based representations.

Dual-mechanism models, on the other hand, rely on a combination of associative links and rules. One use of the term “default” may reserve it for the rule part of a dual mechanism system. The question naturally arises whether this brings with it the expectation that there can only be one default (or rule).³ An important part of the argument for dual-mechanism models is the idea that defaults need not be associated with high frequency. We might wish to associate this possibility with the notion that defaults are fallbacks that are used when other things cannot be, but an important part of the evidence for defaults is that they can be generalized to other items, even when there would be the possibility of following a more specific rule.⁴ One claim is that there may be a preference for affixation (Clahsen 1999: 994). We turn now to the idea that defaults may be associated with cross-linguistic, or even universal, preferences.

3.2 Defaults and the Universal

There is an interesting question about whether defaults in a particular language line up with what is crosslinguistically prevalent, or even universal. In phonological theories that rely on underspecification, the default rule is what is fully underspecified. Phonological rules that are sensitive to context information provide some values, while a default rule is seen as being context-free in the sense that it applies in the absence of any other information (McCarthy 2002: 133). This means that the default applies after everything else has. In Chomskyan syntax one might assume that the notion default equates with what is expected according to Universal Grammar (UG) principles. Universal Grammar principles take precedence over language-particular rules. McCarthy (2002: 133) notes that it follows from this that the “unmarked” is what is found at the beginning of the derivation in Minimalist syntactic approaches, while in phonology it is what emerges at the end.⁵ An important issue that arises when we consider the relationship of the default with what is crosslinguistically prevalent is the degree

³ In her interpretation of the dual mechanism model Dąbrowska (2001) appears to take it as read that there can be only one default rule, a point that is important in her criticism of dual-mechanism models and her argument that there is no default for the genitive singular in Polish. However, an important issue that is overlooked is what form the rule takes. For Polish, for instance, the animacy of the denotation and phonological properties of the stem play a role in determining the realization (see Dąbrowska 2001: 558). If these conditions are considered part of the rule, then the picture changes significantly.

⁴ In recent work on Portuguese verbs Veríssimo and Clahsen (2014) show that their Default Generalization Learner (DGL), which assigns “maximal confidence” to rules that are not sensitive to phonological context, can perform better in following the behavior of human participants than a competing phonologically driven model based on Albright’s (2002) Minimal Generalization Learner (MGL).

⁵ McCarthy contrasts this with feature checking in the classic variant of Minimalism, where the need to check features is the major requirement. Universal rules, because they are “least effort,” take precedence over language-particular ones to ensure that the output requirements are met. For instance, Chomsky (1995: 140) accounts for the fact that do-support under negation does not obey UG principles by appeal to the fact that this would violate the Head Movement Constraint. In this case a language-particular rule applies, because a more general constraint requires. It should be noted that Chomsky does not refer to the UG principles as defaults.

of abstraction involved. The question of what is a default value for a particular feature, such as gender, is very different from considering which particular ordering is required in a derivational approach. But there is another way that we can think of defaults, rather than in terms of the ordering in a derivational system, they can be considered in terms of a declarative system of inheritance, to which we now turn.

4 Inheritance Meets Defaults

In the late 1980s inheritance-based approaches became a particularly attractive option for representing lexical knowledge. In inheritance-based approaches knowledge, in this case lexical knowledge, is treated as a network of relations between nodes, where information flows (is inherited) from one node to another. In monotonic inheritance systems (i.e., those that are *not* default inheritance systems) it is not possible to allow for information that is subject to exceptions to be placed at nodes that make generalizations about an area of knowledge (Touretzky 1986: 3). A good non-linguistic example covers the domain of birds. With monotonic inheritance hierarchies we cannot, for instance, say that birds can fly, because we need to accept that penguins and emus are birds, and the monotonicity of the inheritance system means that we cannot override any statement that says birds fly. With such systems we might try and create classes of flying and non-flying birds, but it may be hard to justify these classes, given that penguins and emus may not otherwise fall together as a natural grouping. Furthermore, it is also difficult to encode our expectations about what a bird usually looks like if we have to use such systems.

With default (i.e., non-monotonic) inheritance systems the problem of making generalizations is obviated, as the network allows for statements that can be overridden. Gazdar (1990) discussed this in a technical report on the DATR language. DATR was designed explicitly for implementing default inheritance networks. See Chapter 29, in particular Section 1.2, for an explanation of DATR and default inheritance, and Evans and Gazdar (1996) for an authoritative exposition of the language. Non-linguistic examples are often a useful way of understanding how default inheritance works. In Figure 11.1 we see a non-linguistic hierarchy where the node BIRD states that birds can fly. This information is inherited by the node EAGLE, while it is explicitly overridden by the node PENGUIN. The property of being able to fly is also overridden by the node that describes Eric the dead eagle, while for Penny the penguin, who is a pilot, the default property of penguins being able to fly is itself overridden, so that Penny follows the more general property of birds being able to fly, albeit for very special reasons. This network also illustrates an important issue, because we can see that the notion of default applies in different ways at different points in the hierarchy, in contrast with the understanding of default as being a

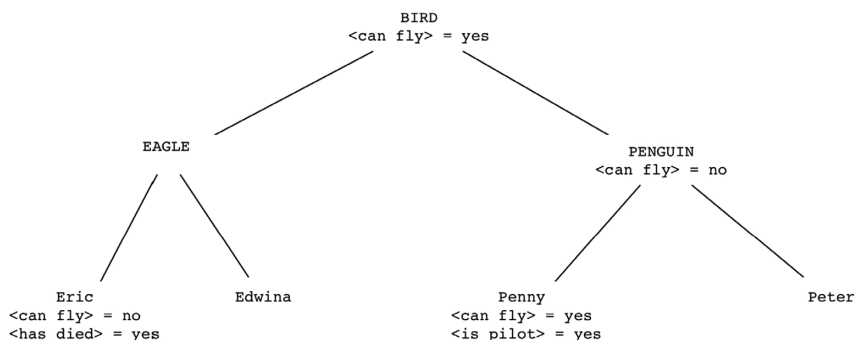


Figure 11.1. Gazdar's (1990: 2) non-linguistic example of default inheritance

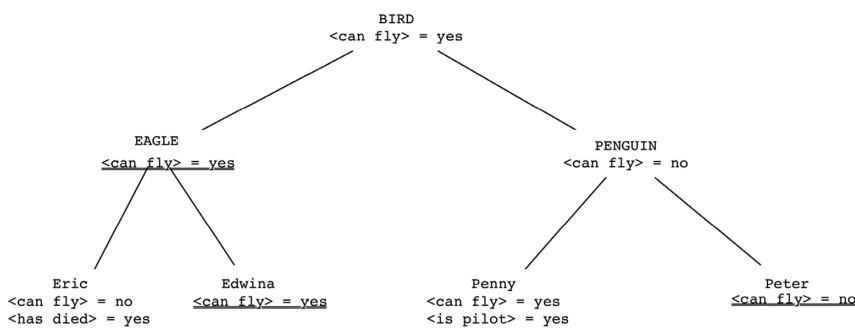


Figure 11.2. Gazdar's (1990: 2) non-linguistic example of default inheritance (with inherited values)

single one-off thing. It's perfectly legitimate to say that the default property for birds is that they can fly, while the default property for penguins is that they cannot. We can talk of defaults as cascaded. At the level of birds, the default is that they fly. At the level of penguins the default is that they don't fly. But individuals may override the generalization about penguins, as we noted for Penny.

A crucial point about the default-inheritance approach is that we need say nothing when the default value applies. We can see this in Figure 11.1 for the node EAGLE, for instance, where nothing is stated about the flying abilities of eagles. Consider Figure 11.2, which is an evaluated version of Figure 11.1 with the inherited values added in.

In Figure 11.2 we can infer that eagles fly, because there is nothing explicitly given at the node EAGLE to state the contrary, so that the inherited value (underlined) is taken directly from BIRD. In contrast, because the node PENGUIN explicitly states that penguins cannot fly, this overrides what is stated at BIRD, and the value for the flying attribute is not inherited. Edwina the eagle inherits the default statement about flight from the node BIRD via the node EAGLE. Peter the penguin inherits the statement about flight from the node PENGUIN. It should be noted that

the inheritance hierarchy involves interaction of both defaults and overrides here. While PENGUIN overrides the default statement about flying, Peter the penguin inherits this overridden value. Hence, an override need not just appear at the bottom of the network, because defaults can be layered or cascaded. We can contrast this with the idea we saw earlier that the default appears to be one rule opposed to everything else.

4.1 Default Inheritance and Morphology

The default inheritance approach is ideally suited for the treatment of morphology, because morphological generalizations are subject to exceptions, and varying degrees of regularity can be observed in inflectional systems. Corbett and Fraser (1993) is a seminal work that introduces the Network Morphology framework, inspired by the DATR language (Evans and Gazdar 1996). This work was extended to account for both the stress and affixal system of Russian nominals (Brown et al. 1996) and gender systems (Fraser and Corbett 1995, 2000; Evans et al. 2002). An important part of the Network Morphology philosophy is computational implementation, and computational fragments exist for languages belonging to a number of families, including Afro-Asiatic, Austronesian, Chukotko-Kamchatkan, Eskimo-Aleut, Gunwinyguan, Indo-European, Nakh-Daghestanian, Nilotic, and Nuclear Torricelli. Diachronic change has also been modeled using Network Morphology (Hippisley 2010; Collier 2013). There is also a monograph-length treatment of the framework (Brown and Hippisley 2012). Recent work includes Baerman's (2012) analysis of the complex case and number system of Nuer nominals.

A clear example of the interaction between default generalizations is inflectional class systems, where there may be more than one “regular” realization for a particular morphosyntactic combination. But the classes share some of the exponents, and individual lexical items can still belong to an inflectional class, but override some of its realizations.

4.2 Default Inheritance and Inflectional Classes

For languages with inflectional class systems the default inheritance approach treats each inflectional class in a way analogous to the different species of bird we discussed in our non-linguistic example. Let us consider the morphology of Polish nouns as given in Tables 11.4–6 (based on Rothstein (1993)).

Our purpose is to determine what the different noun inflectional classes have in common, analogous to the generalization about flying that we made for birds in the non-linguistic example. We can also determine intermediate classes of nouns, as well. Here are some of the generalizations that we can make about Polish nouns on the basis of the data given in Tables 11.4–6:

Table 11.4. *Polish masculine and neuter o-stems*

	I (Masculine o-stems)		IV (Neuter o-stems)	
	gród 'castle'		miasto 'city'	
nom	gród	grody	miasto	miasta
voc	grodzie	grody	miasto	miasta
acc	gród	grody	miasto	miasta
gen	grodu	grodów	miasta	miast
dat	grodowi	grodom	miastu	miastom
ins	grodem	grodami	miastem	miastami
loc	grodzie	grodach	mieście	miastach

Table 11.5. *Polish a- and ja-stems*

	II (Feminine a-stems)		V (Feminine ja-stems)	
	żona 'wife'		bogini 'goddess'	
nom	żona	żony	bogini	boginie
voc	żono	żony	bogini	boginie
acc	żonę	żony	boginię	boginie
gen	żony	żon	bogini	bogiń
dat	żonie	żonom	bogini	boginiom
ins	żoną	żonami	boginią	boginiami
loc	żonie	żonach	bogini	boginiach

Table 11.6. *Polish i-stems*

	III (Feminine i-stems)	
	kość 'bone'	
nom	kość	kości
voc	kości	kości
acc	kość	kości
gen	kości	kości
dat	kości	kościom
ins	kością	kośćmi
loc	kości	kościach

ALL NOUNS

- For all nouns the dative plural is realized by *-om*.
- For all nouns the locative plural is realized by *-ach*.
- The vocative plural is the same as the nominative plural.

MOST NOUNS

- For most nouns the instrumental plural is realized by *-ami*.
- For most nouns the locative singular is realized by *-e* (with the accompanying palatalized stem).

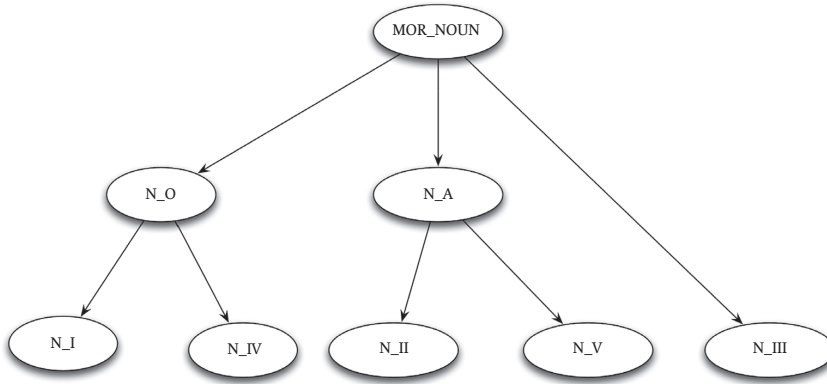


Figure 11.3. An inheritance hierarchy for Polish nouns

- The nominative, vocative, and accusative plural are realized by *-i/-y*.
- The vocative singular is the same as the nominative singular.
- The dative singular has the same form as the locative singular.

CLASSES II and V

- The accusative singular is realized by *-ę*.

CLASSES I and IV

- The instrumental singular is realized by *-em*.

There are also generalizations about the Polish noun data that cannot be seen in Tables 11.4–6. There is an animacy rule that requires any masculine animate noun (essentially an animate noun of class I) to have its accusative singular the same as its genitive singular. Further, nouns denoting male human beings will have genitive-accusative syncretism in the plural with a different form for the nominative plural.

In addition to the information that is specific to an inflectional class we can locate the generalizations above at different points on an inheritance hierarchy (Figure 11.3).

At the node MOR_NOUN we can specify the realization of the dative, instrumental, and locative plural.⁶ A small number of nouns, such as *kość*, have an exceptional instrumental plural. But this can be overridden for the given lexical item (just as the property of flying can be overridden in our non-linguistic example). At MOR_NOUN we can locate the realization for the locative singular, while it is overridden for classes V and III, for instance. We can also specify that the form of the vocative singular and vocative plural are by default the same as the nominative plural, and that

⁶ In fact, if we abstract the theme vowel we can specify this information even higher in a hierarchy for nominal morphology as part of the exponence is shared by adjectives, with a different theme vowel.

by default the dative singular is the same as the locative singular. This will be overridden by class N_I and N_IV. The form of the instrumental singular for classes I and IV can be specified at the node N_O, while the node N_A specifies the shared form of the accusative singular for N_II and N_V. (Note that the choice of names for nodes is an arbitrary matter, in the sense that it has no consequences for the theory, although naming nodes in a clear way is helpful for anyone looking at the theory, of course.)

We saw earlier in Section 2 how Pāṇinian determinism is claimed to resolve the competition between rules in a given rule block. The inheritance-hierarchy approach presented here suggests a further distinction for defaults: **default classes** as opposed to **default rules**. The shape of the inheritance hierarchy determines which class takes precedence in determining the rules that apply to realize a particular morphosyntactic combination. Just as a more general non-linguistic category such as BIRD will be overridden by a more specific one, so a general linguistic category such as MOR_NOUN (the morphological class of nouns) can be overridden by more specific inflectional classes for nouns (different species of noun). Of course, for some languages, this may be of little or no relevance, either because nouns do not have inflectional morphology, or because their morphology is essentially the same for each instance of the noun part of speech. Turkish would be such an example. Figure 11.3 also suggests something about morphological complexity. On the one hand, the number of inflectional classes at the bottom of the hierarchy in Figure 11.3 indicates a significant amount of complexity, because these are categories that are not relevant for syntax. On the other hand, as we progress up the hierarchy, the inflectional classes share morphology (i.e., there are defaults) and so this can be interpreted as the contrasting tendency towards simplicity.

5 Canonicity and Defaults

One important aspect of the research on modeling inflectional class behavior is the idea that inflectional classes are in reality rarely monolithic entities that are entirely discrete: that is, inflectional classes typically share some of their morphology (the default elements). It is therefore worth considering the issue of canonical inflectional classes, as these potentially represent a challenge for a defaults-based view, because canonical inflectional classes do not share their exponents. As the canonical ideal need not exist (Brown and Chumakina 2013: 8), it may be that the expectation there is a default realization represents a kind of constraint on natural languages that have inflectional morphology. However, there are languages that come close to the canonical ideal.

Corbett's (2009) typology treats the canonical inflectional class as a deviation from canonical inflection. He identifies nine criteria that define canonical inflectional classes. These are given in Table 11.7.

Table 11.7. *Corbett's (2009) criteria for canonical inflectional classes*

Criterion	
(1)	"In the canonical situation, forms differ as consistently as possible <i>across</i> inflectional classes, cell by cell." (Corbett 2009: 4)
(2)	"Canonical inflectional classes realize the same morphosyntactic or morphosemantic distinctions (they are of the same structure)." (Corbett 2009: 4)
(3)	" <i>Within</i> a canonical inflectional class each member behaves identically." (Corbett 2009: 4)
(4)	" <i>Within</i> a canonical inflectional class each paradigm cell is of equal status." (Corbett 2009: 5)
(5)	"The larger the number of members of an inflectional class (up to an equal 'share' of the available items) the more canonical that class." (Corbett 2009: 6)
(6)	"In the canonical situation, the distribution of lexical items over inflectional classes is not phonologically motivated." (Corbett 2009: 6)
(7)	"In the canonical situation, the distribution of lexical items over inflectional classes is not syntactically motivated." (Corbett 2009: 6)
(8)	"In the canonical situation, the distribution of lexical items over inflectional classes is not motivated by Part of Speech." (Corbett 2009: 7)
(9)	"In the canonical situation, the distribution of lexical items over inflectional classes is not motivated by pragmatics (including information structure)." (Corbett 2009: 7)

Criterion 1 is particularly important for our discussion of defaults, because it means that every inflectional class will differ from every other inflectional class in terms of the exponence associated with each cell. If we conceive of inflectional classes as different species of bird, this would be like them having nothing in common (e.g., flying) that could be shared between them. Of course, things are more involved than that, as morphological exponence is only one of the things that can be treated as a default. Criterion 2 does allow for some default shape to inflectional classes. Criterion 3 is also important because it means that the canonical system will not have overrides by specific lexical items, because the canonical inflectional class is not a fuzzy entity to which an item belongs to a greater or lesser extent.

Criterion 5 assumes that the canonical situation is that there should be no inflectional classes that are small, inquorate, or limited to one lexical item. The parenthetical qualification "up to an equal 'share'" is also important. If the lexicon is split more or less equally between inflectional classes then frequency contributes no information about what may be considered the default class. For some this might even mean that there can be no default class. But, as we know from the literature, there are proposed examples where the default is claimed not to be the most frequent, in particular the s-plural in German, which is not high frequency but has a cluster of

Table 11.8. *Verbal inflectional classes in Burmeso*

Gender	inflectional class 1		inflectional class 2	
	example: <i>-ihi-</i> 'see'		example: <i>-akwa-</i> 'bite'	
	sg	pl	sg	pl
I	<i>j-</i>	<i>s-</i>	<i>b-</i>	<i>t-</i>
II	<i>g-</i>	<i>s-</i>	<i>n-</i>	<i>t-</i>
III	<i>g-</i>	<i>j-</i>	<i>n-</i>	<i>b-</i>
IV	<i>j-</i>	<i>j-</i>	<i>b-</i>	<i>b-</i>
V	<i>j-</i>	<i>g-</i>	<i>b-</i>	<i>n-</i>
VI	<i>g-</i>	<i>g-</i>	<i>n-</i>	<i>n-</i>

Source: Donohue (2001: 100, 102, via Corbett 2009: 9)

characteristics associated with defaults (Clahsen 1999; Marcus et al. 1995; Sonnenstuhl et al. 1999). An important part of the argument that supports the notion of a default that need not be frequent is the idea that it can apply when the environment or context does not permit other items to do so (Clahsen 1999: 995). But we should consider in relation to this criteria 6–9, because these effectively rule out contextual assignment to an inflectional class. These criteria are a property of canonical inflectional classes, because they are totally arbitrary. Total arbitrariness means that any item can be assigned to an inflectional class in principle. Hence, one can conclude that there is little or no role for defaults in a canonical inflectional class system. The empirical question is whether such a system can actually exist.

According to Corbett (2009: 8–10) the verbal system of Burmeso, as documented by Donohue (2001), comes very close to being a canonical inflectional class system. This is illustrated in Table 11.8.

The verbal inflection illustrated in Table 11.8 is for agreement with the object.⁷ There appears to be no clear semantic motivation for the different sets of prefixes, and the inflectional classes are more or less equal in size (Donohue 2001: 101; Corbett 2009: 9). As can be seen from the table, none of the prefix realizations are shared across the inflectional classes. However, they do share the same patterns of syncretism, and this does need to be stated somewhere. It should also be noted that morphology for TAM is shared across the two different verb types, as demonstrated by the exponent *-maru* (today's past). This itself raises an important issue about whether we are to talk about inflectional classes in terms of exponence or exponents, as distinguished by Stump and Finkel (2013: 21 fn9). The exponence of a morphosyntactic property set (MPS) is the full set of exponents that realize the word-form associated with that MPS. Exponent, on the

⁷ Burmeso has two basic systems of agreement, a prefixal one (Donohue 2001: 98–104), used with verbs, and a suffixal one that is used with a subset of adjectives (Donohue 2001: 105–8). The systems of prefixal and suffixal agreement are associated with different noun classifications, and therefore feature specifications, although there is significant overlap (Donohue 2001: 108). There are instances where both the prefixal and suffixal systems are used together: i) in a very small set of predicates; ii) on verbs in relative clause constructions (Donohue 2001: 108–12).

other hand, is a “minimal morphological realization of some set of one or more morphosyntactic properties” (Stump and Finkel 2013: 21 fn9). Leaving this issue to one side, we reiterate that there needs to be a specification somewhere that the prefixal agreement we observe in Table 11.8 shares the same patterns of syncretism. Hence, given a realizational approach to inflection, there are default generalizations that are required to account for the data in Table 11.8. These include rules that define the shape of the paradigm and the requirement that the information is realized prefixally. So, while the prefixal patterns in Table 11.8 come close to the canonical ideal there are still generalizations to be made that are best captured using a default system.

Default inheritance not only allows us to capture generalizations, but it also allows us to see which parts of a system are subject to override more than others.

6 The Status of Overrides

We might informally equate overrides with exceptionality or irregularity, but as we shall see, what most often happens is that an exceptional case default applies so that an item is odd merely because it resorts back to the most general pattern, rather than being subject to the rule that would normally apply for the given subset of items to which it belongs.

6.1 Overrides and Principal Parts

It is worth considering how defaults relate to principal parts. If we consider the canonical default and the canonical principal part they are opposed in a number of key respects. As Brown and Evans (2012) note, the canonical default is a form from which it is not possible to predict other forms in the paradigm, but it is itself highly predictable, either because a large number of items—all, in the limiting case—have it, or because of well-defined knowledge about when it does not apply. So the canonical default is not predictive (of other forms), but is highly predictable. In contrast, a canonical principal part is highly predictive, but highly unpredictable (Stump and Finkel 2013: 16–17).

6.2 Dirty and Clean Feature Values

When we come to examine the lexicon of a default inheritance model we find that the forms for some cells are more often subject to override than the forms for some others. Let us call the features that define the paradigm cells that are more prone to being overridden “dirty features,” and correspondingly we shall call the features that define the paradigm cells that are less prone to being overridden “clean features.” If we assume that high

Table 11.9. *Which parts of the Russian noun paradigm are more subject to override?*

Morphosyntactic combination	Frequency	Number of overrides (out of 1,533)	Proportion of lexicon
NOM SG	40,878	4	0.26 %
ACC SG	35,258	0	0
GEN SG	31,934	0	0
LOC SG	16,383	(30)	(1.96%)
INS SG	14,937	2	0.13%
NOM PL	14,269	35	2.28%
GEN PL	13,812	24	1.57%
ACC PL	11,651	0	0
DAT SG	7,907	0	0
LOC PL	5,698	0	0
INS PL	4,265	3	0.20%
DAT PL	2,413	0	0

frequency correlates with greater irregularity (see the diachronic example in Chapter 24, Section 6), while low frequency means greater regularity (and also less allomorphy), then we would expect the most frequent feature values to be the dirtiest, and the least frequent feature values to be the cleanest, but this expectation is only partly met. Consider the frequency of morphosyntactic combinations in Russian in Table 11.9.⁸ The counts are taken from Brown et al. (2007) who made use of the Russian National Corpus (Sharoff 2006; Sitchinava 2002).

If our expectations based on frequency were met, the nominative singular, accusative singular, and genitive singular should be overridden in lexical entries more often than other morphosyntactic combinations. The less frequent morphosyntactic combinations fit better with the expectations, although the instrumental plural disturbs the picture. In fact, in the analysis for which the lexicon was created the accusative is determined by an animacy-based rule of referral for all lexical items, overridden at the inflectional class level by declension II in the singular. The default referral means that the forms are inherited either from the nominative or genitive. So even though in the plural the nominative or the genitive can be

⁸ The frequency figures are based on lexemes that occur at least five times (see Brown et al. 2007 for details).

The analysis on which the count of the overrides is discussed is in Brown and Hipsley (2012). It is based on a different sample (Zasorina 1977) and accounts for 1,533 noun lexemes, including the 1,500 most frequent lexemes from Zasorina's sample. The count for the number of overrides takes a specification in the lexical entry where the left-hand-side path begins <mor>. Virtually all of the overrides refer to another node in the network of information, so that they are not absolute overrides. The actual number of overrides is 100, but 4 of these involve some kind of heteroclisia where the paradigm is split according to number. The figures for the locative singular are given in brackets, because they all relate to the second locative form, either where the rules would require a noun not to have one, while it does (sixteen lexemes), or where the rules would require a noun to have one, while it does not (fourteen lexemes).

The proportion figures are calculated as follows: the number of overrides divided by the total number of lexemes in the lexicon (1,533) multiplied by 100.

overridden, the nouns for which this is true will use the value provided by the override, whatever that may be, for its accusative plural. This means that there is never any need for a lexical item to specify its accusative form. What is clear from these figures is that the dirty feature combinations are not necessarily the ones which are the most frequent.

The figures in Table 11.9 describe deviations from the default patterns of non-prosodic exponence. The majority of nouns with inanimate denotation require specification of the declension class to which they belong. So Table 11.9 is a measure of how reliably a form can be predicted once an item is assigned to an inflectional class. Even for the worst cases involving the second locative (in brackets), the nominative plural and the genitive plural, the proportion of the lexicon that the dirty features account for (i.e., the number of lexemes affected) is still no more than 2 percent. This indicates that a model that relies on default combinations of exponents is highly effective.

7 Exceptional and Normal Case Defaults

Even when the default realization is overridden in a lexical entry it is typically the case that a lexeme resorts back to a more general rule. In fact, we need to distinguish between two different types of default, the **exceptional case default** and the **normal case default**. This distinction was first introduced by Fraser and Corbett (1997) in their treatment of the noun class and gender system of Arapesh, drawing on Fortune's (1942) grammar and associated work by Aronoff (1992; 1994: 89–114). The distinction between exceptional case and normal case default can be explained using the following non-linguistic analogy from Evans et al. (2002: 119):

Mary and John both work for a firm based in London. Mary is the personnel manager and works in the office in London. Occasionally, she goes to Paris on a training course. By default, then, Mary works in the office in London. John is a salesman. He normally spends Mondays in the south of England, Tuesdays in the west, and Wednesdays and Thursdays in the north. If, however, a client cancels an appointment, or he has a problem with his car, or there is a department meeting, he goes to the office in London. On Fridays he often plays golf, but if it rains he goes to the office. By default, then, John also works in the office in London. Intuitively the two cases are rather different. Mary is “normally” at the office, John is not. And yet at a higher level of abstraction the office is the default workplace for both. It is these two types of default, both reasonable uses of the term, that have led to differences in usage in the literature, and to confusion. This is why we make the distinction: for Mary, working at the office in London is the normal case default, while for John, working in London is the exceptional case default.

As an example, let us consider the realization of the nominative plural for nouns that belong to declension I in Russian. The rule of exponence is

Table 11.10. Normal case and exceptional case defaults for the nominative plural of nouns with stem/ending stress pattern (in transcription)

	NORMAL CASE DEFAULT NOMINATIVE PLURAL	EXCEPTIONAL CASE DEFAULT NOMINATIVE PLURAL
<i>tórmóz</i> ‘brakes’	<i>tormoz-á</i>	
<i>ókorok</i> ‘ham’	<i>okorok-á</i>	
<i>snég</i> ‘snow’	<i>sneg-á</i>	
<i>lesosád</i> ‘country park’		<i>lesosad-í</i>
<i>dólg</i> ‘debt’		<i>dolg-í</i>
<i>grób</i> ‘coffin’		<i>grob-í</i>

Source: Brown and Hippisley (2012: 89)

conditional in that ending stress in the plural combined with stem stress in the singular (a less common stress pattern) will typically lead to the realization of the nominative plural by stressed *-a*. This requires the use of an “evaluable path” in Network Morphology, as discussed in Brown and Hippisley (2012: 82–3), to switch to evaluate the stress of the noun in question. Because the vast majority of nouns have stem stress in both the singular and plural, the default exponent for declension I is actually unstressed *-i* (as for the majority of Russian nouns). For the subset of declension I nouns with the less common pattern the normal case default is *-á*, while their exceptional case default is what is the normal case default for other nouns, namely *-í* (although this time under stress).

There are 77 nouns in the lexicon of 1,500 most frequent nouns that belong to the appropriate stress pattern and belong to declension I. Of these 47 follow the normal case default for the group (i.e., like *sneg* ‘snow’), while 30 use the exceptional case default (i.e., like *grob* ‘coffin’). It can be seen that these 30 account for a large proportion of the overrides we identified in Table 11.9. Furthermore, it should be noted that it is possible for new items with the stress, especially for specialist terminology, to follow the normal case default *-á*. Hence, this is an important distinction that constitutes substantive linguistic knowledge. This again demonstrates that total irregularity (i.e., the introduction of a completely new form) is extremely rare. In most cases, what we observe is that a lexical item is resorting back to a very general pattern, even though the rules associated with the inflectional class with which it fits most closely would predict another realization.

8 Conclusion

We have seen that defaults are a key concept if we wish to understand how morphological systems work. They allow us to tease out the key generalizations that characterize the system, and they also allow us to see more subtle

effects that are equally relevant, such as which parts of the system are most subject to override and exception. Because defaults make the analysis of demanding morphological systems tractable it is also important that we implement our analyses so that we can check that our solutions for particular problems don't bring new ones with them, something a theoretical framework such as Network Morphology does by using the DATR language (see Chapter 18).

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12

Implicative Relations in Word-based Morphological Systems

Farrell Ackerman and Robert Malouf

If, therefore, we wish to understand language in its true inwardness we must disabuse our minds of preferred “values” and accustom ourselves to look upon English and Hottentot with the same cool, yet interested, detachment.

Sapir 1921: 124

1 Introduction

Speakers of languages with complex morphology and multiple inflection classes confront a large learning task whose solution raises fundamental questions about morphological systems and their organization. This task receives a general formulation as the Paradigm Cell Filling Problem (PCFP) in Ackerman et al. (2009):

PARADIGM CELL FILLING PROBLEM: Given exposure to an inflected word-form of a novel lexeme, what licenses reliable inferences about the other word-forms in its inflectional family?

For example, in Tundra Nenets (Samoyedic branch of Uralic) each noun lexeme has 210 possible inflected forms for the morphosyntactic feature property combinations for seven cases, three numbers, and three persons and numbers for possessors: $(7 \times 3) + (7 \times 3 \times 3 \times 3) = 210$ distinct word-forms.¹ So, confronted with the need to produce a previously unencountered form of a known inflected word, what guides a native speaker’s guesses about the (patterns of) word-forms that encode all of the licit morphosyntactic feature combinations of a lexeme? How do speakers reliably resolve uncertainties in the selection of an appropriate form? In some intuitive

¹ We ignore for present purposes both predicative forms and so-called predestinative forms which host possessive markers serving to indicate future beneficiaries (see Nikolaeva 2015).

sense, the problem seems increasingly difficult (i) the larger the number of morphosyntactic properties a language contains, (ii) the greater the number of allomorphic variants it uses to encode them, and (iii) the more extensive the conjugation classes and subclasses (i.e., distinctive patterns) over which words can be distributed. In fact, morphological *complexity* is commonly calculated by considering these factors.² Ackerman and Malouf (2013) refer to this perspective on morphological typology as *enumerative complexity* or *E-complexity*: this is the classification and quantification of morphological phenomena by reference to factors (i)–(iii) above, which all figure in the formal shapes of words. In this respect, even a language like Tundra Nenets seems impoverished in comparison with, for example, Estonian (Blevins 2006; Baerman 2014a), Seri (Marlett 2009; Baerman 2014b, in press), Archi (Kibrik 1991; Corbett 2013) or South Saami (Gabbard 2015).

The essential challenge, as formulated in the PCFP, is not new, and proposed answers to it have a similar profile (Paul 1891; Anttila 1989; Wurzel 1989; Fertig 2013): analogical inferences from forms belonging to known inflectional patterns permit reasonable guesses concerning likely candidates for unknown forms. Analogy as a mechanism that facilitates morphological learning, guides use, and directs change has gained increasing recognition as a crucial explanatory resource over the years in numerous behavioral and cognitive domains (Esper 1925, 1966, 1973; Gentner et al. 2001; Hofstadter and Sander 2014, among others). But in order for analogy to be useful in understanding the development, maintenance, and changes of morphological systems, the phenomena over which it applies must be clearly delineated.

In this chapter, accordingly, we identify the basic word-based morphological assumptions which permit analogical inferencing to operate effectively via systems of implicational relations. In Section 2 we differentiate between familiar morpheme-based approaches and word-based approaches in terms of their interpretations of the part-whole relations central to morphological analysis. We explore the internal structure of complex words, the status of words in morphological theory, and how this provides insights into the organization of words as systems of relatedness. We begin by suggesting that the construct “morpheme,” construed in the variety of operating assumptions deriving from the Post-Bloomfieldian tradition or more comprehensively, if vacuously, construed as in Beard (1995) and the Distributed Morphology tradition,³ provides little insight into the nature and effects of word internal structure: we will argue that the importance of internal structure for morphology is not in the identification of exponents for meaningful bits, but in ways that the organization of exponents facilitates patterns of discriminability that help to distinguish and relate

² Cf. the articles in Sampson et al. (2010) and Miestamo et al. (2008): the more morphosyntactic distinctions, mappings, and classes, the greater the morphological complexity.

³ Marantz (2013) is a recent defense of this position.

(classes of) words.⁴ Sometimes, as we will see, this involves (semi-)classic morphemic composition, but more commonly it requires considering words as *recombinant gestalts*—that is, wholes consisting of configurations of redeployed elements (segmental, suprasegmental) that each alone do not contribute invariant meanings irrespective of the word contexts in which they occur. Most obviously, the reuse of the same forms with different functions in different word contexts is illustrated by the distributions of morphemes⁵ and the phenomenon of polyfunctionality.⁶ This establishes the word as a patterned entity to be an essential unit of analysis in morphological theory. We then turn from the internal structure of words to their participation as parts within systems of relations constitutive of morphological organization. Developing themes found in Ackerman and Blevins (2008), we discuss affinities between the conception of part-whole relations in word-based approaches and similar analytic assumptions presently leading to reconceptualizations in the developmental sciences. In Section 3 we demonstrate how a particular interpretation of implicational relations among words in paradigms can be understood in information-theoretic terms: we show how relations between words analyzed information-theoretically in terms of conditional entropy suggest new perspectives on old issues and lead to new research questions, including ways to address the PCFP. Focusing on the systems of relations guiding morphological organization, we introduce a different perspective on morphological complexity: instead of focusing on the additive aspect of how individual elements combine and are distributed, the complementary perspective, referred to as *integrative complexity* or I-complexity in Ackerman and Malouf (2013), identifies and measures the relations between individual elements (i.e., the paradigmatic systems) that produce the organization in morphological systems. We also explore some recent developments and applications of the model presented in Section 3. In Section 4 we provide some conclusions.

2 Part-whole Relations

Since the middle of the twentieth century there has been growing recognition of the importance of understanding the principles shaping systemic organization within the developmental sciences (see Gottlieb 1997; Oyama et al. 2001; Jablonka and Lamb 2006; Gilbert and Epel 2008; Overton 2010; Bateson and Gluckman 2011, among others), represented by the family of developmental dynamic systems approaches within both biology and psychology. There is an emerging cross-disciplinary consensus that familiar analyses which reduce complex wholes to their constitutive parts and

⁴ See Blevins (2016) for an extended exploration of this theme. ⁵ See Aronoff (1994), Cruschina et al. (2013).

⁶ Ackerman & Bonami (in press) provide a formal analysis of polyfunctional markers in Tundra Nenets.

formulate associated procedures to reconstruct wholes from these parts has led to inevitable gaps in our understanding of the targeted phenomena: it has been observed that the most ordinary, and often most puzzling, objects display properties that are not explicable in this way. Hence, the revived currency of the mysterious-sounding dictum “The whole is more/different than the sum of its parts.” In line with this, Anderson (1972: 393), arguing for a complex dynamic systems approach to the analysis of complex objects in contrast to the then-prevalent reductionism, writes the following:

The main fallacy in this kind of thinking is that the reductionist hypothesis does not by any means imply a “constructionist” one: The ability to reduce everything to simple fundamental laws does not imply the ability to start from those laws and reconstruct the universe. In fact, the more the elementary particle physicists tell us about the nature of the fundamental laws the less relevance they seem to have to the very real problems of the rest of science, much less to those of society.

The constructionist hypothesis breaks down when confronted with the twin difficulties of scale and complexity. The behavior of large and complex aggregates of elementary particles, it turns out, is not to be understood in terms of a simple extrapolation of the properties of a few particles. Instead, at each level of complexity entirely new properties appear, and the understanding of the new behaviors requires research which I think is as fundamental in its nature as any other.

A view that recognizes the theoretical significance of wholes emerging from their parts necessarily requires an understanding of the parts that receive their value from their participation in those wholes. From this perspective, the focus is on the relations between parts, rather than only on the parts themselves.

Modern generative models of morphology that regard both words and paradigms as epiphenomena rather than first-class theoretical objects, simply reducible to their parts (if abstracted correctly) and combinatoric rules (if formulated correctly), make this same constructionist error (see Blevins (2006) on constructionist vs. abstractionist approaches to morphological analysis). In contrast, from a contemporary perspective the hypotheses guiding Word and Paradigm proposals have a natural affinity to much research in the complexity sciences and their efforts to explicate and explain systemic organization in different domains.

For example, Russell (1930), arguing against reductionist genocentric speculations⁷ for understanding the development of morphology in biology, observes that “the unity of the organism is ... not decomposable without loss, and cannot be resynthesized in its original completeness from

⁷ This is, effectively, what Benítez-Burraco and Longa (2010) refer to as *Evo-Devo_{GEN}* in their reassessment of longstanding operating assumptions in Chomskyan theory. Their claim is that Chomskyan theory as ordinarily practiced is incompatible with the sort of systems perspective on biological analysis associated with most research in Evolutionary Developmental Biology. Accordingly, they propose a radically revised version of the theory that adopts many insights of perennial critics of that framework. For example, Elman et al. (1996) articulates a systems perspective on language and development that argues against *Evo-Devo_{GEN}* from a systems perspective.

the abstract components distinguished by analysis” (Russell 1930: 146). This early insight, as well as the two “cardinal laws” he formulates, can be seen as foundational for most modern research on the central role for systems and wholes in developmental science (Gilbert and Sarkar 2000; Stiles 2008; Bateson and Gluckman 2011). His two laws are usefully phrased as follows (Russell 1930: 147):

- (i) The activity of the whole cannot be fully explained in terms of the activities of the parts isolated by analysis, and it can be less explained the more abstract are the parts distinguished.
- (ii) No part of any living unity and no single process of any complex organic activity can be fully understood in isolation from the structure and the function of the organism as a whole.

Returning to language, Matthews (1991: 204) observes that morphological analysis focuses on identifying patterns of part-whole relations constitutive of word internal structure as well as the relatedness between words that produces the organization characteristic of paradigmatic systems.

[W]ords are not merely wholes made up of parts, but are themselves construable as parts with respect to systems of forms in which they participate.

Differing views about part-whole relations permit a perspicuous contrast between (post)structuralist assumptions typified in generativist (particularly Chomskyan) approaches and the classical representations associated with Word and Paradigm (WP) approaches.⁸ In particular, the distinctive properties of these approaches can be identified by distinguishing between two different domains over which part-whole relations are definable. We will argue that word-based approaches, unlike “morpheme”-based approaches, recognize words and paradigms as wholes whose theoretical status provides instructive insights into morphological organization.

In the domain of inflectional word structure questions arise concerning the internal composition of (complex) words, especially concerning the relevant units of analysis, their types of combination and their association with morphosyntactic properties. For example, relevant inquiry concerns whether all of the pieces of complex words are meaningful, whether linear and hierarchical combination are the sole modes of arrangement, and whether composition is the only means for achieving the meanings associated with words. We will refer to this as *Domain 1*.

The appropriate identification of word internal structure facilitates the discovery of inflectional patterns that (classes of) words participate in. In the domain of relations between words questions arise concerning sets and subsets of patterns that constitute the organization of morphological systems: this is the domain of paradigm structure which, of course,

⁸ See Blevins (2016) for a comprehensive introduction to Word and Pattern morphology.

presupposes that words are construed as parts of patterned wholes. We will refer to this as *Domain 2*.

2.1 Domain 1: The Internal Structure of Words

The central focus of structuralist and generative morphology has been on the internal structure of words – that is, on *Domain 1*. A prevailing assumption has been that internal structure consists of morphemes, interpreted in an increasingly capacious and theory-driven fashion over the years (Marantz 2013, but see Hay and Baayen 2005).

Understanding a complicated whole by reducing it into constitutive parts is a familiar and successful analytic strategy in the sciences. Within the field of linguistic morphology, Blevins (2016), following Hockett (1987), refers to this as **disassembly**. For example, the complicated Hungarian word in (1) can be disassembled into four parts, each bearing its own meaning.

- (1) bátor-ság-om-ról
 brave-ness-1SG.POSS-about
 ‘about my bravery’

It is conventionally thought in Post-Bloomfieldian structuralist morphology and its modern congeners within the generative paradigm, that it is the theoretician’s task to identify the constitutive pieces of complex words and to explicate the nature of the reassembly processes that reconstitute the whole from its parts. For (1) this is straightforward: a simple concatenation of the disassembled parts additively produces a word that reflects both the form and the meaning of these parts.⁹ In the present instance, the meaning of the assembled whole can be construed as a composite of its meaningful pieces: an adjectival base meaning ‘brave’ is followed by a marker of nominalization and this is followed in turn by a possessive marker and a case marker. What theory requires, accordingly, is an inventory of parts and the rules that arrange them into words. A widespread approach to morphological analysis, reinforced in introductory linguistic textbooks and assumed in highly developed structuralist approaches such as Distributed Morphology, hypothesizes that the fundamental units of disassembly and reassembly are **morphemes**. Morphemes, in their ordinary interpretation, are biunique form-meaning pairings.¹⁰

⁹ We ignore here the issue of possible hierarchical structure within the word.

¹⁰ Recent efforts within Distributed Morphology have assimilated the criticisms leveled at both standard and extended notions of the morpheme construct by denominating all of the word internal structure conceived as non-morphemic in WP models as *morphemic*: this is motivated by Beard’s lexeme/morpheme proposal, according to which every element which is not a lexeme is a morpheme. This concurs with common assumptions within WP approaches that part of morphology is the study of word internal structure, but it also, in effect, defines all word internal structure as necessarily morphemic. It includes as “morphemic” every type of exponent conventionally used to argue against the standard notion of morpheme. In doing so, it locates the difference between WP and structuralist approaches in their

This approach can be characterized as syntagmatic, because it emphasizes both the linear concatenation of constitutive parts as well as their hierarchical arrangement into (binary) branching structures, and compositional, because it derives the meaning of the whole word from the meanings of its identifiable parts, including the scopal relations provided by the hierarchical organization of its elements. On this view, Hungarian morphology can serve as a model system for understanding crosslinguistic morphology, since it so clearly exemplifies the essential assumptions guiding morphemic theory. In fact, this basic analytic strategy appears so intuitive, given the instructive example of Hungarian, that it seems commonsensical to extend it to languages in which the meanings of the parts and the composite meaning of the whole are less transparently related than they are in Hungarian. This is the issue Lounsbury (1953) raised when he wondered whether morphological theory should be predicated on theoretizing a “fictive agglutinative analog.” How much are all languages underlyingly like an idealized version of Hungarian is on its surface? In this connection, a fundamental theoretical question that arises, for both Hungarian and other languages, concerns whether the instructions for reassembly of the pieces in terms of, for example, linear sequence or hierarchy can adequately recapture the nature of Hungarian complex words and whether the parts’ participation in the whole in Hungarian and in other languages more generally is unrecapturable without diacritic instructions for reassembly posited in all such theories.

With at least equal plausability, even such straightforward Hungarian data can be interpreted as motivating a morphological theory guided by the assumption that there are gradient degrees of regularity, as in Bybee (1985) and Bochner (1993), among others. Of course, in Hungarian, as in other languages, there are similarly structured words that are not simply the sums of their parts. Hungarian *egész-ség-em-ről* ‘about my health’ contains all the same basic parts as *bátor-ság-om-ról* (namely, an adjective root, a nominalizer, a possessive marker, and an elative case suffix), but the derived nominal *egész-ség* conventionally denotes ‘health,’ similar to what occurs in English, not the expected compositional meaning ‘wholeness.’ Accepting the need to stipulate the meaning of the derived noun, however,

implementational choices and the guiding assumptions about how language analysis corresponds with the analysis of complex objects in other disciplines. The crucial question appears to be not what the elements of word internal structure are called, but how they are used in different morphological approaches.

For instance, since DM adopts the standard many-to-many relations between morphosyntactic properties and their forms found in WP proposals, a distinguishing difference between alternative approaches concerns whether the “internal structure of inflectional morphology receives a syntactic treatment” (Marantz 2013: 908): the syntactic treatment of words is one of the gambits guiding research in DM that differentiates it from WP approaches. In the latter, morphology and syntax are interdependent, but independent systems governed by their own primitives and principles of organization: syntax is not morphology beyond the word, as suggested by the structuralists, nor is morphology syntax below the word, as suggested in various generative proposals. Finally, concerning correspondence with other disciplines, it is not evident how the implementational preferences in, for example, DM relate to results achieved by systems-oriented proposals such as those described here.

the rest of the word's meaning conforms with expectation. Such locally idiosyncratic departures from expectations, then, can be viewed as restricted deviations that support the basic analysis into meaningful parts and division between regular and irregular forms. In both instances the basic elements recur in essentially the same locations and functions: the potential role of their patterned organization is hidden by the coincidence of the same pieces organized in the same way.

Consideration of the first past tense realizations of *-em* conjugation verbs in Mari (Uralic) provides a simple demonstration of how the organization of elements can be as crucial as the elements themselves. This is illustrated with partial paradigms for the representative verb *kol* 'die.'

(2)		1ST PAST AFFIRMATIVE	1ST PAST NEGATIVE
	SG1	kolâ-š - â m	š-â m kolâ
	SG2	kolâ-š - â c	š-â c kolâ
	SG3	kolâ-š	âš kolâ

In Mari there are clearly segmentable elements whose invariant sequence is associated with past tense and 1sg subject for the relevant conjugation class: on the other hand, it is the location of this unit as a suffix or as an independent unit preceding the verbal stem that is associated with positive versus negative polarity of verbs, respectively.¹¹ The same pieces deployed in different morphological configurations convey different polarity values for verbs: they take on different functions in the word context in which they occur.

We find another, far more complex, example of the challenge of conveying, for example, the singular versus plural number distinction in nouns, in the Agar dialect of Dinka (Eastern Nilotic) as analyzed in Andersen (2014).¹² This language distinguishes case and number for its inventory of mostly monosyllabic and di-syllabic noun lexemes by word internal interactions among four parameters: (i) vowel length, (ii) tone, (iii) voice quality of the vowel, and (iv) vowel quality alternation grade. He presents the following noun pairs to illustrate the evident independence of any specific collection of these parameters with determinate number values:

(3)	SG	PL	
	dít	dj̥ɛ̃t	'bird'
	kòɔɔr	kàar	'elbow'
	rj̥ɛ̃m	rīm	'blood'
	cj̥ɛ̃c	cíc	'bee'
	láj	laj	'animal'

¹¹ Following Ackerman and Stump (2004), we assume that the periphrastic expressions for negative polarity fill cells in the morphological paradigm of the lexeme 'die.' See Bonami (2015) for a formal treatment of the relation between multiword morphological expressions and their syntactic realization.

¹² See Baerman (2012) for a detailed analysis of similar data in Nuer that recognizes the importance of the ideas presented in this chapter for the organization of the Nuer system.

màac	mêεc	‘fire’
dòm	dũum	‘field’
tòon	tõon	‘pot’
twõoon	tũun	‘ember’
uḡam	uḡõom	‘thigh’

Grossly describing one simple contrast, when we compare the pairs of words for ‘thigh’ and ‘elbow,’ it becomes clear that they display mirror images with respect to length and tone for their singular and plural exponents. Whereas the singular for ‘elbow’ has triple length for its vowels and low tone on the first vowel, this is the word internal pattern for the plural of ‘thigh.’ Similarly, the double length vowels and low tone for the singular of ‘thigh’ parallels the same pattern for the plural of ‘elbow.’ Concerning the relation between singular and plural pairs of the subset of types presented above, Andersen (2014: 226) writes:

From the very beginning of linguistic research on Dinka, it has been noted that number inflection of nouns in this language is irregular. Mitterutzner (1866: 15) and Beltrame (1880: 22–24) stated that there is no general rule for forming the plural from the singular, and both authors made observations about the types of phonetic differences existing between the singular form and the plural form of a noun . . . That number inflection of simple native nouns, such as those . . . above, is indeed irregular and unpredictable, has recently been established by Ladd et al. (2009). The plural form cannot be predicted from the singular form, nor can the singular form be predicted from the plural form, and the number inflection may appear to be totally irregular.

An approach to word structure that focuses on the surface shapes of word pairs, rather than on the generation of individual words, predicts that there is hidden patternment in this evident profusion of forms. It is the morphologist’s task to reveal this. Indeed, Andersen delineates numerous distinct patterns, demonstrating that what seemed utterly irregular is actually organized into different patterns and subpatterns with many or few members. Patterned pairings of words emerge from varying configurations of vowel length, tone, vowel quality, and vowel gradation. A crucial ingredient for understanding this system is the recognition that words are primary objects of morphological theory and that, consequently, contrasts between words disclose the patterned nature of morphological organization. Indeed, a fundamental distinction between “morpheme”-based and word-based approaches is the claim in the former approach that words are epiphenomal and the hypothesis in the latter that they represent an important independent level of analysis. This basic view is foundational for the careful exploration of Georgian morphology in Gurevich (2006: 44):

The meaning of the whole word licenses the exponents to be used, but there is no precondition that the meanings of the exponents have to combine to

comprise the meaning of the whole. Compositionality may, indeed, emerge, but as a side product rather than a central principle, or perhaps as an effective learning strategy. The whole itself may contribute meaning to the meanings of the parts, or may override the meanings of the parts.

(Classes of) words are wholes that are distinguishable by means of the patterns associated with their pieces. From a word-based perspective, surface word-forms are best viewed as “recombinant gestalts” or configurations of recurrent partials (segmental or suprasegmental) that get distributed in principled ways among members of paradigms. This parallels what Oudeyer (2006: 22) describes as the “systematic reuse” (we would suggest *systemic* reuse) of phonological distinctions:

all languages have repertoires of gestures and combinations of gestures which are small in relation to the repertoires of syllables, and whose elements are systematically reused to make syllables.

Similarly the domain of morphology can be seen as an instance of a complex adaptive system, redeploying the same pieces in new ways for different purposes. Given this, the analysis of morphology begins to look like it can benefit from methods used in other fields which study such systems.

The adoption of the word as an independent and necessary unit of analysis also permits words, in turn, to be parts of paradigmatic systems or niches. In this respect, a consequence of permitting words to be contrasted with words is the possibility of discovering morphological organization in the systems of relations between words. This accords with the observation from Robins (1959: 128) that

words anchored, as it were, in the paradigms of which they form a part usually bear a consistent, relatively simple and statable grammatical function. The word is a more stable and solid focus of grammatical relations than the component morpheme by itself. Put another way, grammatical statements are abstractions, but they are more profitably abstracted from words as wholes than from individual morphemes.

In this connection Blevins (2016) makes an incisive observation about the consequences of favoring a focus on pieces and their composition, while ignoring the pivotal role of the word in morphology. Solely focusing on the comprehensive reduction of the word into smaller pieces denies a whole line of inquiry into morphology—namely, the examination of how surface patterns of words cohere into organized systems. In particular, the surface expressions of words do not simply motivate the need for operations that transpose covert invariant representations into overt word-forms, but they are centrally informative units which contribute to the similarity and difference relations facilitating the organization of and relations between (sub)paradigms. It is to this other aspect of the part-whole aspect of morphological organization that we turn to now.

2.2 Domain 2: The Place of Words in the Systemic Organization of Paradigms

The value of describing contrasts between words differing in morphosyntactic content and surface exponence is evident from the Mari and Agar Dinka examples discussed in the preceding section: the words used in these data displays are representative of general patterns instantiated by morphological systems in these languages. Rather than being epiphenomena, like words, as suggested in some theoretical frameworks, the patterns extracted from the comparisons between related words can be interpreted as instructive about fundamental organizing principles of morphological systems. As argued in the following section, such patterns provide data for quantifying and modeling relations between (classes of) words.

The explanatory utility of words and paradigms in the dynamics of language change is unquestionable. This is especially evident from instances of analogy. For example, Anttila (1989: 91) provides a simple example from Estonian, where the loss of medial *-k* as an onset to a closed syllable had consequences for forms of words without medial *-sk*. The nominative singular form of the word *kask* ‘birch’ had an original plural form *kas-k-et* ‘birches.’ Since the *-k* functioned as the onset to the closed syllable of the case/number marker, it was elided: the new form was *kased*. This form resembled the nominative plural for some *-s* final words. For example, the original nominative singular for ‘fir’ was *kuus*, while its nominative plural was *kuused*. This resemblance to the nominative plural for ‘birch’ led to an innovatory nominal singular form for ‘fir,’ specifically *kuusk*. Historical examples such as this demonstrate the importance of words and their role in morphological systems. But, they also suggest that language as a constantly changing object is profitably viewed more generally as a dynamic system. This was the view of Paul (1891: 5–6):

Thus it is that the different uses, which have come to be associated with a word or a phrase, associate themselves with each other. Thus to the different cases of the same noun, the different tenses, moods and persons of the same verb, the different derivatives of the same root, associate themselves, thanks to the relationships between their sounds and the meaning; . . . further forms of different words with similar functions—e.g., all plurals, all genitives, . . . all masculines which form their plural by means of umlaut as contrasted with those that form it otherwise . . . These associations may one and all arise and operate without consciousness, and they must not be confounded with grammatical categories, which are the result of conscious abstraction, though they not infrequently cover the same ground.

Paul also observed that patterned relations which inhered in such associative networks were useful as analogical bases for grammatical generalizations. Indeed, Davies (1998: 259) identifies the creative role that analogy has in Paul’s conception of language organization:

Paul's concept of analogy and of analogical proportion is a definite attempt at providing a generalized account at a certain level of detail of how language production occurs and of how the speaker and hearer can produce an infinite number of forms and sentences which they have not heard before.

Appropriate analogical inferences are facilitated by the implicational relations characteristic of paradigm structure as observed by Matthews (1991) and explored by Wurzel (1989). The basic nature of such structure is made plain in Paunonen's (1976) analysis of Finnish nominal paradigms.¹³ Following the classification scheme found in Pihel and Pikamäe (1999: 758–71) we can represent a subset of the Finnish nominal paradigms as follows:¹⁴

(4)	NOM SG	GEN SG	PTV SG	PTV PL	INESS PL	
	ovi	oven	ovea	ovia	ovissa	'door' (8)
	kieli	kielen	kieltä	kieliä	kielissä	'language' (32)
	vesi	veden	vettä	vesiä	vesissä	'water' (10)
	lasi	lasin	lasia	laseja	laseissa	'glass' (4)
	nalle	nallen	nallea	nalleja	nalleissa	'teddy' (9)
	kirje	kirjeen	kirjettä	kirjeitä	kirjeissä	'letter' (78)

The numbers in parentheses after the glosses refer to Pihel and Pikamäe's classes. Looking at classes 8, 32, 10, and 4, it becomes clear that nominative singular forms ending in the vowel *-i* are not diagnostic of the corresponding genitive singular word-form: these variants end in *-en* for 8 and 32, but in *-in* for class 4. Moreover, familiarity with the genitive singular forms for classes 8, 32, and 10 is not directly diagnostic for predicting the nominative singular, since there is a consonant difference in the stem for class 10 from *-d* to *-s*. Likewise, knowledge of the genitive singular is not unambiguously diagnostic of the partitive singular for these classes, since class 8 appears to pattern with class 9 for this morphosyntactic property set in ending with *-ea*, while 32 and 10 appear to pattern together, both taking *-tä*. Though it seems that there is a kaleidoscope of patterns in this subparadigm, a close look reveals that there are some individual forms in specific cells that are predictive of forms in other cells, while in other instances ensembles of forms from several cells jointly predict the particular patterns for words. For example, knowledge of the partitive plural form of a word in class 4 and 9 is not enough to predict their nominative singular variants. However, knowledge of both the partitive plural and the genitive singular are jointly predictive of the correct nominative singular forms. Relatedly, knowledge of the partitive singular alone for class 8 and class 4 is not enough to predict whether the nominative singular ends in *-i* or *-e*. But

¹³ See Thymé (1993) for an extended exploration of this phenomenon in Finnish.

¹⁴ The following discussion describes the patterns in the simplest way in order to provide a sense of the nature of implicational relations. Among other factors, it ignores well-known phonological generalizations and patterns of stem alternation.

knowledge of the forms for both partitive singular and partitive plural is reliably predictive of the nominative singular forms.¹⁵ Paradigmatic implications of this sort appear to be an essential property of morphological organization crosslinguistically and are particularly important in languages with complex morphological systems. The existence of relations between words such as these in complex systems motivates the need for the application of new quantitative methods for revealing patterns that would otherwise remain undetected and for calculating degrees of relatedness between the words within (and across) identified patterns. This will be the subject of Section 3.

2.3 Summary

In sum, it is useful to distinguish between different approaches to morphology in terms of how they conceptualize part-whole relations with respect to *Domain 1* and *Domain 2*. So, what is the difference in the interpretation of word internal structure between “morpheme”-based and word-based approaches? From a word-based perspective the “morpheme”-based foci on resolving the indeterminacies of segmentation, developing reassembly and readjustment rules, assuming a stark division between regular and irregular formations, and presuming the epiphenomal status of words seem to misunderstand the fundamentally part-whole organization of morphology. The crosslinguistic examination of word internal structure reveals, instead, how the configurative organization of elements constitutive of words yields patterns that distinguish (classes of) words from each other. The function of internal structure is, accordingly, discriminative (see Baayen and Ramscar 2015; Ramscar et al. 2015): it provides discriminably different patterns that facilitate the patterns of similarity and difference that words participate in.

This leads to questions concerning how word-forms are organized into structured networks of conjugation and declension classes within inflectional and derivational families. It becomes natural to ask why the systems of organization cohere in the ways that they do, how such organization is learned, and whether the nature of the organization reflects learnability constraints, either specific to language or relevant in other learned domains as well. The largest difference between these approaches concerns whether words as whole units are regarded as theoretical objects of interest: they are not in generative approaches, but they are in WP approaches. Given the status of words as theoretical objects they can function as parts in systems of relations that constitute another whole—namely, the patterns of related words. This is a dimension of paradigmatic organization, where whole words constitute parts of patterns which themselves are constitutive of

¹⁵ There are, of course, many other implicative relations among forms in this illustrative subparadigm.

larger systems of word patterns and their interrelations. Beyond the descriptions of paradigmatic structure in terms of implicative organization and intuitions concerning their importance, modern development of word-based proposals have also devised ways to measure and quantify the relations constitutive of this structure. We explicate and explore one particularly fertile approach to this below.

3 Information Theoretic Models

The complexity associated with lexically conditioned allomorphy typically shows only loose correlation with systematic phonological or semantic conditions (synchronically, at least) and often seems to serve no apparent communicative function. All natural languages show a certain degree of what Baerman et al. (2015: 2) call “gratuitous” morphological complexity and Wurzel (1986: 76) describes as “ballast” in the linguistic system.

Take, for example, Pite Saami nominal paradigms. In Pite Saami, seven cases (setting aside the marginal essive and abessive) and two numbers are encoded via a suffix and choice of a weak or strong stem, where stem grades are distinguished by regular patterns of consonant and vowel alternations. For example, the complete paradigm for *bäbbmo* ‘food’ is (Wilbur 2014: 102):

(5)		SING	PLUR
	NOM	bäbbmo	biebmo
	GEN	biebmo	biebmoj
	ACC	biebmov	biebmojd
	ILL	bäbbmoj	biebmojda
	INESS	biebmon	biebmojn
	ELAT	biebmost	biebmojst
	COM	biebmojn	biebmoj

Following Wilbur (2014), Pite Saami has eight nominal declensions showing distinct grade and suffix patterns, shown in Table 12.1. Since the assignment of lexical items to particular declensions is largely arbitrary (though influenced by phonological factors), these classes add complexity to the inflectional system in a way that serves no communicative purpose.

In classical paradigm-based models of morphology, a morphological system is represented via two distinct components: a set of exemplary full paradigms that exhibit the inflectional classes of a language, and sets of diagnostic principal parts which can be used to deduce which inflectional class a given lexeme belongs to. Speakers may memorize complete paradigms for frequent lexemes, but for infrequent lexemes speakers must produce word-forms by analogy from known lexical items. Given the right word-forms of a novel lexeme, Word and Paradigm models provide a general strategy for filling in the rest of the paradigm by exploiting its

Table 12.1. *Pite Saami nominal inflection classes (adapted from Wilbur 2014)*

CLASS	NOM. SG	GEN. SG	ACC.SG	ILL.SG	INESS. SG	ELAT.SG	COM.SG
Ia	str+a	wk+a	wk+av	str+aj	wk+an	wk+ast	wk+ajn
Ib	str+á	wk+á	wk+áv	str+áj	wk+án	wk+ást	wk+ájñ
Ic	str+o	wk+o	wk+ov	str+oj	wk+on	wk+ost	wk+ojñ
Id	str+å	wk+å	wk+áv	str+áj	wk+án	wk+ást	wk+ájñ
Ie ^a	str+e	wk+e	wk+ev	str+áj	wk+en	wk+est	wk+ijn
II ^b	wk+aj	str+a	str+av	str+aj	str+an	str+ast	str+ajn
IIIa	wk+∅	str+a	str+av	str+ij	str+in	str+ist	str+ijn
IIIb	wk+V ^c	str+a	str+av	str+ij	str+in	str+ist	str+ijn
CLASS	NOM.PL	GEN.PL	ACC.PL	ILL.PL	INESS.PL	ELAT.PL	COM.PL
Ia	wk+a	wk+aj	wk+ajd	wk+ajda	wk+ajn	wk+ajst	wk+aj
Ib	wk+á	wk+áj	wk+ájd	wk+ájda	wk+áñ	wk+ájst	wk+áj
Ic	wk+o	wk+oj	wk+ojd	wk+ojda	wk+on	wk+ojst	wk+oj
Id	wk+å	wk+áj	wk+ájd	wk+ájda	wk+áñ	wk+ájst	wk+áj
Ie	wk+e	wk+ij	wk+ijd	wk+ijda	wk+ijn	wk+ijst	wk+ij
II	str+a	str+aj	str+ajd	str+ajda	str+ajn	str+ajst	str+aj
IIIa	str+a	str+ij	str+ijd	str+ijda	str+ijn	str+ijst	str+ij
IIIb	str+a	str+ij	str+ijd	str+ijda	str+ijn	str+ijst	str+ij

^a Class Ie nouns are also distinguished by “non-adjacent regressive vowel harmony triggered by the presence of /j/ in certain case/number suffixes” (Wilbur 2014: 102).

^b Class II nouns show variation in the suffix vowel, though “there do not appear to be many words in Class II, and the data in the corpus are ultimately inconclusive” (Wilbur 2014: 104).

^c In Class IIIb, nominative singular forms drop a stem-final consonant. For example, compare Class IIIa *vanás* ‘boat’ NOM.SG ~ *vadnás-a* GEN.SG and Class IIIb *bena* ‘dog’ NOM.SG ~ *bednag-a* GEN.SG. In both, the *-n- ~ -dn-* alternation follows from general stem grade patterns, but the loss of the final *-g* in *bena* does not (Wilbur 2014: 106).

implicational structure. Traditionally conceived, a small set of diagnostic **principal parts** is often sufficient to identify the inflectional class of a lexeme and thus to accurately predict the remaining word forms of the lexeme. Paradigm-based models also reflect a measure of E-complexity: languages with a greater number of possible exponents, inflectional classes, and principal parts will require more word-forms to be memorized by the language user (and recorded by the lexicographer) in exemplary paradigms.

However, from the point of view of the (fluent) language user, this is an artificial measure of complexity. While speakers of morphologically complex languages do often have to produce word forms that they have never heard before, they rarely have to predict all forms of a given lexeme. On the contrary, speakers must produce some subset of the complete paradigm of a lexeme given knowledge of some other subset, a task which rarely requires completely resolving a lexeme’s inflectional class membership. In addition, speakers have no guarantee that they will have been exposed to the most relevant or diagnostic principal parts of a novel lexeme. Thus, patterns of implicational relations among all word forms within paradigms,

not just principal parts, can be interpreted as providing speakers with a means for carrying out these predictions with incomplete information.¹⁶

3.1 Entropy

In order to assess the strength of implicational relations among word forms, we will use the information-theoretic notion **entropy** as the measure of uncertainty or predictability (Ackerman et al. 2009; Ackerman and Malouf 2013).¹⁷ This permits us to quantify “prediction” as a reduction in uncertainty, or information entropy (Shannon 1948).¹⁸ Suppose we are given a random variable X which can take on one of a set of alternative values $x_1, x_2, \dots, x_n$ with corresponding probability $p(x_1), p(x_2), \dots, p(x_n)$. Then, the amount of uncertainty in X , or, alternatively, the degree of information conveyed on learning the value of X , is the entropy $H(X)$:

$$H(X) = -\sum_i p(x_i) \log_2 p(x_i)$$

The entropy $H(X)$ is the weighted average of the **surprisal** $-\log_2 p(x_i)$ for each possible outcome x_i . The surprisal is a measure of the amount of information expressed by a particular outcome measured in bits, where 1 bit is the information content of a choice between two equally probable outcomes. Outcomes which are less probable (and therefore harder to predict) have higher surprisal. Specifically, surprisal is 0 bits for outcomes which always occur ($p(x) = 1$) and approaches ∞ for very unlikely events (as $p(x)$ approaches 0). The more choices there are in a given domain and the more evenly distributed the probability of each particular alternative, the greater the uncertainty or surprise there is (on average) that a particular choice among competitors will be made and, hence, the greater the entropy. Conversely, choices with only a few possible outcomes or with one or two highly probable outcomes among many unlikely exceptions have a low entropy.

With this as background we can now return to the Pite Saami nominal paradigms in Table 12.1 to quantify the uncertainty among the nominal types. Suppose we want to represent the inflection class membership of an arbitrary lexeme. This is, for instance, the problem faced by a lexicographer preparing a dictionary of the language. If D is the set of declensions for a particular paradigm, the probability (assuming all declensions are equally likely) of an arbitrary lexeme belonging to a particular paradigm d is

$$p(d) = \frac{1}{|D|}$$

¹⁶ This fact motivates Stump and Finkel (2009, 2013) to propose a notion of “cell predictability” as one measure of paradigm transparency.

¹⁷ There are different ways to calculate complexity and the way that it impacts on the predictiveness and predictability of forms. A particularly well-developed alternative can be found in Stump and Finkel (2013).

¹⁸ For a comprehensive treatment of information theory, see Cover and Thomas (2006), while Peirce (1980) offers a more accessible introduction.

Since in the Pite Saami example there are eight distinct classes, the probability of any lexeme belonging to any one class would be $\frac{1}{8}$. We could represent a lexeme's declension as a choice among eight equally likely alternatives, which thus has an entropy of $-\log_2 8 = 3$ bits. This is the declension entropy $H(D)$, the average information required to record the inflection class membership of a lexeme.

In general, not all inflection classes are equally likely: for Pite Saami, Wilbur (2014: 100) reports that Class I is "a sort of default class" which contains the majority of nouns, while Class II and III are relatively rare. In any inflectional system, some classes will have more members than others, and a randomly selected lexeme is more likely to be a member of a class with many members. Let $F_{\text{typ}}(d)$ be the **type frequency** of declension d : in other words, the number of lexemes that are members of that class. Then, in general, the probability of a declension d is:

$$p(d) = \frac{F_{\text{typ}}(d)}{\sum_{d \in D} F_{\text{typ}}(d)}$$

That is, the probability of a randomly selected word being in declension d is just the number of lexemes which actually are in declension d divided by the sum of the lexeme counts for all declensions (which in turn is just the total number of lexemes in the relevant vocabulary). Factoring type frequency into our calculation of declension entropy can only reduce our estimate, sometimes substantially. Hypothetically, suppose that 95 percent of Pite Saami noun lexemes are evenly divided among the subclasses of Class I and the remaining 5 percent are divided among the other three classes. Then, our estimate of the declension entropy would be reduced from 3 bits to 2.6 bits.

In many cases, inflectional class membership is also at least partly predictable by external factors, such as the phonological shape or lexical gender of the root. Any information that helps speakers predict the realization of a word form can only reduce the entropy. For the sake of this example, we ignore both frequency and these external factors. This means that the entropy values we present are upper bounds. If all factors are taken into account the actual entropies will likely be much lower.

Recording the declension of an arbitrary noun lexeme (the problem faced by our hypothetical lexicographer) is more difficult than the problem faced by a speaker. An exhaustive dictionary might provide complete paradigms showing all of the inflected forms of a lexeme or class of lexemes, while speakers need only produce one single form in any particular context. When we look at individual paradigm cells rather than full paradigms/inflection classes, we find much less uncertainty than the declension entropy would lead us to expect. While there are eight declensions in Table 12.1, most cells show only seven distinct forms, and the illative singular only has five possible realizations.

Let $D_{c=r}$ be the set of declensions for which the paradigm cell c has the formal realization r . Then the probability $p_c(r)$ that a paradigm cell c of a particular lexeme has the realization r is the probability of that lexeme belonging to one of the declensions in $D_{c=r}$, or:

$$p(r) = \sum_{d \in D_{c=r}} p(d)$$

The entropy of this distribution is the **paradigm cell entropy** $H(c)$, the uncertainty in the realization for a paradigm cell c . Carrying out the necessary calculations for the Pite Saami paradigms, we get:

(6)	NOM SG	GEN SG	ACC SG	ILL SG	INESS SG	ELAT SG	COM SG
	3.000	2.406	2.406	2.250	2.750	2.750	2.750
	NOM PL	GEN PL	ACC PL	ILL PL	INESS PL	ELAT PL	COM PL
	2.406	2.750	2.750	2.750	2.750	2.750	2.750

Note that the paradigm cell entropy varies across the paradigm cells. The illative singular only has five possible realizations and an entropy of 2.250 bits, while the most diverse cells have an entropy (at 3.00 bits, assuming uniform declension probabilities) equal to that of the declension system as a whole. The average entropy across all cells is 2.658 bits; this average is a measure of how difficult it is for a speaker to guess the realization of any one word form of any particular lexeme in the absence of any information about that lexeme's declension. An entropy of 2.658 bits is equivalent to selecting among only $2^{2.658} = 6.31$ equally likely alternatives. That is, the Pite Saami paradigms in Table 12.1 fall into eight declensions, but selecting the realization for a particular word form of a lexeme is as difficult as a choice among a little more than six equally likely alternatives.

3.2 Conditional Entropy

Guessing the realization of a single word-form is quite a bit easier than guessing the declension of a lexeme. But even this overstates the complexity of the system, as speakers must have some information about the lexeme in order to know that the lexeme even exists. At a minimum, speakers will know at least one word-form of a lexeme for which they wish to produce a novel word-form.

To quantify the predictability of one form given the other, we can measure the size of the surprise associated with these forms using **conditional entropy** $H(Y|X)$, the uncertainty in the value of Y given that we already know the value of X :

$$\begin{aligned} H(Y|X) &= H(X, Y) - H(X) \\ &= - \sum_{x \in X} \sum_{y \in Y} p(x, y) \log_2 p(y|x) \end{aligned}$$

The smaller $H(Y|X)$ is, the more predictable Y is on the basis of X : in other words, the less surprised one is that Y is selected given knowledge of X . In the case where X completely determines Y , the conditional entropy $H(Y|X)$ is 0 bits: given the value of X , there is no question remaining as to what the value of Y is. On the other hand, if X gives us no information about Y at all, the conditional entropy $H(Y|X)$ is equal to $H(Y)$: given the value of X , we are just as uncertain about the value of Y as we would be without knowing X at all.

Above we defined $p_c(r)$, the probability that paradigm cell c of a lexeme has the realization r . We can easily generalize that to the joint probability of two cells c_1 and c_2 having the realizations r_1 and r_2 respectively:

$$p_{c_1, c_2}(r_1, r_2) = \sum_{d \in D_{c_1=r_1 \wedge c_2=r_2}} p(d)$$

To quantify paradigm cell inter-predictability in terms of conditional entropy, we can define the conditional probability of a realization given another realization of a cell in the same lexeme's paradigm:

$$P_{c_1}(r_1|c_2 = r_2) = \frac{P_{c_1, c_2}(r_1, r_2)}{P_{c_2}(r_2)}$$

With this background, the conditional entropy $H(c_1|c_2)$ of a cell c_1 given knowledge of the realization of c_2 for a particular lexeme is:

$$H(c_1|c_2) = - \sum \sum p_{c_1}(r_1) p_{c_2}(r_2) \log_2 p_{c_1}(r_1|c_2 = r_2)$$

In the case of the Pite Saami forms in Table 12.1, if we know the genitive singular, then we know the nominative plural; these forms are always identical. If we know the nominative plural is marked by the weak grade stem and the suffix *-a*, then we can predict with certainty that the illative singular is marked by the strong grade stem and the suffix *-aj*. That is, $H(\text{ILL.SG} | \text{NOM.PL} = \text{wk}+a)$ is 0 bits. If, though, the nominative plural is in *str+a*, there are two possibilities for the first-person plural, either *str+aj* (in one class) or *str+ij* (in two classes). Therefore, $H(\text{ILL.SG} | \text{NOM.PL} = \text{str}+a) = 0.918$ bits. Averaging across each of the possible realizations for the nominative plural, we get the conditional entropy:

$$H(\text{ILL.SG} | \text{NOM.PL}) = 0.344 \text{ bits}$$

In other words, while guessing the *ILL.SG* of a lexeme is a choice among five alternatives, guessing the *ILL.SG* on the basis of the *NOM.PL* requires (on average) a choice among only $2^{0.344} = 1.3$ alternatives.

The entropy is a measure of the difficulty for solving one instance of what was referred to above as the Paradigm Cell Filling Problem: predicting a specific unknown word-form from a specific known word-form. A complete table of pairwise conditional entropies for Pite Saami nouns is given in Table 12.2. One obvious pattern is that for the majority of cell pairs, the conditional entropy is zero bits. That is, most cells in the paradigm are

Table 12.2. *Conditional entropies $H(\text{col}|\text{row})$ for Pite Saami noun paradigms in Table 12.1*

	NOM.SG	GEN.SG	ACC.SG	ILL.SG	INESS.SG	ELAT.SG	COM.SG
NOM.SG	—	0.000	0.000	0.000	0.000	0.000	0.000
GEN.SG	0.594	—	0.000	0.344	0.344	0.344	0.344
ACC.SG	0.594	0.000	—	0.344	0.344	0.344	0.344
ILL.SG	0.750	0.500	0.500	—	0.500	0.500	0.500
INESS.SG	0.250	0.000	0.000	0.000	—	0.000	0.000
ELAT.SG	0.250	0.000	0.000	0.000	0.000	—	0.000
COM.SG	0.250	0.000	0.000	0.000	0.000	0.000	—
NOM.PL	0.594	0.000	0.000	0.344	0.344	0.344	0.344
GEN.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
ACC.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
ILL.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
INESS.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
ELAT.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
COM.PL	0.250	0.000	0.000	0.000	0.000	0.000	0.000
	NOM.PL	GEN.PL	ACC.PL	ILL.PL	INESS.PL	ELAT.PL	COM.PL
NOM.SG	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GEN.SG	0.000	0.344	0.344	0.344	0.344	0.344	0.344
ACC.SG	0.000	0.344	0.344	0.344	0.344	0.344	0.344
ILL.SG	0.500	0.500	0.500	0.500	0.500	0.500	0.500
INESS.SG	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ELAT.SG	0.000	0.000	0.000	0.000	0.000	0.000	0.000
COM.SG	0.000	0.000	0.000	0.000	0.000	0.000	0.000
NOM.PL	—	0.344	0.344	0.344	0.344	0.344	0.344
GEN.PL	0.000	—	0.000	0.000	0.000	0.000	0.000
ACC.PL	0.000	0.000	—	0.000	0.000	0.000	0.000
ILL.PL	0.000	0.000	0.000	—	0.000	0.000	0.000
INESS.PL	0.000	0.000	0.000	0.000	—	0.000	0.000
ELAT.PL	0.000	0.000	0.000	0.000	0.000	—	0.000
COM.PL	0.000	0.000	0.000	0.000	0.000	0.000	—

completely predictable from most other cells. And, even for the cells which are not completely predictable, the conditional entropy is consistently less than one bit: all cells are mostly predictable from any other cell.

These values tell us how difficult it is to guess one particular word-form on the basis of one other particular word-form. In general, however, we cannot predict which forms a speaker will generalize from or to. This will depend on the cell probability $p(c)$, the probability that a randomly selected word-form is some lexeme's realization of cell c . In the simplest case we can assume that all cells are equally likely, so if C is the set of cells in a paradigm then:

$$p(c) = \frac{1}{|C|}$$

Or, we could estimate $p(c)$ from the **token frequency** $F_{\text{tok}}(c)$ of the cell c in a representative corpus:

$$p(c) = \frac{F_{\text{tok}}(c)}{\sum_{c \in C} F_{\text{tok}}(c)}$$

Given $p(c)$, the expected values $E[\text{col} = c_1]$ and $E[\text{row} = c_2]$ are the average uncertainty in guessing the form of some cell c_1 or guessing based on the form of cell c_2 (respectively):

$$E[\text{col} = c_1] = \sum_{c_2} p(c_2)H(c_1|c_2)$$

$$E[\text{row} = c_2] = \sum_{c_1} p(c_1)H(c_1|c_2)$$

Columns averages $E[\text{col}]$ are a measure of **predictedness**, or how difficult it is to guess the realization of a cell (on average) given knowledge of some other cell. For Pite Saami, we get:

(7)

NOM.SG	GEN.SG	ACC.SG	ILL.SG	INESS.SG	ELAT.SG	COM.SG
0.368	0.038	0.038	0.079	0.118	0.118	0.118
NOM.PL	GEN.PL	ACC.PL	ILL.PL	INESS.PL	ELAT.PL	COM.PL
0.038	0.118	0.118	0.118	0.118	0.118	0.118

Row averages indicate a cell's **predictiveness**: the average uncertainty in another paradigm cell given knowledge of that cell. For Pite Saami, we have:

(8)

NOM.SG	GEN.SG	ACC.SG	ILL.SG	INESS.SG	ELAT.SG	COM.SG
0.000	0.311	0.311	0.519	0.019	0.019	0.019
NOM.PL	GEN.PL	ACC.PL	ILL.PL	INESS.PL	ELAT.PL	COM.PL
0.311	0.019	0.019	0.019	0.019	0.019	0.019

The nominative singular is very predictive but harder to predict: on its basis all other forms are completely predictable, making it a principal part in the classical sense. The illative singular is the least predictive: knowing the ILL.SG leaves on average 0.519 bits of uncertainty remaining about the realization of another cell.

The average across all possible pairs of word-forms, the overall **average conditional entropy** $H(P)$ is:

$$\begin{aligned} H(p) &= \sum_{c_1} p(c_1)E[\text{col} = c_1] \\ &= \sum_{c_2} p(c_2)E[\text{row} = c_2] \\ &= \sum_{c_1} \sum_{c_2} H(c_1|c_2) \end{aligned}$$

For our Pite Saami example, $H(P)$ is 0.116 bits, equivalent to a choice among only $2^{0.116} = 1.08$ equally likely declensions. That is, while Pite Saami has eight nominal declensions from the point of view of a lexicographer trying to describe the language, for a speaker trying to use the system it has on average only slightly more than one: this is the I-complexity of this

paradigm. Accordingly, inflectional systems in the form of Table 12.1 have the potential to greatly overstate the apparent complexity of a morphological system.

In (6) above, we saw that the average entropy per cell in the Pite Saami nominal paradigm is 2.658 bits, and the average conditional entropy given one other cell is 0.116 bits. That means that, on average, each paradigm cell provides $2.658 - 0.116 = 2.542$ bits of information about each other cell. So, while these paradigms show a moderate degree of E-complexity (measured either by the number of paradigm cells and inflection classes or by paradigm cell entropy), each word-form of a lexeme also provides the speaker with a lot of information about the other word-forms. By exploiting these implicational relations, speakers can make reliable inferences about unknown cells on the basis of known ones.

These results are in line with the range of average conditional entropy values reported by Ackerman and Malouf (2013). In a small sample of paradigms taken from typologically and genetically diverse languages, the average conditional entropy ranged from 0 bits to 0.75 bits. The sample included languages with impressively complex-looking morphological systems, such as Nuer (see Section 2.1) and Chiquihuitlán Mazatec (a language with at least 109 different verbal conjugations). Despite the large range in the E-complexities of these languages, as measured by the number of paradigm cells, allomorphs, and inflection classes, the I-complexities fell within a narrow range.

One thing to note about these results is that they do not depend on the specific forms in the paradigm. Predictably following our discussion of word-internal structure, all that matters is whether a speaker can discriminate between two forms: the specific form and the manner of discrimination (whether by affixes, tone, stress, ablaut, etc.) is irrelevant. A (hypothetical) straightforwardly agglutinative language with the paradigm in (9) has an average conditional entropy of 0 bits, as expected:

(9)	CLASS	NOM.SG	NOM.PL	ACC.SG	ACC.PL
	I	-a	-am	-aj	-ajm
	II	-o	-om	-oj	-ojm

However, a similarly hypothetical fusional paradigm like the one in (10) also has an average conditional entropy of 0 bits:

(10)	CLASS	NOM.SG	NOM.PL	ACC.SG	ACC.PL
	I	-am	-ij	-im	-ux
	II	-it	-os	-un	-ad

In both paradigms, each cell uniquely identifies the inflection class. There may be other reasons that paradigms like (9) are preferred. They might be easier for children to learn, or they might simply be more likely to evolve through natural processes of grammaticalization. Indeed, given the syntactic origins of many morphological markers, word internal structure

of the forms that occupy paradigm cells is commonly encountered among the world's languages (Bickel and Nichols 2013a, 2013b). Instructively, from the perspective of I-complexity, these systems are equivalent, suggesting that there are many strategies that can produce similar outcomes. An information-theoretic approach, accordingly, provides important insights about crosslinguistic morphological organization that are inaccessible without the recognition of words and paradigms as primary objects of analysis.

In the examples in (9) and (10), it is the inventory of affixes that leads to low conditional entropy. Rearranging alignment between allomorphs and inflection classes would make no difference. In most real languages, however, inflection classes are organized into an implicational structure in a way that supports speakers' ability to generalize to unknown forms.

To quantify the role that implicational organization specifically plays in Pite Saami morphology, we can perform a simple "bootstrap" simulation (Davison and Hinkley 1997). Take Pite Saami₀, an alternate version of Pite Saami with the same E-complexity but with formal realizations assigned randomly to paradigm cells. More specifically, we generate Pite Saami₀ by randomly shuffling the cells in each of the columns in Table 12.1, so that each declension is produced by randomly selecting (without replacement) for each of the fourteen paradigm cells one of the possible realizations of that cell. The result is a language with more or less the same E-complexity – the same number of declensions, paradigm cells, and allomorphs – as Pite Saami, but with no implicational structure. If we repeat this experiment and compute the average conditional entropy for a range of randomly generated Pite Saami₀s, we find that no randomized Pite Saami₀ had an average conditional entropy as low as the actual language, and the average of the average conditional entropy for the randomized languages is 0.322 bits. The observed average conditional entropy is well outside what would be expected under the null hypothesis, which we can confidently reject in favor of the alternative, namely that assignment of realizations to cells in Pite Saami is not in fact random. Instead, realizations are assigned to cells in a way that reduces average conditional entropy by licensing inferences about unknown word-forms and is crucial to lowering its I-complexity.

In contrast, Ackerman and Malouf (2013) performed this same experiment with Russian, a language with relatively low E-complexity, and got a very different result: the average conditional entropy of randomized versions of Russian is 0.541 bits, only slightly higher than the actual average conditional entropy of 0.538 bits. This indicates that the implicational structure of the Russian paradigm may be less important for constraining the overall average conditional entropy (see Sims and Parker 2016). Nearly any random mapping between the morphosyntactic property sets and the resources for exponence in Russian yields low entropy, so there is no need for such languages to rely on implicational organization.

3.3 Emerging Research Directions

While the simplest and most straightforward way to reduce uncertainty would be to have the one-to-one mappings without any allomorphy found in proto-typical agglutinative strategies, even casual acquaintance with crosslinguistic morphological systems reveals that this is strikingly uncommon. However, the differences in strategies are rendered unimportant from the present perspective, since efficient integrative complexity can be achieved in many ways in different language systems. In this connection, the organization of morphological systems discovered by the use of information-theoretic and other quantitative measures encourages a more careful examination of subtle cues to morphological structure that further facilitates this organization and makes it learnable. The hypothesis that morphology is sensitive to uncertainty reduction and the effects that this has on accurate inferencing (i.e., providing an answer to the PCFP) leads to experimental research and modeling in order to understand both language particular systems and typological phenomena.

In the previous section we introduced how information-theoretic measures have been applied to reveal relations that otherwise remain latent in the data distributions. This encourages new ways of inquiring about familiar issues that bear on what has become newly visible in the domain of morphological organization. These are the perennial issues bearing on the identification of veridical data sets, the resources responsible for the learnability of such data sets and the distillation of principles guiding crosslinguistic generalizations that are responsive to language variation.

One direction pursued in current research is an effort to more directly ground entropy calculations in linguistic forms. As noted above, the manner of calculating entropy shown here gives an upper bound on entropy. Two significant factors which have the potential to greatly reduce the effective entropy are excluded. For one, they assume that all inflection classes are equally likely, which is certainly not the case for real inflection systems. In fact, in Pite Saami, as in most systems, the majority of lexemes fall into one or two classes, leaving the remaining classes as “irregular” or “exceptional.” For a given number of classes, the uniform distribution will be the one with the highest entropy. The kinds of highly skewed distributions that are found in natural inflectional systems will have much lower entropy.¹⁹ Most grammatical descriptions give little or no details about the number of lexemes in each inflection class, but class type frequencies can usually be inferred from dictionaries or wordlists (Bonami and Henri 2010).

A second important property of real linguistic systems is not accounted for in the calculations shown here. While inflection class systems are, by

¹⁹ See Shannon (1948) for a formal discussion. Intuitively, though, knowledge of unequal inflection class probabilities will make it easier for speakers to guess the realization of some paradigm cell of a novel lexeme. This prior knowledge of frequencies is a source of information, and information lowers entropy.

our working definition, arbitrary, most involve at least probabilistic correlations with factors such as semantic class, phonological form, grammatical gender, lexical tier, and other external semantic or grammatical dimensions of classification. The influence of these external factors is difficult to quantify. But, to the extent that these factors help speakers solve the PCFP, they will serve to lower the average conditional entropy of the paradigms, and should be included in the calculations.

A more worrisome problem with the calculations in the previous section is that they depend on the particular analysis of Pite Saami verbs sketched in Table 12.1.²⁰ The accuracy of the entropy values depends on the correctness of Wilbur's analysis, the knowledge implicit in that analysis that native speakers are able to draw on, and the ability of native speakers to apply that knowledge in specific instances. All three of these assumptions are suspect. No linguistic analysis, no matter how carefully constructed, captures every detail of a language. As (Sapir 1921: 39) observed, "all grammars leak." Inflection class systems often include remnants of old historical developments, leading to highly abstract analyses, the synchronic psychology reality of which is unclear. The analysis in Table 12.1 depends on a distinction between strong and weak stems which is overtly marked by a sometimes idiosyncratic combination of vowel and consonant alternations. And finally, in order to apply this analysis to solving the PCFP, speakers need to be able to recognize whether a word-form is strong or weak in isolation, which sometimes presupposes knowledge of exactly the information which they are trying to predict. For example, not all Pite Saami nouns participate in grade alternations. For nouns that do, an illative plural in *-ajda* is diagnostic of class membership. But, for these nouns that do not show an overt grade distinction, an illative plural in *-ajda* could indicate membership in class Ia or in class II. The average conditional entropy of the system for these nouns, with only affixal marking and no stem alternations, is 0.237 bits, more than twice what was calculated above.

These are cogent criticisms that have been made by Sims (2015) in her response to Ackerman and Malouf's (2013) analysis of Modern Greek, and more extensively by Bonami and Boyé (2014), Bonami and Luís (2014), who adapt Albright and Hayes's (2003) Minimal Generalization Learner to extract implication relations directly from surface representations of paradigms, Bonami and Beniamine (2015) and Sims and Parker (2016). This allows them to include sensitivity to class frequencies in their model and to avoid assuming in advance a particular analysis of the data. Their learning algorithm induces an analysis using only the information that is available to speakers learning the system. In more current work, Bonami and Beniamine (2015) have extended this to address the effects associated with several cells for jointly predicting previously unencountered word-forms.

²⁰ In a slightly different context, the importance of the underlying analytic assumptions to complexity measures is explored by Stump and Finkel (2013, 2015).

Recent research within this information-theoretic approach has gone in numerous directions. There have been efforts that (1) identify larger data sets supplemented with frequency information to serve as objects of measurement to replace the measurement of forms derived from descriptive grammars, as well as developing appropriate tools for their measurement (Bonami 2014; Bonami and Beniamine 2015; Sims 2015), (2) more carefully explore the nature of the phonological/phonetic stimuli constitutive of word internal structure and, more generally, inquire about the appropriate forms that words as objects of analysis should take (Lehiste 1972; Kemps et al. 2005; Blazej and Cohen-Goldberg 2015; Plag et al. 2015; Seyfarth et al. 2015; Seyfarth et al. 2016), (3) explore how analogical inference may rely upon implicative organization in the learning of complex morphological systems (Baayen and Ramscar 2015; Ramscar et al. 2015), (4) identify cross-linguistic generalizations concerning possible constraints on the organization of morphological systems (Stump and Finkel 2013; Ackerman and Malouf 2015; Baerman et al. 2015) and (5) re-examine morphologically challenging phenomena such as blends (Seyfarth and Myslin 2014, and Lepic 2015) and periphrasis (Lee 2013).

4 Conclusions

A word-based implicative approach, as characterized here, is leading morphological theory to “refurbish its foundations” (Hockett 1987) and to undergo important reconceptualizations concerning its methodologies, its objects of inquiry, and ideas about theory construction. The nature of these changes align it more with recent dynamic systems perspectives on analysis in the developmental sciences (Lehrman 1953, 1970; von Bertalanffy 1973; Oyama et al. 2001), both (ecological) evolutionary developmental biology (Gilbert and Epel 2008; Arthur 2010; Laland et al. 2010) and developmental psychology (Karmiloff-Smith 1994; Elman et al. 1996; Stiles 2008; Spencer et al. 2009; Hood et al. 2010). In the broadest terms this relates to their emphases on the (probabilistic) modeling of complex interactions of multi-level systems.

Morphology is clearly an adaptive system consisting of discriminatable parts: word internal structure represents patterns of elements constitutive of words, and words are the parts that constitute the patterns of paradigm structure. The analogy with biological systems permits researchers to entertain the notion that the evident complexity of morphological organization emerges from relatively simple interactions among its contributing morphological, phonological, phonetic, and semantic component parts. As Camazine et al. (2001) suggest with respect to biological systems,

Relatively little needs to be coded at the behavioral level ... In place of explicitly coding for a pattern by means of a blueprint or recipe, self-organized pattern formation relies on positive feedback, negative feedback, and a dynamic system involving large numbers of actions and interactions.

With such self-organization, environmental randomness can act as the “*imagination of the system*,” the raw material from which structures arise. Fluctuations can act as seeds from which patterns and structures are nucleated and grow. (Camazine et al. 2001: 26)

This way of seeing has permitted researchers analyzing complex phenomena to see what their unassisted imaginations failed to anticipate: remarkable ranges of possibility and extraordinary variation become visible and cohere when the appropriate assumptions and tools are used to make sense of the “*imagination of the system*.” To solve the PCFP and related problems necessitates exploring the imagination in morphological systems and this requires a proper understanding of word internal structure and the patterns of relatedness within which words are organized.

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Part IV

Morphological Frameworks

13

Classical Morphemics: Assumptions, Extensions, and Alternatives

Laurie Bauer

1 Introduction

1.1 The Term “Morpheme” and the Notion of Morpheme

Although the term “morpheme” is not that old, its origins are not as clear as might be expected. The notion of morphology—not necessarily in the linguistic sense—is sometimes attributed to Goethe (see e.g. Dressler et al. 2001: 185), but the term “morpheme” itself is usually attributed to Baudouin de Courtenay, who defines it as “that part of a word which is endowed with psychological autonomy and is for the very same reason not further divisible” (Baudouin de Courtenay 1972: 153). Certainly the term was in general use by about 1910 (Stankiewicz 1972: 36), although, it should be noted that there has probably never been a single understanding of the morpheme, but rather a range of interpretations of the term built round a common core, as set out in Section 2.

In Section 2 below, I shall consider some of the ways in which that common core is more or less variable, before moving on to consider factors which have been suggested as being fundamentally inimical to the whole notion of the morpheme.

1.2 Parallels with Phoneme

It is not entirely clear to what extent the notion of morpheme was based on the notion of phoneme (though see Hockett 1987; Anderson 1992: 11–14), but it is clear that the parallels have often been drawn explicitly, which implies that practitioners have seen the details of the way morphemes work as being driven by what they know about phonemes. This stretches the terminology. To go with phone, phoneme, and allophone we get morph, morpheme, and allomorph, each defined in similar ways: phones and

morphs are occurrent in linguistic structure,¹ phonemes and morphemes are abstractions from the data, allophones and allomorphs are in complementary distribution but share function. There is a general expectation of structural analogy (Anderson and Ewen 1987: 283; Bauer 1994) or isomorphism (Hockett 1987), phrased by Anderson and Ewen (1987: 283) as “we expect, *ceteris paribus*, different levels to display the same basic structural properties.” This creates problems, as we shall see. Among them is the notion of segmentability, the idea that you can slice the phonetic string into sequences of consonant and vowel elements (with stress and tone providing an awkward but manageable set of exceptions). You can cover a lot of phonology without disturbing this assumption, but the moment you try to discuss the morphology of a flectional language in these terms, trouble arises. Much of the reworking of morphological theory that has happened under the heading of Word-and-Paradigm or A-morphous Morphology can be seen as an attempt to deny the plausibility of complete segmentability for morphology (with, of course, the consequent disavowal of the morpheme). That such a fundamental part of the structural analogy can be rejected suggests that we should not necessarily expect parallelism between the phoneme and the morpheme, and should consider instances where it may not hold.

2 The Morpheme: Core and Periphery

In this section, we start with what I take to be the central idea of classical morphemics (in Section 2.1 and 2.2), and go on to consider places where there are variations in the way the notion of the morpheme is used in the literature (in Sections 2.4 to 2.6). The disagreement may or may not indicate problems with the theoretical notions at the core. In Section 3, places where there are clearly theoretical problems with the core meaning of the morpheme will be considered.

2.1 Minimal Sign

Probably the fundamental insight behind the morpheme is that it is the smallest linguistic sign, hence the definition of the morpheme as a minimal sign (for the words, see e.g. Hjelmslev (1963: 85) and Martinet (1967: 15); for definitions in this spirit see Bloomfield (1933: 162) – “morphemes as the smallest signals” – and Hockett (1958a: 123)) which is succinct, but not necessarily perspicacious. For Saussure (1916: 98–9) a sign is a psychological entity which has two facets: the conceptual and the acoustic (which we might, now, call the semantic and the phonetic). In other words, a sign

¹ Even this is rather imprecise; phones and morphs are types, and tokens of these types occur in words.

unites meaning and form. Unless there is meaning united with form, there can be no sign. We shall have cause to return to this requirement later. A minimal sign is the smallest sign—that is, a sign which cannot be considered to be made up of smaller entities uniting meaning and form in the same way.

However, as pointed out by Luschützky (2000), “minimal sign” is not a sufficient definition of a morpheme. A “minimal sign” would include phonaesthemes such as the *gl-* in *glimmer*, *glimpse*, *glint*, *glitter*, and so on, while these are usually taken to be a sub-morphemic entities (Kubryakova and Mugdan 2000). The main problem here is usually seen to be what is left in the word once these elements have been removed. Morphemes are, by their nature, expected to be recurrent (to be found in a number of different word-types in the language), while *impse* from *glimpse* does not recur in English, and, perhaps more importantly, morphemes are expected to be the ultimate elements in a word: that is, morphemes must lead to an exhaustive analysis of the word, while it may be that there are minimal signs which do not. More strictly, what is in question here is the extent to which a morphemic analysis can give rise to unique morphs (such as *cran-* in *cranberry* and *-ter* in *laughter*) which occur only once in the language: any morphemic analysis needs restrictions on the circumstances under which this can be done, and any process which multiplies unique morphs is unwelcome.

We shall return in Section 2.6 to what we mean precisely by meaning and form in the morpheme.

2.2 Allomorphy

It happens frequently that two morphs of similar or related form are synonymous or have the same function and are in complementary distribution. A simple example is provided by the English morph /s/ found in a word like *cats*, the morph /z/ found in a word like *dogs* and the morph /ɪz/ in a word like *horses*. All of these morphs can be glossed as meaning ‘plural,’ and which of these morphs is found is determined entirely (in adult language) by the final sound of the base to which they are attached. They are thus in complementary distribution. The situation here is entirely analogous to the situation with allophones of phonemes: items of similar form and function which are in complementary distribution (and therefore never contrast) are viewed as being variants of a more abstract element. Correspondingly, /s/, /z/ and /ɪz/ are to be considered allomorphs of the morpheme which we might variously represent as {s}, {plural}, {s₁} or even {965}.²

The case given above is a very clearcut case in that (a) there are no exceptions and (b) the conditioning factor for the distribution of

² The number, of course, is chosen at random, the point being that the nomenclature does not have to be related to the form or the meaning, but could be essentially unmotivated.

the variants or allomorphs is phonological, and thus transparent, and (c) the allomorphs are phonologically closely related. Where the conditioning factor is lexical or grammatical, the question of allomorphy becomes more vexed (see, e.g., Nida 1958: 258–9, who allows both but is clearly more comfortable with phonological conditioning, or Fábregas and Scalise 2012: 16 who specifically limit allomorphy to the phonological cases). Given a now rather dated variant of English in which *one die* has as its plural *two dice* and the plural marker is /s/ on the end of a voiced base, it is less clear whether this is suitably termed an allomorph of the same morpheme. Given that the first-person singular of the present tense of the indicative of the Latin verb *amāre* ‘to sing’ is *amō* ‘I love’ and the equivalent form of the pluperfect is *amāveram* ‘I had loved,’ it is not clear that *-am* and *-ō* can be viewed as allomorphs of a single first-person singular morpheme, conditioned by the tense in which they occur.³ Part of this relates to the phonological relatedness of allomorphs. Where allophones are concerned, phonetic relatedness is a part of the requirement: [h] and [ŋ] cannot be allophones of the same phoneme in English despite being in complementary distribution.⁴ A similar requirement is implied in the definition of the sign that there must be constant form and meaning. But degree of phonological relatedness is not a simple concept. Is voicing (the only phonological feature the two seem to share) sufficient to accept that *-am* and *-ō* can be allomorphs? Can *fish* and *piscatorial* be linked sufficiently to say they contain the same morpheme on the basis of well-known changes in Indo-European and the history of English? Different analysts can come to different conclusions in the face of questions like this (see Lightner 1983 for the position that the same morpheme might be involved in these words).

Not necessarily because of the difficulties in drawing the line between things which are and are not formally related (there are similar problems with the notion of semantically related), some scholars, particularly in the early days of morphemic analysis, ignore the notion of allomorphy and see what others would call the allomorph as being the sign (having a given form and a given meaning), and thus see a morpheme as being a meaningful form. Such a meaning can be inconsistently surmised from statements by Baudouin de Courtenay and Bloomfield (see Mugdan 1986), and also from some more recent definitions. Under such an interpretation, the notion of allomorphy loses its meaning, and rules determining the distribution of synonymous morphemes become more important.

³ An analysis of more data might conclude that it is the *-m* that denotes ‘first person’ rather than all of the *-am*, but this cannot be deduced from the two examples provided.

⁴ It should be noted that the limits of similarity are equally ill-defined in phonology, though the principle is rarely queried.

2.3 Every Language Is Like Turkish: The Agglutinating Myth

If a word is made up of a sequence of signs, the implication is that the word can be sliced like a loaf of bread into relatively independent slices, each of which shares features in that they all have recognizable form and meaning. However, not all words in all languages work the same way, and the analysis of an Arabic word such as *kitab* ‘book’ into a root *k-t-b* ‘write’ and a vocalic pattern *-i-a-* provides one kind of extreme example which fits uneasily with these assumptions. We will find other examples which are awkward in this kind of analysis below. Since Turkish is commonly seen as a prototypical language which does fit the slicing assumption, we can say that classical morphemic analysis assumes that all languages are like Turkish: in the jargon of typology, they are agglutinating. Many of the objections to classical morphemes arise because of features in languages which are not easily analyzable under this assumption, as will be seen below.⁵

2.4 Including or Not Including Bases

In the French tradition, as typified by Martinet (1967: 15–16), morphemes are grammatical items (prototypically, inflectional affixes, but also, for Martinet, including prepositions), while lexical elements such as *cat* or the base *port-* from *porter* ‘to carry’ are not morphemes but lexemes (in a sense not generally shared by Anglophone scholars), both morphemes and lexemes being subtypes of moneme. Although this view is developed by Martinet, variants are occasionally found in the work of other scholars.

2.5 Items versus Processes

The normal way to make a noun plural in English is to add an extra item to the word, namely a suffix: *cat* versus *cat-s*, for instance. However, there are some words where the plural is marked by the vowel in the base: *foot* versus *feet*, for instance. A classical morphemic analysis requires an analysis into signs. Here there are a number of possibilities, including *f__t* + *oo* or + *ee* (an infixation analysis), a zero-analysis where the plural is *foot* + $\emptyset$ and *foot* → *feet* / __ {plural}, or an analysis proposed by Nida (1949: 54) according to which /*u*/ → /*i*/ is a “replacive morpheme” (see also Harris 1958: 110–12, who, however, sees this as a morph, not a morpheme). Hockett (1958b: 394) argues that the base forms in such cases act tactically as single morphs, and we might also argue on typological and psychological grounds that the infixation analysis is insufficient. In principle any analysis with zero fails the definition of the morpheme as a sign: if there is no form part of the sign, there is no sign. The replacive analysis, however, takes a process

⁵ Lounsbury (1953: 13) sees a morphophonemic representation as setting up “a fictitious agglutinating analog” to the actual language structure. The same metaphor is given a slightly different origin.

and calls it a form. Later analyses have been relatively happy to see a process as equivalent to a morpheme, but it is recognized by the earliest practitioners as a problem for the classical morpheme.

2.6 Priority to Form or to Meaning

Although the notion of the sign gives equal weight to form and to meaning, practitioners have, in practice, given very different weights to the two sides when it comes to the morpheme. Thus, for instance, we find Jensen (1990: 2) saying that “morphemes ... are typically but not necessarily meaningful,” which seems to give some priority to the formal side. At the two extremes, we find Aronoff (1976) and Plag (1999). Aronoff argues that given the regularities to be found in English words in *-cede* which have nominalizations in *-cession* or in *-mit* which have nominalizations in *-mission*, *-cede*, and *-mit* should be viewed as morphemes despite the fact that we cannot provide a constant meaning for them in current English. That is: form is all, and meaning is irrelevant. At the other end of the scale, Plag (1999: 228, for instance) claims that “-ize and -ify are phonologically conditioned allomorphs” of a single morpheme because they are in complementary distribution and synonymous. That is: meaning is everything, and form is irrelevant. Most scholars, like Jensen, take up some middle position in this debate, but the fact that such extreme differences are found in the literature indicates that there is a problem of definition here.

3 Problems for Morphemes

3.1 Synonymy

The regular plural marker in English is added freely to new nouns and can be analyzed in words like *cats*, *dogs* and *horses* with its three regular variants. The question arises, though, as to what we are to make of the plural marker in *oxen* (which may be unique in English, or may be a variant of the marker found in *brethren* and, possibly, *children*). Is it an allomorph of the same morpheme as the marker in *dogs*, and so on, or not? The problem here is the requirement for constancy of form: /n/ and /z/ have voicing and alveolarity in common, but given that the amount of form that must be in common is vague, it is not clear whether that is sufficient to allow them to be analyzed as allomorphs of the same morpheme. The final morphemes in *sanctifie-s*, *backward-s* and *Bab-s* share more form with the final morpheme in *dog-s* without being taken to belong to the same morpheme. Most practitioners treat *-en* as an allomorph of {plural} that is lexically conditioned (Bloomfield 1933: 215). However, there is no principled reason why *-en* cannot be seen as belonging to a separate morpheme from the /z/ in *dogs*, but one which happens to be synonymous with it.

3.2 Polysemy

A glance at any standard dictionary makes it clear that many words (including ones which are minimal signs) can be considered as having more than one meaning—that is, they are polysemous. Therefore, if we accept that morphemes can be bases as well as inflectional affixes (see above), we must accept that the meaning of morphemes may include a range of distinguishable meanings. For instance, the *OED* gives several meanings for *gear*, including “clothing,” “equipment,” “implements,” “combination of mechanical appliances,” and “toothed wheels.” While it may be that the individual analyst would wish to draw the line between polysemy and homonymy in a different place from that chosen by the *OED*, and say that some of these are homophonous but distinct words, the notion of words having more than one meaning is not controversial. It is rather more controversial to suggest that inflectional affixes may have more than one meaning. While English *-ed* may mark either a past tense or a past participle, for instance (and some would add a passive participle), most analysts would see two morphemes here (possibly three) rather than just one. With derivational affixes, polysemy is, at least, not abnormal: the English *-er* can mark human agents (*interpreter*), animal agents (*warbler*), instruments (*blender*), locations (*diner*), or other inanimates (*scorcher*), and this is usually interpreted as polysemy rather than homonymy. Thus the meaning side of the linguistic sign must be appropriately treated as being not always a single fixed meaning (though there may be such cases), but a range of potential meanings, which may or may not be derivable by general principles.

3.3 Synchrony and Diachrony

Many morphemes remain analyzable after they have ceased to be productive. A few examples should make the point. The suffix *-th* is visible in a number of words of English including *depth*, *truth*, and *warmth*. It may not be recognizable any more, though it is present etymologically, in *birth*, *filth*, and *health*. No new forms in *-th* have been listed in the *OED* for a couple of hundred years. The *-ock* in *bullock* and *hillock* can also be found, etymologically speaking, though less obviously with morphemic value, in *haddock* and *tussock*. The point is, should any of these be regarded as morphemes? And if we are not doing morphology, are we simply doing a piece of etymological analysis? That is, we might say that to analyze a suffix in *breadth* is pure etymology and not morphology at all.

Cases such as Aronoff's (1976) *gooseberry* or Anderson's (1992) *appreciable*, where the relationship of the berry to the goose or the relationship between being able to appreciate good food and an appreciable distance may not be clear, are in principle just the same. We can decide they are no longer instances of morphology and not to be analyzed by the linguist, or we can analyze them as being morphologically complex but recognize that meanings of new words can change independently of their bases once they are

part of the established vocabulary of the speech community. Neither should endanger the fundamental notion of a morpheme.

There are notorious cases where this has become a matter of dispute in the literature, the most obvious one being the analysis of items like *reduce*, *refer*, *remit*, *reside*, where any analysis of *re-* might be best seen as etymological rather than morphological because the *re-* in these words has no constant meaning. The point is of some practical interest, since *-th* is still most often analyzed as an affix precisely to illustrate the lack of productivity. Morphological practice, if not theory, needs a bit of tidying up in areas like this.

3.4 Contiguity

If the word can be sliced into morphs which exhaust the structure of the word, then the simplest hypothesis is that the slices will each be made up of an entire morph, and that the morphs will be composed of contiguous material in the word. This is the morphological analog of what Goldsmith (1999: 138) calls the Absolute Slicing Hypothesis in phonology: the idea that the word can be sliced up into relevant, psychologically real, segments.

The hypothesis fails in morphology as it fails in phonology, and to some extent for the same reasons. In the data in (1), taken from Fyem, a Nigerian language, plurality is marked by high tone, but by high tone which permeates the whole word, however many syllables there may be in the word (Nettle 1998).

In the data below only low tone (no marking) and high tone (acute accent) are illustrated.

(1)	kwi	'rat'	kwí	'rats'
	gom	'baboon'	góm	'baboons'
	gorok	'crow'	górók	'crows'
	botorí	'quiver'	bótórí	'quivers'
	kukwára	'yard'	kúkwára	'yards'

There are also many examples of non-contiguous morphs. The example from Arabic already cited is perhaps one of the best known types. While other analyses are possible, if we look at *kitab* 'book' in terms of morphemes which we expect to be sliceable from the word we have to assign *k-t-b* to one morpheme (meaning 'write') and *-i-a-* to another morpheme. Any textbook will also provide illustrations of circumfixes or, more generally, parasyntesis, where discontinuous pieces of form are added simultaneously to a base to give a particular semantic effect. Discontinuity, of itself, may not disprove the Absolute Slicing Hypothesis, but it makes it rather less likely that it is true, and certainly disconfirms the idea that all morphs are contiguous. At the very least this demands a rather more sophisticated view of how morphemes might operate.

3.5 Internal Modification

There are many kinds of internal modification, often distinguished terminologically, although we need not worry about the terminological distinctions here in most of the instances. Internal modification can be said to occur when a change in status, which could be marked by an affix, is actually marked not by an affix but by a change in the phonological form of the base. Various examples will be given below (sometimes reprising examples used elsewhere in this chapter), with slightly different types of internal modification. The importance of this type of data for theories of the morpheme is that fixed meaning is not attached to a contiguous phonological form, but to some aspect of a morph, and so it is awkward to maintain the Absolute Slicing Hypothesis if one wishes to say that each piece of meaning must be attached to a given fixed piece of form.

The first example of internal modification has already been illustrated in (1), where the segmental form of a particular word remains fixed, but the suprasegmental form, the tone, changes, with what one might expect to be morphological effect. There is no need to repeat the example here.

A second example also involves suprasegmentals, namely stress. The example is slightly controversial, but there is a variable class of English nouns and verbs which are superficially distinguished in terms of their stress. Membership of this class is not completely stable, with old forms vanishing and new forms being added and some variation from dialect to dialect, but the instances in (2) should illustrate the point.

(2)	<i>Noun</i>	<i>Verb</i>
	áugment	augmént
	cóntrast	contrást
	éscort	escórt
	fínance	finánce
	pérmit	permít
	ségment	segmént
	tránsfer	transfér

The generalization here is that nouns are stressed on the leftmost of the two syllables, verbs on the rightmost. There are further complications if adjectives or trisyllables are also considered. Some phonological theories see stress as being attached to a particular vowel, in which case vowels here are being changed, others see stress as an independent variable, in which case that phonological variable is being changed. In neither case can we clearly analyze independent morphs carrying the expected meanings.

In the examples in (3), there is vowel change indicating a change of status from singular to plural, a change which is marked elsewhere in the language by the use of suffixes.

(3)	<i>Singular</i>	<i>Plural</i>	<i>Gloss</i>
	Apfel	Äpfel	‘apple’
	Bogen	Bögen	‘arch’
	Garten	Gärten	‘garden’
	Hammer	Hämmer	‘hammer’
	Ofen	Öfen	‘stove’
	Schnabel	Schnäbel	‘beak’
- Source:* German (Hammer 1991: 10)

The next examples are rather similar, except that this time it is not a vowel that is changed but a consonant.

(4)	<i>Noun</i>	<i>Verb</i>
	belief	believe
	calf	calve
	device	devise
	house /s/	house /z/
	sheath	sheathe
	shelf	shelve

In (4) the voicing of the final consonant shows the difference between noun and verb.

A more complex type of example is provided by root-and-pattern morphology of the type that is found in Semitic. The patterns laid out in (5) for Hebrew (Tobin 2004: 1347) illustrate some of the basic ways in which the *binyanim* (usually glossed as ‘paradigms’) work for the root *k-t-v* ‘write’ (the functions given are only first approximations).

(5)	<i>Pattern</i>	<i>Verb</i>	<i>Gloss</i>	<i>Function</i>
	CaCaC	KaTaV	‘wrote’	basic
	niCCaC	niKTaV	‘was written’	basic passive
	CiCeC	KiTeV	‘inscribed’	intensive
	CuCaC	KuTaV	‘was inscribed’	intensive passive
	hiCCiC	hiKTiV	‘dictated’	causative
	huCCaC	huKTaV	‘was dictated’	causative passive
	hitCaCeC	hitKaTeV	‘corresponded’	reflexive

The root and pattern picture of Hebrew morphology, though, is far more extensive than these verb patterns show, including extra forms such as those in (6) (Tobin 2004: 1344):

- (6) *KToV* ‘write!’ (imperative, masculine, singular), *KaTaVa* ‘news report,’ *KiTuVit* ‘subtitle,’ *KTaV* ‘handwriting,’ *miKTaVa* ‘desk,’ *hitKaTVut* ‘correspondence’

Although there are prefixes and suffixes involved here, it is the complex patterns of interdigitation of root and vowel pattern which make the system so complex. While this might be described in terms of

discontinuous morphemes, alternative process-based descriptions—including autosegmental descriptions—seem far more suitable for the description of such phenomena.

Finally, in this section, we will consider a phenomenon where the slicing of the data is not necessarily problematic, but where the form of the material is derived, and its only constants are at a fairly abstract level. This is the case of reduplication. Consider the examples from Yaqui in (7).

(7)	<i>Base</i>	<i>Habitual</i>	<i>Gloss</i>
	vusa	vuvusa	'awaken'
	chike	chichike	'comb one's hair'
	vamse	vamvamse	'hurry'
	chepta	chepchepta	'jump over'
	bwalkote	bwalbwalkote	'soften'

Source: Yaqui (Haugen 2005)

It appears that the morph which marks habituality in Yaqui is discovered by copying the first syllable of the base. That is, the form is simply specified as being a syllable, and its actual segmental makeup is determined for each base individually. Though we might say that *vu-*, *chi-*, *vam-*, *chep-*, and *bwal-* are allomorphs of the same morpheme (and that might be the only way to deal with this in terms of the classical morpheme), again some processual explanation will be more satisfactory.

3.6 Multiple Bases for the Same Lexeme

Language is full of cases of suppletion, where two or more phonologically distant forms are in complementary distribution. Consider the examples of *good* and *better* or *go* and *went*, for instance. This is another case of synonymous morphemes, and should not, in principle, be an insuperable problem, although it is a source of irregularity of patterning. There is a genuine question as to whether the *-er* in *better* should be considered as belonging to the same morpheme as the *-er* in *heavier*, but most scholars would make this analysis rather than seeing the whole of *better* as unanalyzable from the morphological point of view. The larger question is how far this analysis of suppletion can or should be stretched. Bloomfield (1933: 215) sees the /ʃɪld/ in *children* as suppletive and the *-en* in *oxen* as suppletive to the regular *-s* plural marking. One possible analysis of the *foot/feet* pair is that we have two suppletive bases for the morpheme {foot} (and, equally, that all the strong verbs in English have multiple bases). While this is a possible analysis of English, there seems to be little to commend it as these alternate bases are not used for other purposes in English. In Latin, however, a suppletive supine form such as *lātum* from *ferō* 'to bear' gives rise to *lātito* 'frequentative of carry,' *lātor* 'mover of a motion,' *lātūra* 'carrying of burdens' and so becomes a base in other derivations as well as in the inflectional system.

3.7 Extended Exponence

Consider the Latin form *amāverim* ‘I have loved (subjunctive).’ The root is *am-*, the *-v-* marks the perfect, and the *-ā-* is a thematic vowel, which will be discussed further in 3.9 below. The *-m* marks first-person singular, but the *-i-* before the *-m* occurs only in this particular tense/mood combination. The *-er-* occurs in the perfect, future perfect, and pluperfect tenses, indicative or subjunctive. So the fact that this is a perfect form is shown by the *-v-*, by the *-er-*, and by the *-i-*, the fact that this is subjunctive is shown by the *-i-* and by the final *-m* (which, although it can occur in some tenses in the indicative, is general in the subjunctive and not found in the perfect indicative). Not only does the *-i-* indicate two separate things (this will be taken up in Section 3.8), but both perfect and subjunctive are signaled by more than one morph in the word. This means that the meaning is not associated with one particular piece of form, but with a number of pieces of form, some of which also signal other things: the clean relationship between form and meaning is lost. If the meanings of the morphemes (the sememes) are taken to be these elements (and not combinations of the elements “perfect,” “subjunctive,” “first person,” and so on) the notion of the morpheme as a minimal sign can no longer be maintained. The only way to rescue the classical morpheme is to have larger morphs with more complex meanings.

3.8 Cumulative Exponence

In the Latin nominal paradigms given in (8), it is straightforward to isolate the root of the word, but rather more difficult to know how to analyze the inflectional material.

(8)	Number	Case	‘lord’	‘girl’	‘war’
			(masculine noun)	(feminine noun)	(neuter noun)
Singular		Nominative	dominus	puella	bellum
		Accusative	dominum	puellam	bellum
		Genitive	dominī	puellae	bellī
		Dative	dominō	puellae	bellō
		Ablative	dominō	puellā	bellō
Plural		Nominative	dominī	puellae	bella
		Accusative	dominōs	puellās	bella
		Genitive	dominōrum	puellārum	bellōrum
		Dative	dominīs	puellis	bellīs
		Ablative	dominīs	puellis	bellīs

Although there are two numbers (singular and plural), five cases and three genders (or different nominal paradigms), there is no morph which is consistently found as a representation of any of these ten categories. Equally, in many instances there is syncretism, and a given case-number marker is not unique to a particular slot in the paradigm (consider

-is, which is found in three genders, two cases though always in the plural, and -ae, which is only found in the feminine noun, but can be singular or plural and any one of three case-number combinations). Thus, although we have here ten meanings or functions, none of them is ever uniquely shown by a morph which does not carry other meanings or functions.

The assumption underlying the notion that there is a problem here for the morpheme is that each identifiable meaning should be a morpheme in its own right. The actual situation illustrated in (8) is that any given analyzable form has not one but a series of meanings. Another reason why the material shown in (8) might be taken to be problematic is because of the syncretisms, a given form is not uniquely associated with a single set of meanings. The two are best treated individually.

The problem of syncretism is fundamentally the problem of homonymy. *Pier* and *peer* (of the realm) have the same phonological form and yet have completely different meanings. All languages have a certain amount of homonymy (something which is perhaps surprising given the number of combinations of segments which remain unused in any language: e.g., there is no word *peeb* in English, despite there being several pronounced like *pier*); homonymy cannot be a huge problem for cognition in general terms. Syncretism does not appear to be very different: in a sentence context, it is unlikely that a dative singular like *puellae* will be confused with a nominative plural like *puellae* because of syntactic context and agreement phenomena. We can thus discount syncretism as a problem in these instances.

The notion that the meaning of a morpheme must be minimal is not part of the definition of morpheme. Consider the -s on the end of English *instructs*. It shows third person (*He/she/it instructs*, **I/you instructs*), it shows singularity (*He/she/it instructs*, **They instructs*) and it shows non-past tense (*He/she/it instructs*, *He/she/it instructed*). In this case, scholars might conclude that it represents three morphemes, but such an analysis seems less likely than in the case of the Latin paradigm. It could be that {third-person singular non-past} is a morpheme in English. If such an example is not convincing, consider the semantics of the suffix -ize as discussed by Plag (1999: 140). Plag gives the semantics of -ize as shown in (9). Whatever we want to claim about this meaning, it is clear that it cannot be semantically minimal, and therefore we cannot assume that the meaning of any morpheme is semantically minimal.

(9) CAUSE([. . .]_j, GO([Property, Thing]_{Theme/Base}; [TO [Property, Thing]_{Base/Theme}]))

Such a conclusion, while it may to a certain extent solve the problem of cumulation in affixes, has another effect, which may also be considered undesirable. That is, it leads to a proliferation of morphemes. If, for instance, there has to be a morpheme {a₁} “feminine, nominative, singular,” another morpheme {a₂} “neuter, nominative, plural” and another {a₃} “neuter, accusative, plural” and so on across all the paradigms, we will have

more morphemes than we will have if we simply have the ten fundamental notions that are cross-classified in the paradigms in (8). This lack of economy may simply be the price of having a coherent notion of the morpheme in the classical framework.

There is some slight disagreement about the nomenclature of morphs which carry several distinguishable meanings in a cumulative way. For some authorities, all of these are portmanteau morphs (see, e.g., Hockett 1958b: 239, who also includes morphs like *feet* and *sung* and even *sheep* as a plural in the same category); Nida (1958: 257), on the other hand, accepts the term portmanteau morph only where a single morph represents a sequence of two words, as with the French *au* ‘to the [masculine]’, historically derived from the preposition *à* and the definite article *le*, and paradigmatically related to the sequence *à la* ‘to the [feminine]’.

3.9 Empty Morphs

Occasionally, we find apparent morphs which have no meaning. Some examples are given below.

If we take the name *Plato* and add the suffix *-ist*, we find we get *Platonist*. If we compare with *Zolaist*, which lacks the *-n-*, we find no meaning that cannot be attributed to the base or the affix, yet there is an extra element of form in the one which is not found in the other and which appears to carry no meaning. If it has a function, that function is probably phonological (possibly phonological in the donor language). If we do not accept *-n-* as a separate morph, we must attribute it either to *Plato* (so that *Platon* is an allomorph of {*Plato*}) or to *-ist*. In this case, given that we find *Platonic* but no other intrusive *-n-* before *-ist*, the choice seems simple, but in some cases it may be essentially random, and treating such things as separate morphs seems more realistic (see Bauer et al. 2013 for some discussion). These elements can be termed extenders.

Consider the examples from Italian in (10).

(10)	‘love’	‘fear’	‘serve’
‘I ~’	amo	temo	servo
‘we ~’	amiamo	temiamo	serviamo
‘I ~d’	amavo	temevo	servivo
‘we ~d’	amavamo	temevamo	servivamo
‘we will ~’	ameremo	temeremo	serviremo

The roots of these words are *am-*, *tem-*, and *serv-*; the first-person plural marker is *-mo*, and the *-ia-* that occurs before the *-mo* appears to be a marker of present tense, though not present in the first person of the present tense, where the only suffix, *-o*, must mark first person. The perfect marker is *-v-*, which co-occurs with a following *-a-* in the first-person plural, the future is marked by both *-er-* and a following *-e-*. This leaves an *-a-*, *-e-*, and *-i-* in the rows with perfects unexplained. We do not need to associate them with any

meaning (for there is no meaning left which is carried by these forms). They appear to be meaningless. Traditionally, these are called thematic vowels. We might say that they do have a function—namely, to indicate to which conjugation class the various verbs belong—but most authorities do not see this as sufficient “meaning” for a morpheme to carry. Again we could treat these vowels as being part of the stem, so that *ama-* is an allomorph of {am} which occurs in particular verb forms, but this seems too lexically driven, since the *-a-* occurs with a whole series of first conjugation verbs, not just with the verb *to love*.

Forms with no meaning cannot be signs; if they are to belong to morphemes they must have some meaning or function. If they have no independent meaning or function, they must be assigned to one or other of the adjacent morphemes, since a morphemic analysis must exhaust the word being analyzed with no residue. If all these solutions are rejected, these empty morphs (“empty” of meaning) are problematic for the classical morpheme. Nonetheless, practitioners accept the notion of empty morpheme, at least as long as it has the canonical form of a morpheme in the language concerned (Hockett 1958b: 237).

3.10 Superfluous Morphs

Consider the examples in (11) from Italian.

(11)	Gloss	Masculine	Feminine	Adverb
	‘average’	medio	media	mediamente
	‘blind’	cieco	cieca	ciestamente
	‘excellent’	ottimo	ottima	ottimamente
	‘last’	ultimo	ultima	ultimamente
	‘painful’	doloroso	dolorosa	dolorosamente
	‘polite’	cortese	cortese	cortesemente
	‘serious’	serio	seria	seriamente

In every case, the adverb is formed from the feminine form of the adjective, and yet there is no feminine meaning attached to the adverb. While there is a perfectly good historical reason for this strange state of affairs, synchronically there is a morph present in these words whose meaning is not observable in the relevant words, though the meaning is clear elsewhere. We might treat this as another type of empty morph, were it not that this form is firmly attached to a meaning in other related words; the meaning attached to the sign is superfluous in the derived adverbs. Another alternative is to treat it as a morpheme (see §4.3), but that is not available in classical morphemic theory.

3.11 Subtraction

In Koasati, verbs are marked for whether they take a singular or plural object. Some examples (from Kimball 1991: 317–20) are given in (12).

Adjacent identical vowels are pronounced long. Note that /l/ assimilates to an immediately preceding sonorant consonant.

(12)	<i>Singular</i>	<i>Plural</i>	<i>Gloss</i>
	ataká-a-li-n	aták-li-n	'to hang something'
	albití-i-li-n	albít-li-n	'to place on top of'
	apoló-o-ka-n	apól-ka-n	'to sleep with someone'
	tipá-s-li-n	típ-li-n	'to pick something off'
	simá-t-li-n	sím-mi-n	'to cut up tanned skin'
	tiwá-p-li-n	tíw-wi-n	'to open something'
	lomá-p-li-n	lom-mi-n	'to whip something'
	talá-f-ka-n	tál-ka-n	'to whittle something'
	tafilá-m-mi-n	tafil-li-n	'to overturn something'

Note that the form of the singular is not predictable from the form of the plural, so that the singular base must be learnt. The plural form, though, is predictable from the form of the singular: remove the rhyme of the final syllable of the base to create the base for the plural form. This works whether the rhyme is a long vowel or a sequence of vowel and consonant. (For further discussion see Broadwell (1993) on the morphology and Lombardi and McCarthy (1991) on the phonology.) Contrary to the expected iconic pattern, the more meaning of the plural is represented by less form in the plural base.

In such instances, it is never clear whether real speakers prefer the economical “hocus-pocus” solution (Householder 1952), or whether they learn a number of unpredictable paradigms, avoiding subtraction but complicating the grammar. In some well-known cases (such as the Maori passive), it is clear that they take the latter route, but we cannot evaluate the Koasati examples – which look convincing – in this regard.

Hockett (1958b: 394) sees the existence of subtraction as leading to the collapse of the classical morpheme in an Item and Arrangement grammar. For a much more detailed discussion see Manova (2011).

A different kind of deletion of phonological material is provided by clipping. Some English examples are given in (13). There are also, in English, many examples where there is clipping with subsequent (or perhaps simultaneous) suffixation, as in (14).

(13)	perambulator	pram
	jumbo jet	jumbo
	photograph	photo
	influenza	flu
	reconnaissance	recon
	optical art	op art
(14)	relative/relation	rellie
	garbage collector	garbo
	musician	muso

(bathing) costume	cossie
road manager	roadie
pregnant	preggers

While the forms above clearly involve deletion, they can also be viewed as fitting the exuberant material of the base into a much more constrained template, which allows a specified amount of phonological material to remain (Lappe 2007). In this view it is not so much a matter of deletion as it is a matter of limited retention. While the analysis is compelling, it is not clear whether it is sufficient to do away with the need for subtraction. In any case, the analysis appears not to apply to the Koasati examples in (12), where the plural base has different numbers of syllables, but always one fewer than the singular base.

It is not clear whether instances like *anarchistic* should be included as cases of subtraction. The meaning of *anarchist* and *anarchistic* seem to make reference to *anarchism*, despite the fact that the morph *-ism* is not present in these other forms. If instances like this are cases of subtraction, it extends the amount of subtraction we find in morphology.

3.12 Zeroes

There seems to be general agreement (Hockett 1958b: 389; Nida 1958: 263) that we cannot have a morpheme whose only form is zero (i.e., no form at all). Thus there is no morpheme {singular} on nouns like *cat*, *dog*, *horse* in English; rather, singularity is shown by the lack of plural marking. However, there is rather less agreement on just where you can have a zero morph even though, in principle, a zero morph has no form and therefore cannot be a sign and so cannot be part of a morpheme.

Consider, for instance, the paradigm for one type of Russian feminine noun provided in (15).

(15)	<i>gazyeta</i> 'newspaper'	
	<i>Singular</i>	<i>Plural</i>
<i>Nominative</i>	<i>gazyeta</i>	<i>gazyety</i>
<i>Accusative</i>	<i>gazyetu</i>	<i>gazyety</i>
<i>Genitive</i>	<i>gazety</i>	<i>gazyet</i>
<i>Dative</i>	<i>gazyete</i>	<i>gazyetam</i>
<i>Instrumental</i>	<i>gazyetoi</i>	<i>gazyetami</i>
<i>Prepositional</i>	<i>gazyete</i>	<i>gazyetakh</i>

The point to note about (15) is that there is a suffixal ending for every case/number except the genitive plural, where the bare stem is found. In other paradigms of Russian nouns, the genitive plural does have an overt suffixal marker. Here many analysts would wish to see a zero morph for the genitive plural marker, partly because the form with no marker is

not the unmarked form (in the wider sense of “unmarked” which includes reference to matters such as frequency and distribution as well as cognitive factors).

At the other end of the scale, a case which has been much discussed in the literature is what to do with zeroes in derivation. If we assume that *down* is fundamentally a preposition, then we might need a zero marker of its change to an adverb in a sentence like *She looked down*. We might also need a zero to show its change of status to a verb in *He told us to down the water*. And yet again, we might need another zero to change *down* to a noun in *They seem to have a down on me*. So here we have three different zeroes, all contrasting with each other, and also contrasting with a lack of zero. Even if we think the preposition and adverb are basically the same part of speech (transitive and intransitive preposition, for example), the example seems untenable (see, e.g., Bauer et al. 2013).

There are two questions here. The first is how far we are willing to stretch the notion of the morpheme as a sign, and how much weight we are giving to the form side of the sign. Strictly, if we adopt the notion of a morpheme as a sign, we should not allow any zeroes. To allow zeroes is to give meaning precedence over form in the setting up of morphemes. While many (perhaps most) morphologists are relatively relaxed about that idea, we appear to have no generally accepted and principled way of stopping the spread of zeroes once they are accepted.

The second question is how a zero is conceived of. In the morpheme-morph theory, the zero must realise a meaning and must be overt. In a non-morphemic approach to morphology, a zero (or rather a lack of form) could arise because there is no rule to create a form (so that there is no rule which creates an ending for the genitive plural of the relevant Russian nouns). If zeros are reinterpreted as lack of marking, they may be less problematical. But this solution is not available in classical morphemic theory and, also, it implies that the grammar never needs to make reference to the zero. Myers (1984) suggests that in English zero-derivation (or conversion), the zero cannot be followed by further derivational markers, and so has to be overt in the grammar. However, Bauer et al. (2013: 504) cite examples such as *harpooner*, *plasterer*, *emptiable* which appear to violate the supposed constraint. (On different kinds of zero, see further Trommer 2012.)

3.13 Inversion

Inversion is a phenomenon which, while it is known from a number of languages, is most fully described for Algonquian languages. Consider the data in (16).

- (16) a. Ni-pēh-ā-nān-ak
 1-await-DIRECT-1 PL-3 PL
 ‘we await them’

- b. Ni-pēh-iko-nān-ak
 1-await-INV-1PL-3PL
 'they await us'

Source: Plains Cree (Klaiman 1992)

The importance of the pair illustrated in (16) is that although both subject and object person and number are marked in the verb-form, precisely the same set of person and number markers indicates different persons in each of these roles. It is not the case that the final *-ak* means 3pl subject or 3pl object, and its position does not influence its interpretation; it is a matter of whether it is direct or inverse which influences whether it will be interpreted as subject or object. From the point of view of the system of Plains Cree, the important thing is that the first person should always occur in the word-form ahead of the third person.

In more general terms, we can see that part of the information related to a particular morph is determined not by the morph itself but by another morph in the word-form. This is masked to some extent by the fact that in some forms of the paradigm there may be no overt marking of the fact that a particular instance is direct, as shown in (17).

- (17) Ni-wāpam-āw-ak
 1-see-SG-3PL
 'I see them.'

The problem here is that the meaning associated with a particular form is not determined by the form, but by the environment in which the form is found. It is not only in instances of inversion that this might be said to occur. The *-b-* in Latin *amābō* 'I shall love' does not obviously have any semantic relationship to the *-b-* in Latin *amābam* 'I was loving' (a pattern which is repeated throughout first- and second-conjugation verbs). More seriously, in templatic languages such as Navajo, a particular form may have subtly different meanings depending on which slot in the template it occurs in (Spencer 1991: 212), and there may also be homophonous forms whose meanings are so different that they have to be considered separate morphemes (rather like the final *-er* on *bigger* and final *-er* on *killer* in English).

The question can be reduced to the question of whether the meaning of a morpheme can be stated as being one thing in the presence of one morph/ morpheme (or class of morphemes), but something different in the presence of another. In such terms, the problem seems rather less worrisome. It seems to be parallel to the phonological dispute as to whether [r] can belong to /t/ intervocally but to /r/ when it immediately follows /θ/ in English (in *butter* [bʌtə(r)] versus *threw* [θru:], for instance). Despite Chomsky's (1964) objections to such analyses in phonology, it is clear that they were accepted by practitioners in the 1940s and 1950s, and presumably the morphological congener would also have been seen as a practical solution.

4 Attempts to Avoid the Problems

4.1 Amorphousness

Various forms of Word-and-Paradigm morphology (see, e.g., Matthews 1972) or A-morphous Morphology (see, e.g., Anderson 1992) attempt to overcome the weaknesses in the classical morpheme by formalizing a view of morphology which can be seen as implicit in the descriptions of the grammarians of the classical languages. According to this view the word is the fundamental unit of analysis, and while the word carries various meanings (so that Latin *amō* 'I love' carries meanings such as 'love,' 'first person,' 'singular,' 'present tense,' 'indicative') and has within it various formal elements (such as *am-* and *-ō*), there are no morphemes as such, only the meanings, many of them notated as features, and rules which derive form from the cluster of meanings to be realized in the word (see Anderson 1984 for the notion that it is the rules which replace the morphemes). Features are an efficient way of cross-classifying various data where no priority can be given to any particular element that needs to be captured, but it is not clear that the features can be precisely equated to what Bloomfield (1933) calls sememes, the meanings associated with morphemes.

Despite its strengths, this approach is associated with some problems. The major one of these is that if the classical morpheme treats every language as though it is Turkish, this approach treats every language as though it were Latin. The argument in favour of this is that if some languages have features like Latin, then a morphological theory needs to be able to deal with them appropriately and needs the power to do so. But the downside of this is that the grammar is overly powerful for a very large number of languages (including Turkish), which need only a small subset of the formal capacities that the theory provides. If your theory allows the morphology to do anything, you have no explanation of why some languages would not do everything, but are limited in fairly regular ways to a subset of these things.

So while these approaches resolve some of the issues which affect the inflectional morphology of some languages (issues such as extended exponence and cumulative exponence), they raise another set of problems, which were perfectly well dealt with by the classical morpheme.

4.2 Morphemes as Processes, Rules, Paradigmatic Slots

In the Word-and-Paradigm types of approach, morphemes are replaced with, among other things, a series of rules which build phonological structure. Whether it is the rule that is seen as the (partial) equivalent of the morpheme (Anderson 1984) or the process of building, there is a dynamic aspect of morphology here which is not available in the classical morpheme. The notion of process predates modern versions of Word-and-Paradigm, and it has already been shown that in replacive morphs (§2.5),

even proponents of the classical morpheme were in effect dealing with processes masquerading as forms. Some morphological patterns lend themselves particularly well to a description involving processes: reduplication is typically formulated as if it were a matter of copying material from a base and adding it to that base, where both *copying* and *adding* are processual metaphors. But even affixation can easily be seen as a process, again a process of adding particular formal elements to a base in a particular position with a given semantic effect. Conversion, too, may be seen as a process, taking a given input and outputting the same form with a different categorical label. So the notion of process is a powerful one, and historically became even more powerful with the advent of generative morphology, where rules were written using a dynamic notion (the arrow notation, for instance) and a dynamic jargon (“is rewritten as”). It is thus unsurprising that the Item and Process view of morphological structure followed so closely from the Item and Arrangement view, and has persisted even if Item and Arrangement has staged something of a comeback in declarative views of grammar.

Other minor (or even quite major) variations on the notion of morpheme have been envisaged, and Mugdan (1986) gives a careful overview. To the extent that morphology is seen as paradigmatic structure, it might be argued that the morphemes are the slots in the paradigm, while the morphs are the material which fills those slots, whether invariant, phonologically or lexically conditioned. The basic idea of a meaningful piece of form can be phrased in a number of ways, and mostly those reformulations indicate the same unit and differences in coverage appear only peripherally.

4.3 Morphemes as Forms and Morphomes

One trend that seems to move the morpheme further away from the classical notion—and this has already been mentioned above—is to view the morpheme much more from the formal side than from the meaning side. Most practitioners who have a morpheme in the classical style seem to be more influenced by constancy of meaning than by constancy of form in determining what forms belong to a particular morpheme. This new trend is to look away from the meaning and concentrate on formal behavior.

At one extreme we find the notion of a morphome (Aronoff 1994). The morphome is a series of morphs which occur in identical circumstances even though there may be two or more different meanings attached to the morphs. Aronoff gives the example of the past participle and the passive participle in English: where the past participle ends in *-ed* (in some appropriate phonological form), so does the passive participle: *have killed*, *be killed*; when one ends in *-en*, so does the other: *have stolen*, *be stolen*; when one is irregular, the other is too: *have hit*, *be hit*. For Aronoff, there is a single morphome here, even if there may be two classical morphemes. I find the example unconvincing, because there is no reason to assume that there is a

passive participle at all: the passive could simply be a construction which employs the past participle. However, the notion of the morpheme has been widely employed in the historical study of the Romance languages, where different verb stems tend to recur in varied but predictable positions in paradigms (and thus with no single meaning being attached to them) despite the range of forms that the stems may take (see, e.g., the papers in Cruschina et al. 2013). While my personal view is that the notion still requires some clarification, it is an innovative approach to morphological structure which, unlike the classical morpheme, does not rely on the close relationship between individual forms and individual meanings.

4.4 Morphemes as Content: Distributed Morphology

Although the term “morpheme” is used in Distributed Morphology (DM), it is defined in such a way as to denote a completely different entity from that denoted by “morpheme” in structuralist theories. If the morpheme is a new look at the morpheme focusing on its formal side, the DM morpheme focuses on the content side: “the term morpheme properly refers to a syntactic (or morphological) terminal node and its content, not to the phonological expression of that terminal” (Harley and Noyer 1999: 4). Distributed Morphology also draws a distinction between l-morphemes and f-morphemes (lexical and functional, respectively), which recalls the use of the terms “lexème” and “morphème” in Martinet.

5 How Serious are the Problems?

At various points in the discussion I have indicated that there seems to be a way out which allows the classical morpheme (or something very like it) to stand without objection. The main objection, it seems to me, is that solutions which use classical morphemes are often not very economical, and that more economy can be achieved with alternative approaches, particularly with process-based approaches. This does not invalidate the morpheme, but it might be a reason to prefer an analysis which is couched in rather different terms.

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Natural Morphology

Wolfgang U. Dressler and Marianne Kilani-Schoch

1 Introduction

1.1 Sources of Natural Morphology and Relations to Other Models

Natural Morphology (NM) emerged by the end of the 1970s as a semiotically and cognitively based functionalist theory in the continuation of Natural Phonology (Stampe 1973; Donegan and Stampe 1979). Praguian structuralism, with the concepts of markedness and interplay between the paradigmatic and syntagmatic axis (Jakobson 1971), and Peircean semiotics (introduced into linguistics by Jakobson) are two additional key sources. NM has also taken over from these forerunners the idea that determining what is natural depends on both internal evidence of descriptive synchronic facts and on “external” evidence (particularly from diachronic change, language-acquisition studies and other psycho- and neurolinguistic studies). In this way NM, founded in 1977 by Mayerthaler, Dressler, and Wurzel (Dressler et al. 1987), following the lead of one chapter in Mayerthaler (1977), belongs to the family of models characterized by a cognitive perspective.

The theoretical framework of NM is built on sources differing from formalist schools, although many notions are shared, such as the distinction between potential, actual, and illegal complex words and inflectional word-forms (see §§2.4, 3.3.5), notions of headedness (§3.1.5) and of default (§3.3.2), the importance of paradigms (including overabundance) (§3.3.2) and of interfaces between various language components (§4). As a theory of preferences, NM differs from other morphological theories but preferences are still parallel to notions of violable constraints that Optimality Theory (see Chapter 20) has elaborated on bases taken over from Natural Phonology. Preferences also lead to contemporary issues of measuring complexity (§3.2.4). In its insistence that universal preferences are a response to difficulties of language performance NM comes close to usage-based construction grammar (see Chapter 12).

1.2 Naturalness

Naturalness is a theoretical principle of evaluation of linguistic facts and of accounting for morphological asymmetries or preferences – in other words, for what is more or less natural or marked among comparable morphological phenomena. The search for extralinguistic motivations of morphological patterns determining what is universally preferred is based on cognitive principles involved in performance, and on external evidence from diachronic change (Wurzel 1994; Dressler et al. 1995; Dressler 2003), child language acquisition (Bittner et al. 2003; Stephany and Voeikova 2009; Dressler 2010; Dressler 2012) (cf. Chapter 27) and psycholinguistic experiments (Jarema and Libben 2007; Korecky-Kröll et al. 2012) (see Chapter 28).

In the deductive framework of NM, naturalness/natural is not used as a synonym of intuitively plausible or crosslinguistically frequent (cf. Gaeta 2006; Haspelmath 2006; Andersen 2008; Bybee 2011; Dressler 2011). Naturalness is a covert notion for a set of more specific terms, ranging, for example, from parametric relations of transparency, iconicity, and so on to productivity, regularity, subregularity, and so forth, to be defined in specific cognitively grounded subtheories. Frequency of use (cf. Chapter 24) is derived from the preferences except in certain cases of markedness reversal (Mayerthaler 1981; Haspelmath 2006: 32, 43, 46) (cf. §3.1).

At the highest level of the theory – in other words, within the subtheory of universal naturalness (cf. Mayerthaler 1981) (see §3.1) – naturalness is understood as cognitively simple, easily accessible, and therefore universally preferred. The notion of cognitive simplicity is provisionally established by referring to experimental cognitive studies as well as to acquisition research about what is universally favored by adult speakers or by children. Psycholinguistics, for example, gives abundant evidence for the ordering preference of derivational and inflectional affixes or for the preference of affixation over modification (see, e.g., Marslen-Wilson and Tyler 1998). This cognitive basis is theorized in a restricted number of universal semiotic parameters (see Chapters 26 and 28).

The subtheory of typological naturalness accounts for language types as consistent choices among natural parameters (Dressler 1985a, 1986, 1988a) (see §3.2), and the subtheory of language-specific naturalness or system-adequacy deals with the normal patterns within the morphology of a specific language (Wurzel 1984) (see §3.3). Universal parameters as well as the three subtheories are inherently conflicting (cf. Kilani-Schoch 1988) (see §3.1.8).

1.3 Outline of the Chapter

Section 2 provides essential intensional properties of NM and the extension of its domain. Section 3 describes the three subtheories from the most general to the most specific: the seven parameters of universal naturalness

and some of their conflicts. These conflicts are resolved within the second subtheory of typological naturalness. The section on the third subtheory of language-specific system-adequacy sketches the model of input-oriented, prototypically productive dynamic morphology and output-oriented stored static morphology and sets arguments for continua of regularities, subregularities, and irregularities.

In the last section, emphasis will be put on the interfaces between morphology and other language components and on transitional domains and units explored by NM.

2 Principles and Distinctions

2.1 Basic Units

For naturalness theory, as we understand it, the basic communicative unit is the discourse (which is a semiotic supersign and which can be segmented into texts); for its interface with morphology, see Section 4.5. The basic grammatical unit is the sentence, but the basic semiotic (Peirce 1965) and stored unit is the word (Wurzel 1984; Dressler 1988b; Jarema and Libben 2007), more precisely the lexeme (see Chapter 3) which is the basis for the paradigm of all inflectional word-forms of the same lexeme as in the paradigm of the lexeme GO: *go*, *goe-s*, *go-ing*, *wen(-?)t*, *go(-?)ne*. Morphemes are morphological constituents of words. As signs on signs, they are secondary and phonemes are tertiary signs (see Chapter 13).

Many studies have shown that morphologically complex words are automatically parsed (see Longtin et al. 2003; Marslen-Wilson 2006; Pirrelli et al. 2011 for a summary). Moreover, acquisition studies highlight that children start to decompose morphologically complex words when in an early acquisition phase they detect the existence of morphology (Dressler et al. 2003a). Hence, the model of NM uses both types of units. It is at the same time morpheme- and lexeme-based (Kilani-Schoch and Dressler 2005), like other intermediate models between dual- and single-route models (e.g., realizational models; see Chapter 28).

2.2 Gradualness

Within NM, concepts are relative or gradual: in contrast to the Praguean dichotomous concept of markedness, natural/unnatural (unmarked/ marked) means “more or less natural than” in relation to two corresponding categories and within a specific subtheory of either universal naturalness, or of typological or language-specific naturalness (see §3).

Similarly, we assume fuzzy internal and external boundaries (within morphology and between morphology and the other components of grammar and beyond) (cf. Mayerthaler 1981; Kilani-Schoch and Dressler 2005). For instance NM posits a gradual continuum from syntax to morphology: phrasal

syntax – multilexical unit – juxtaposition – compounding – semi-affixation – derivation (Dressler 2007a) (see §4). Furthermore, Dressler (1989) proposed a gradual scale from prototypical derivation (e.g., class-changing nominalization of adjectives) over non-prototypical derivation (e.g., diminutive formation in most languages, whereas in Bantu languages it belongs to non-prototypical inflection), and non-prototypical inflection (e.g., plural formation) to prototypical inflection (e.g., case). The last two categories correspond to Booij's (2000) contrast between inherent and contextual inflection (cf. Chapter 2), but there is no correspondence to the other categories of the cline.

This gradual cline explains, for example, the variations in head properties: whereas prototypical compounding and derivation have all of them, the non-prototypical derivational category of diminutive formation lacks in many Slavic, Romance, and other languages the head property of determining the word class of the complex word, as in Italian *brun-otto* 'brownish' versus nominalization of the adjective in English *brown-ie*. Within inflection, only non-prototypical inflection can change the word-class – for example, in infinitives, where certain verbal properties are changed to nominal ones, or in changes to the semantics of the base as found in lexical plurals such as *fathers* 'ancestors' (Acquaviva 2008) (cf. Chapter 2).

Other instances of concepts modelled in terms of gradualness are productivity (§§2.4, 3.3.5), regularity–sub-/irregularity (§§3.3.1, 3.3.4), suppletion (§3.3.4), and universal parameters (§§3.1.1–3.1.6).

Gradualness seems to have psycholinguistic correlates: recent processing studies highlight the sensitivity of memory to fine gradual distinctions between units which determine processing (cf. Baayen et al. 2011; Siyanova-Chanturia 2013).

2.3 Domain of Morphology: Grammatical versus Extragrammatical versus Marginal Morphology

Morphology as a component of grammar only accounts for a part of morphology at large. For example, echowords, blends, hypocoristics, and other abbreviations, or linguistic games and onomastic morphology (Crocco-Galèas 1991; Nübling et al. 2012), are not accounted for within the morphological grammar of languages. Highly unpredictable interspeaker variation, lack of meaning change and alternative outputs, among other features, differentiate them from "cognized" (Chomsky 1980) grammatical rules. Natural Morphology situates such phenomena in the domain of extragrammatical morphology, which comprises the set of heterogeneous phenomena violating at least some grammatical property (Doleschal and Thornton 2000; Dressler 2000a; Fradin et al. 2009; Kilani-Schoch and Dressler 2014b).

The domain of morphology is thus divided by NM into grammatical (or plain) morphology (that is, grammatical competence for morphological

rules manipulating meaning and form in a regular, predictable way) and extragrammatical morphology (so-called expressive morphology, cf. Zwicky and Pullum 1987). An additional distinction between prototypical grammatical morphology and non-prototypical or marginal morphology should be added, for example suppletion (see §3.3.4).

2.4 Productivity: Potential versus Actual System of Grammar

Productivity, be it derivational or inflectional, is a core notion of NM: it is considered as a primitive and constitutive property of grammar, located at the level of grammatical competence: in other words, the potential system of grammar which accounts for potential words (in the sense of Aronoff 1976) or word-forms (Schultink 1961; van Marle 1985; Dressler 1997, 1998; Dressler and Ladányi 2000; Bauer 2001; Dressler 2004, 2007b; Gardani 2013).

It provides speakers with the ability to grade non-existing multimorphemic forms in terms of potentiality (Dressler 1997; Korecky-Kröll et al. 2012). Morphological rules are supposed to be prototypically productive—in other words, to apply to new forms which match their structural description (syntagmatic dimension)—unless their domain is limited on the level of the actual grammatical system, for example through competition of rules or patterns (paradigmatic dimension) (Dressler and Ladányi 1998; Dressler 2004).

Grammatical productivity on the level of the potential system is distinct from (surface) analogy (Skousen 1989), type frequency on the level of language as institution (norms) (Wurzel 1994; Bybee 1995; Bauer 2001), and token frequency on the level of performance (see Baayen et al. 2003). Productivity must be distinguished from surface analogy, which has been conceptualized by Motsch (1981) for the formation of a neologism in exact imitation of one specific existing item: for example, the French *amerr-i-r* ‘to alight on water,’ *alun-i-r* ‘to land on the moon,’ and *a-mars-i-r* ‘to land on Mars’ have been coined according to the precise model of *atterr-i-r* ‘to land’ and not to an abstract rule pattern, as shown by the orthography of *amerr-i-r*: the double *rr* can only be accounted for by surface analogy with *atterr-i-r*.

3 The Three Subtheories of Natural Morphology

The structure of NM is a deductive hierarchy, from the level of universal morphological preferences or subtheory of universal markedness theory of system-independent morphological naturalness, to the level of typological naturalness, then to the lowest level of language-specific system adequacy or system-dependent naturalness (Kilani-Schoch and Dressler 2005).

Typological naturalness acts as a filter of, and elaboration on, universal naturalness/markedness, and analogously, language-specific system adequacy as a filter of, and elaboration on, typological adequacy. Each lower-level filter can specify and even overturn preferences of the preceding higher-order level (cf. Dressler et al. 1987; Bittner 1988; Wheeler 1993).

3.1 Universal naturalness

Mayerthaler (1981) was the first to elaborate a model of markedness which covers both markedness of morphological content relations of more versus less marked between all contrasting categories (e.g. plural more marked than singular, dual more marked than plural, inanimate than animate, other persons than the first, non-present tenses than present, and so on) and markedness of morphological coding of such categories.

In the universal subtheory of markedness or preferences, morphological properties are evaluated on scales based on the following semiotic and cognitive parameters of indexicality, iconicity, morphosemantic and morphotactic transparency, biuniqueness, figure and ground, and binarity. These scales are derived from adding up several binary markedness relationships on each parameter (see §§3.1.1, 3.1.7).

Here naturalness does not refer to any global or overall preference, but to what is universally preferred on one given parameter.

3.1.1 Iconicity

The best-known and most discussed semiotically derived parameter is the parameter of iconicity, which refers to analogy relations between meanings and forms (see Croft 2008; Haiman 2008; Haspelmath 2008; Bybee 2011; Downing and Stiebels 2012; Siewierska and Bakker 2013; Kilani-Schoch and Dressler 2014a). It is based on Peirce's (1965) concept of icons with its hypoicons: images, diagrams, and metaphors.

Images are the most iconic hypoicons insofar as they represent a direct similarity between signans and signatum: for example, the expression of diminutive formation via palatality (see Dressler and Merlini Barbaresi 1994), in other words by way of phonetic iconicity. In the case of the phoneme /i/, there is an acoustic analogy or synesthesia between the height of the formants and high pitch voice, based on the prototypical child-centered speech situation of diminutives.

Images are scarce in grammatical morphology where universal bases are limited by the normality of the specific system and therefore are mainly found in extragrammatical morphology, namely in onomatopoeia, whereas elsewhere in (grammatical) morphology an arbitrary or, in Peircean terms, symbolic connection between form and meaning is needed, which is generally too small in linguistic images.

Of course, the cock's cry is more of a symbol and less of an image in English *Cock-a-doodle-doo* than in German *Kikeriki*, Italian *Chicchirichi*,

French *Cocorico*, and so on. But such minimalization of image properties are an exception in onomatopoeia.

The scale of morphological iconicity (constructional iconicity, Mayerthaler 1981) comprises first *diagrams* which show analogy between the relations of the constitutive parts of the signans and the relations of the constitutive parts of the signatum, as in the universal preference for an analogical relation between the phonological structure or size of (longer) lexical morphemes and the phonological structure or size of (shorter) grammatical morphemes and the richer semantics of lexical than of grammatical morphemes.

Both inflection and derivational morphology have the preference for diagrammatic iconicity in preferring concatenative morphology (composition, affixation, and other additive operations) to nonconcatenative morphology. For example, the plural *roof-s* or the derived agent noun *danc-er* are diagrammatically contrasted to their unmarked base because the addition of the suffix is analogical to the addition of meaning.

Iconicity is weaker in metaphors which present only a partial parallelism between form and meaning as in all morphological operations of modification, such as plural *feet* or *song*, derived from *foot* and *sing*, where plural and the derived noun respectively are indicated by apophony – in other words, the addition of markedness conveyed by the plural meaning is not directly paralleled by an addition in the signans but merely indirectly by a modification.

Non-iconic techniques are illustrated by zero-affixation (pl. *sheep*) and conversion (*cash* – *to cash*) (see Crocco-Galèas 1990; Manova 2011).

Lowest on the scale are anti-iconic techniques, corresponding essentially to subtraction. For instance there is the extremely rare subtractive plural (such as Franconian *hon* ‘dog,’ plural of *hond*) (Dressler 2000b) and extra-grammatical operations, such as in abbreviatory devices. Thus we can see that an effect of higher versus lower degrees of iconicity predicts cross-linguistic frequency distributions.

Thus the scale of iconicity is derived from the following binary markedness relations: 1) iconic versus non-iconic, 2) maximally iconic (diagrammatic) versus partially iconic (modification), 3) non-iconic zero morphology and conversion versus anti-iconic subtraction.

3.1.2 Indexicality

According to Peirce (1965), an index is a sign where the signans directly refers to the signatum, preferably to an adjacent signatum. Thus affixation of a marker to an immediately adjacent base is preferred to having for example an intermediate interfix, as in the Spanish diminutive *puebl-ito* from *pueblo* ‘village’ versus the interfixed variant *puebl-ec-ito* (Dressler and Merlini Barbaresi 1994).

The generalization that derivational affixes tend to be positioned between lexical roots/stems and inflectional affixes (Greenberg 1963) is another

instance of morphological indexicality and has been extended to the preferential right-bound order (Dressler 1989): root/stem–prototypical derivation–non-prototypical derivation–non-prototypical (= inherent) inflection–prototypical (= contextual) inflection (Dressler 2014a, see Chapter 7).

This order is first motivated by the indexical adjacency principle: case suffixes are best posited on the periphery of a word-form in order to be closest to the word-external world of syntactic constructions and to be first parsed after syntactic parsing, morphological parsing starting at the periphery of a word-form. For a similar reason, attributive demonstratives are best placed at the periphery of a noun phrase (see Cysouw 2010).

However, it is also motivated by the main linguistic functions of derivational versus inflectional morphology – that is, the derivational function of providing the lexicon with morphosemantically and morphotactically motivated derived words and of enriching the lexicon with new words, which does not favour a peripheral position of a derivational affix, versus the syntactic function of inflection which favours a peripheral position.

Indexicality plays also a role in allomorphy, insofar as it is greater in affix- versus stem-allomorphy (see §3.3).

3.1.3 Morphosemantic Transparency

The parameters of morphosemantic and morphotactic transparency¹ stem from the semiotic preference for transparency (Koj 1979) and the general function of morphology, already postulated by Saussure (1973: 180–4), to make words less arbitrary via morphosemantic and morphotactic motivation. Full morphosemantic transparency means fully compositional meaning, as is generally the case in inflection due to the strictly categorial meaning of markers (Rainer et al. 2014): for example, the meaning of *birds* equals the meaning of *bird* and of plurality. There is however morphosemantic opacity in cases of parasitic inflectional morphology and of non-iconic zero morphology (as in conversion and zero plurals; see §3.1.1). A relatively frequent case of parasitic morphology can be found in the formation of conditionals. Thus, in French and English, the conditional *je chante-r-ais* = *I'd sing* looks like the past tense form of the respective future *je chante-r-ai* = *I'll sing*, but this relation can motivate synchronically the meaning of conditionals only to a small degree.

In word-formation, morphosemantic transparency (and thus full motivation) can never be complete since Frege's principle of semantic compositionality holds only for syntax. All accepted words are stored and thus lexicalized (Bauer 1983; Meyer 1992). A differentiation should be made between transparent word-formation meaning – that is, the potential

¹ *Morphosemantic* refers to the meaning change between the base and the derived form – in other words, the difference between the derived meaning and the meaning of the base. The term *morphotactic* refers to the formal structure of the word or morpheme.

meanings of derived morphological patterns (equivalent to Corbin's 1987 notion of *sens construit*) – and actual lexicalized word meaning. Word-formation rules can only predict the former.

Typically, compounds are morphosemantically more transparent than derivations, because they are more descriptive (see Seiler 1991). For example, the compound *dishwashing machine* tells the language user more about what it is, than the derivation *dishwash-er*; in other words, such a compound serves the function of semantic motivation better than the corresponding derivation does (Dressler 2005). Nevertheless, morphosemantic transparency of compounds may also vary to a large extent. Note the very opaque French *couvre-feu* '[lit.] fire cover,' loaned into English as a totally morphologically unmotivated simplex word *curfew*.

3.1.4 Morphotactic Transparency

Morphotactic transparency of a complex word or inflectional word-form is optimal if its constituents can be perceived without opacifying obstructions.

Perception can be hindered first by the different degrees of variation in the shape of morphemes: phonological processes opacify very little (e.g., flapping in *rider* vs. *ride* or resyllabification as in *bake* – *ba\$ker*). Morphophonological rules introduce more opacity (e.g., homorganic assimilation of the negative prefix *in-* in *ir-relevant* vs. prepositional *in religion*, Bonet and Harbour 2012: 202–3, pl. *wive-s*), even more so in case of allomorphic rules (*divide*–*division*, *sing*–*sang*). Total suppletion is the most opacifying (*one*–*first*, *am*–*is*). Partial suppletion as in *brother* – pl. *brethren* (also morphosemantically rather opaque) is less opacifying. In distinction to subregular allomorphic rules, partial suppletions are irregular and thus isolated.

Due to the preference for diagrammaticity (§3.1.1), morphosemantically transparent patterns tend to be morphotactically transparent as well and vice versa. Similarly, opaque patterns tend to be so both morphotactically and morphosemantically (e.g., personal pronouns, Dressler and Merlini Barbaresi 1994; Siewierska and Bakker 2013); in other words, there is a trend towards iconicity between degrees of morphosemantic and morphotactic transparency/opacity.

Next comes the continuous or discontinuous structure of morphemes. Discontinuous morphs such as circumfixation (e.g., German past participle *ge-koch-t* 'cook-ed') or infixation (discontinuous base, e.g., Latin *vi-n-c-o* from the root /vik/ 'vanquish'), which either breaks the affix or interrupts the base, are dispreferred and indeed do not occur in the grammatical morphology of several languages, such as English (unless in extragrammatical infixation, as in *abso-blooming-lutely*, Zwicky and Pullum 1987).

Words as primary signs are the most transparent bases of morphological rules, both morphotactically and morphosemantically: most so if they are autonomous words in their uninflected form; less so in inflected forms, such as in the compounds *sport horse* versus *sport+s man* (Dressler 1988b;

Rainer 1993: 98 ff.). They are more transparent than stems, roots, or phrases, because each (de)composition operation renders production and perception more complex and thus less transparent, morphotactically and morphosemantically.

3.1.5 Figure-ground

Perception requires distinct signs—in other words, syntagmatic contrasts between a more important foreground or figure and a less important background (Scherer 1984).

In word formation, a head represents the grammatical figure, which determines the grammatical function of the whole complex word; the non-head, the grammatical ground.

Therefore, morphosemantic transparency of the head of a compound is more important than that of its non-head. For example, if diminutives are morphosemantically opaque, this is usually due to the lexical meaning contributed by the non-head, whereas the meaning of relative smallness is still present, for example in the English *brownie*, where the word-formation rule just produces the meaning “something relatively small and brown,” which describes the relative smallness of the fairy figure or chocolate cake, but tells us very little about the lexical content. In a division of labour between head and non-head, the non-head is usually more important for semantic discourse coherence (Dressler and Mörtz 2012). For example, the compound *peace treaty* is much more likely to occur within a text dealing with war and peace than in a text dealing with various sorts of treaties. The head is even less important for discourse coherence in suffixations.

Subordinate compounds (where the non-head is subordinated to the head) are universally preferred over coordinate compounds which have two or more morphosemantic heads (see Wunderlich 1986: 241), because these lack the clear figure-ground distinction of subordinate compounds. Thus in *speaker-hearer* both members are of equal status, although the plural ending attaches only to the right member, just as with inflectional heads (Dressler 2005).

The figure-ground distinction between head and non-head is established by morphosemantic and morphotactic subordination of a non-head under a head: *a bookseller* is a type of *seller*, with which it shares the syntactic and semantic features of being an animate, agent noun (morphosemantic headhood), and the plural suffix is attached to the same second element (morphotactic headhood). Similarly, *sell-er* shares with other parallel derived forms the agent word-formation pattern in *-er* in which the non-head specifies the type of agent. In a gendered language, the morphological head also determines the gender of the whole morphological construction (compound or derivation).

The preferred morphotactic order of non-heads to be followed by heads in many languages recalls the suffixing preference, whereby suffixes are

preferred to prefixes, as well as the tendency for prefixes not to be the head. An explanation for this right-hand head preference may lie in the psycholinguistic recency effect, which makes the end of a word more salient (Dressler 2005).

3.1.6 Biuniqueness

Biuniqueness is related to the readiness to identify the relationships between meaning and form. The scale of biuniqueness to ambiguity comprises three grades with uniqueness (partial ambiguity) inbetween.

Biuniqueness implies that one and the same form has always the same meaning and, vice versa, one and the same meaning is morphologically expressed only by one form, such as the Hungarian plural *-k*. In terminology (bi)uniqueness tends to hold for affixes, such as *-itis* in medicine, and for compound members: for example, in assigning the meaning of an applied science to the combining form *-graphy*, as in *lexico-graphy*, *termino-graphy* versus *lexico-logy*, *termino-logy* for descriptive counterparts.

Allomorphy, as in German noun plurals, represents an instance of uniqueness or partial ambiguity (one-to-many relation between the same meaning and different forms). Conversely, the German superlative is expressed by *-st*, but this suffix also denotes the second-person singular of verbs.

When allomorphy combines with the signaling of different functions by the same exponent, there is non-uniqueness or multiple ambiguity—for example, in English the suffix /z/ signals third singular, plural, enclitic Saxon “genitive,” and diminutivity (as in hypocoristic *Wills*), but diminutivity is also expressed by *-ie*, *-let* and *-et(te)*, and plural can also have the form of the suffix *-en* and of umlaut (*feet*). In derivation, typical examples are the suffixes *-er* (agent and instrument and local nouns, comparative vs. agent nouns in *-ist*, *-ator*) or *-en* (forming adjectives and verbs, also a plural marker), always in competition with other suffixes (cf. Plag 2004; Dressler et al. 2006).

The importance of biuniqueness is severely restricted in the languages of the world due to conflict with the principle of economy. This may explain the existence of homophony and rampant polysemy (Dressler 1996).

3.1.7 Binarity

The parameter of binarity provides the reference unit of gradualness. In NM's view a naturalness scale consists of groups of binary markedness relations, such as masculine—feminine, present—non-present, indicative—subjunctive, active—passive, and so on (cf. Mayerthaler 1981). Binary relations are pervasive in grammar, both paradigmatically and syntagmatically, based on the binary nature of neurological information transmittance. As has been ascertained already within structuralist linguistics (see Jakobson 1971), even apparently ternary relations have usually to be split up into binary relations. Thus there is evidence such as implicative relations,

agreement neutralization between dual and plural in languages which have a dual (e.g., Slovenian and Ancient Greek, plus diachronic evidence), that the ternary opposition singular – plural – dual must be split up into the two binary oppositions: singular vs. non-singular, plural vs. dual.

In syntagmatic relations, the preferred patterning consists in concatenating one additional morpheme to one base, for example by single prefixing, suffixing, or infixing to a base, whereas in less natural and therefore much rarer circumfixing, two elements are affixed to a base. In compounding, subordinating three-member compounds usually have to be grouped into two binary relations, such as [[[three][year]][old]], where the phrase [[three][year]] represents an intermediate unit.

The parameter of binarity also plays a role in the optimal shape of words. There is a cross-linguistic preference for one morphological word to be equated with one prosodic foot, motivated by rhythmic and perceptual factors (figure-ground contrast) and evidenced by the expanse of trochaic and iambic feet in the languages of the world (see Hayes 1985; Hurch 1996; see Chapter 19). The most natural word is hence binary (disyllabic) rather than trisyllabic, polysyllabic, or monosyllabic, two syllables constituting the most natural foot. But typological differences are important.

3.1.8 Conflicts between Parameters

Since naturalness is a relative concept to be specified for each language component, naturalness conflicts between parameters either of the same grammatical component or of different components (morphology versus phonology/syntax) limit the effect of universal preferences cross-linguistically.

Thus optimality on the parameter of diagrammaticity may contradict the indexicality preference for proximity between affix and stem (§3.1.2). In expressing several meanings separately, diagrammaticity favours polymorphic word-forms, but this contradicts the preference for dissyllabic word-form.

Another conflict exists between indexicality, which favours fusional word-forms with cumulative exponents, and morphotactic and morphosemantic transparency which disfavors fusional word-forms (see §3.2.1).

Predictions for diachronic (grammar-initiated) change hold that unnatural changes can be partially explained by recourse to conflicts between parameters. Take, for example, hypercharacterization as in Middle English *child-er/child-re* > *children* where one and the same meaning of plurality, is expressed twice instead of once only. Here iconicity and morphotactic transparency of the added suffix contradict uniqueness and win out (Dressler 2003) (cf. Chapter 26) at a time when the first suffix was already unproductive, whereas the second was still productive, similar to unproductive umlaut and hypercharacterizing productive suffix in *brethr-en*.

3.2 Typological Naturalness/Adequacy

In contrast to universal “paradigmatic” and autonomous naturalness of the first subtheory, whereby preferences are isolated from each other, typological naturalness is relational. It coordinates or relates different universal naturalness parameters (see §3). For example, as to the order of suffixes, plural and case suffixes are separated in the ideal construct of the agglutinating type of language, whereas number and case are cumulatively expressed in the ideal construct of the inflecting-fusional type (cf. Skalička 1979; Dressler et al. 2006), which limits the applicability of the adjacency principle, hence morphotactic and morphosemantic transparency as well as diagrammaticity (see §§3.1.2, 3.1.8).

Or the universal preference for a biunique relation between form and meaning, which is highly weighted (and thus not reweighted) in agglutinating languages (with the effect of adding up separate biunique suffixes of, e.g., first number and then case), is reweighted at the lower level of typological adequacy in inflecting-fusional languages with the benefit of having just one cumulative inflectional suffix, e.g. which signals simultaneously number and case, as in the dative plural Turkish *ev+ler+e* versus the Ancient Greek *oik+ois* ‘to the houses.’

3.2.1 Solutions to Conflicts

Inspired by Skalička’s views on ideal language types (thus not identical with classes of languages as in traditional language typology) which consist of properties which favor (or disfavor) one another, we can reinterpret language types as (alternative) sets of consistent responses to naturalness conflicts. Since not all of the most natural options on all parameters can be combined within one language, naturalness on certain parameters must be, so to say, sacrificed for greater naturalness on others (Dressler 1985a, 1985b; Sgall 1993).

We have seen above (§3.1.8) that relative unnaturalness on the parameters of indexicality, transparency, or biuniqueness, respectively, obtains little weight and is outweighed by greater naturalness on another parameter (respectively iconicity, indexicality, transparency). This happens especially in certain language types: in agglutinating and incorporating-polysynthetic languages, naturalness on the parameter of diagrammaticity and transparency takes place at the expense of the parameter of indexicality, whereas in inflecting-fusional languages, morphotactic and morphosemantic transparency are outweighed by indexicality. By maximally reducing the distance between morphological indices and their object – in other words, between exponents and their basis – fusional word-forms with cumulative exponents are characterized by their indexicality.

Similarly, suppletion, the most unnatural option on the parameter of morphotactic transparency, originates in inflecting-fusional rather than in agglutinating languages.

3.2.2 Types

Linguistic types are conceived as ideal typological constructs which existing languages approach to a greater or smaller extent, in the sense of Skalička (1979). Not only do typological choices of the various parameters favor or disfavor each other, but there is also an interface with syntax: morphology, in the agglutinating, incorporating-polysynthetic and (strongly) inflecting-fusional type, assumes tasks which in other language types belong to syntax. For example, instances of direct versus indirect object marking are signaled morphologically by different case forms in strongly inflecting-fusional and agglutinating languages, whereas they are signaled syntactically, for example by prepositions and/or word order, in weakly inflecting or isolating languages.

The typological approach developed by NM does not hold for morphology as a whole but for subcomponents, such as verb inflection or noun inflection. For example, French and Bulgarian approach the isolating type much more in nouns than in verbs. The phenomena of one particular language are individually ordered on a parameterized typological scale: for instance, in French noun morphology the expression of number is more isolating than the expression of gender.

The isolating type has (ideally) no grammatical morphology (i.e., no morphological word class differentiation) but may have much extragrammatical morphology (ideophones, onomatopoeics) and a preference for monosyllabic words. Strongly isolating Vietnamese has no inflection nor derivation but only compounding. These characteristics favor the universal parameters of transparency and biuniqueness.

In the same vein, weakly inflecting languages, which also approach the isolating type, show also a strong preference for autonomous bases (i.e., for word-based inflection and derivation), while inflecting languages favor stems as bases, especially in inflection, and introflecting languages traditionally have a morphology based on roots (and patterns) (see Shimron 2002; Boudelaa and Marslen-Wilson 2011).

Main features of the inflecting-fusional (well represented in Latin) and agglutinating types (best represented in Turkish) have been seen in Section 3.2.1. The introflecting type (as in Classical Arabic) is quite similar to the inflecting type (Kilani-Schoch and Dressler 2005), with the exception of the root-base preference and a much richer word-formation morphology.

Finally, the incorporating-polysynthetic type emphasizes the word and the role of morphology within the word by morphologization of various grammatical categories and relations. In contrast to the agglutinating type, morphological biuniqueness and transparency are weak due to affixal homophony and multiple exponence. Some compensation is realized by incorporation of objects into verbal compounds, well known and frequent in Inuit and many Amerindian languages, comparable to the relatively rare and only bimorphemic English complex verbs such as *dish-wash*. In these languages the incorporated noun can only have the

function of an object which represents a unique relation between morphological form and meaning (cf. Chapter 25).

3.2.3 Competition

Inflectional patterns, such as inflectional classes (see §3.3.2), compete among themselves, to a greater degree in inflecting-fusional and in intro-flecting languages than in other language types, such as in the Latin verbal classes of *amāre*, *monēre*, *finīre*, *dicere*. Competition shows up also in the way Latin nouns are converted into verbs. For example, *laus* ‘praise,’ genitive *laud-is* is converted into *laud-āre* ‘praise,’ but *hymnus* ‘hymn’ into *hymn-īre* ‘to sing hymns’ and *metus* ‘fear’ into *metu-ere* ‘to fear’ (Dressler 2002).

A second-level competition occurs in overabundance (see Thornton 2011, 2012) (see Chapter 9)—in other words, when one and the same word has competing inflectional forms, such as past participles *cloven*, *cleaved*, *cleft*. Overabundance appears to be the greater, the richer the inflectional component of a language is; for example, it is greater in most Slavic declension systems than in Bulgarian, Macedonian, Romance, and Germanic declensions.

The constructs of neither the ideal isolating type nor the agglutinating type have inflection classes, which is almost the case in very isolating French noun inflection and in very agglutinating Turkish verb and noun inflection. Less agglutinating languages (e.g., Hungarian, Finnish) exhibit shallow inflection class hierarchies (Dressler et al. 2006). In word-formation, less rule competition means less paradigmatic restrictions on the productivity of a single word-formation rule, because productive rules without rivals are more productive than rules with rivals: for example, English ordinal number formation with the suffix *-th* versus competition between verb formations by the productive suffixes *-ize* and *-ate*.

Weakly inflecting-fusional systems (e.g., verb inflection in Romance languages) have more complex class hierarchies, mainly due to unproductive mini-microclasses consisting only of two or three paradigms (see §3.3.2). The more strongly inflecting a system is, the more complex its class hierarchies are and the more macroclasses and productive microclasses occur, as shown with Lithuanian, Russian, and Latin in contrast to German verb inflection (Dressler et al. 2006).

Inflectional competition violates the ideal of biuniqueness (non-canoncity in Corbett’s terms) (Dressler and Mörtz 2012), transparency, and diagrammaticity, but, together with syntactic agreement, represents a kind of compensation in terms of indexicality whenever a specific inflectional microclass typically indicates a semantic classification such as in Latin stative verbs ending in *-ēre* (e.g., *alb-ēre* ‘to be white’), or the nominal *-a* microclass being by default feminine, whereas nominative singular *-us* is by default masculine.

Beyond typology, competition also pertains to the level of system-specific naturalness/adequacy (see §3.3). For instance, whereas the nature of the

base of morphological rules is typologically distributed, with a preference for the most natural word-based inflection in agglutinating and isolating types, and for the least natural root-based inflection in the introflecting type (§3.2.2), in inflecting-fusional languages stem-based and root-based inflection and word formation are dominant.

Manova and Dressler (2005) and Manova (2011) have found a similar pattern for morphological conversion, whereby the inflecting-fusional type allows for root-based, stem-based, and word-based conversion rules: for example, in the Latin root-based verb *alb-ēre* from *alb-us* ‘white’ versus the stem-based *fini-re* from *fin-i-s* ‘end.’ In languages of the isolating and agglutinating types, conversion is word-based, as in English *a cut* derived from *to cut*.

3.2.4 Richness versus Complexity

Morphological richness can be distinguished from morphological complexity (Dressler 1999, 2011). Morphological richness consists in the quantity of productive morphological patterns (see §§2.4 and 3.3.5) and has an interface with syntax and the lexicon, whereas morphological complexity includes, in addition to the amount of morphological richness, also all unproductive morphological patterns (see Dressler 1999). The richer a system of inflectional morphology is, the more communicative tasks it takes over from the syntax and the lexicon. This is especially the case in richly incorporating-polysynthetic languages which approach closely either the ideal agglutinating or the ideal incorporating language type, in sharp contrast to the ideal isolating type (in the sense of Skalička 1979). For example, in Turkish, inflectional morphology often expresses what is expressed by prepositional phrases and secondary clauses in English.

Thus, the size of a paradigm cannot be considered as a primary criterion of complexity, as proposed by Baerman et al. (2015); it is a criterion of morphological richness dependent on the importance of inflectional morphology in the morphology-syntax interface (Dressler 1999, 2011).

In distinguishing richness from complexity NM differs from all other current models of complexity.

3.3 Language-specific/System-dependent Naturalness/ System-adequacy

The subtheory of system-adequacy (Wurzel 1984, 1987) explains apparent contradictions with universal and typological naturalness by referring to the identity of the language-specific morphological system—in other words, the typical or “normal” structural properties of a system. These structural properties form the principle of system-adequacy (Wurzel 1993: 2594).

Among competing system-defining structural properties, the most dominant ones are the most adequate (e.g., stem-based inflection in Latin vs. word-based inflection in Turkish). In Wurzel's model, dominance is equivalent to the most (type-token) frequent properties (Haspelmath 2006: 60). In Dressler's model, it refers to degree of productivity.

Thus, in the verb inflection systems of English, Dutch, German, and most Romance languages, it is a system-defining property to have just two macroclasses, one of them being dominant and thus more system-adequate. In English, this macroclass comprises all weak verbs which simply add /d/ to the base in the preterite and in the homophonous past participle. Slavic languages have more verb macroclasses (see Kilani-Schoch and Dressler 2005; Dressler et al. 2006). For the derivational morphology of English the feature [+/- Latinate] (see Plag 2004: 84) is system-defining and [-Latinate] suffixes, such as *-ness*, are dominant and more system-adequate than their [+Latinate] counterparts. Therefore *-ness* may also be attached to Latinate bases, as in *opaque-ness* instead of the Latinate variant *opac-ity*.

Since it focuses on the organization of morphological systems, the subtheory of system-adequacy is the subtheory of NM which is the most formalized and compatible with other current models of inflectional morphology such as Aronoff (1994) and Stump (2001) (Manova 2011: 40; see Chapter 17).

3.3.1 Dynamic versus Static Morphology

According to proposals by Dressler (1997, 2002, 2004, 2005; Dressler and Kilani-Schoch 2003; Dressler et al. 2003b, 2006; Kilani-Schoch and Dressler 2005), the morphological model is composed of two overlapping morphologies: input-oriented dynamic morphology, whose core is formed by productive patterns and easily accounted for by morphological rules, and static morphology, which consists in the organization of all memorized surface forms (i.e., those which have enough token frequency to have a chance of being stored in the mental lexicon).

There is a large area of overlap between the two mechanisms of dynamic and static morphology. For example, on the one hand, the inflectional paradigms of English regular weak verbs are handled by productive rules of dynamic morphology, but many findings have shown that frequent forms of frequent verbs are also stored as parts of static morphology (see Baayen 2007; Pirrelli et al. 2011). On the other hand, the inflectional forms of all unproductive weak verbs, such as *keep*, *kept*, and the forms of all strong verbs are stored as parts of static morphology, but subregular verbs of microclasses with some type frequency can also be handled by minor rules, at least at a higher level of language awareness, such as the microclass of *sing*, *sang*, *sung*. Only truly irregular verbs, such as *bring*, *brought* can be handled only by static morphology (Dressler and Kilani-Schoch 2008; Dressler 2011).

3.3.2 Implications—Inflectional Paradigms—Classes of Inflectional Paradigms

Paradigms (see Chapter 9) and inflectional classes of dynamic morphology are hierarchically organized. A clear distinction is made here between an inflectional paradigm as a set of all inflectional forms of one lemma/lexeme, be it regular or irregular (e.g., suppletive) (Wurzel 1984; Dressler and Kilani-Schoch 2003), and an inflectional class as a set of paradigms (Dressler 2002). Paradigms form classes from macroclasses down to microclasses.

An inflectional microclass is the smallest subset of any inflectional class above the paradigm, definable as the set of paradigms which share exactly the same morphological generalizations, but may differ via the application of phonological processes, in the sense of Natural Phonology. Thus, in English, all weak verbs whose preterite and past participle are formed by mere affixation of *-ed* form one microclass (the only productive one of English verbs), irrespective of whether there is phonological assimilation of /d/ to /t/ as in *work-ed* or insertion of a vowel as in *end-ed*.

An isolated paradigm is a paradigm which differs morphologically or morphophonologically from all other paradigms, such as the isolated English paradigms *go*, *went*, *gone*; *do*, *did*, *done*.

We define an inflectional macroclass differently from Carstairs-McCarthy (1994: 745). A macroclass is the most general type of class, which comprises several classes, sub(sub)classes or at least microclasses. The nucleus of a macroclass is, prototypically, a productive microclass, as in English weak verbs, but not in the macroclass of strong verbs. The hierarchical makeup of a macroclass follows the principle of default inheritance (cf. Corbett and Fraser 1993) and can be represented by a tree structure (see Chapter 18).

The notion of paradigm-structure conditions has been elaborated by Wurzel (1984, 1987), along with the notions of implications and reference forms. System-defining paradigm-structure conditions are of two kinds: non-morphological (phonological and syntactic-semantic properties such as gender, animacy, etc.) and morphological conditions (e.g., specific exponents/inflectional membership) that work implicatively and form the basis for the derivation of other morphological properties: for example, if a German noun is masculine and forms the plural with /e/, then it has /s/ in the genitive singular. These conditions build up the structure of paradigms in connecting the inflectional forms and contribute to the learnability of inflectional systems. Particular lexically specific word-forms, from which all word-forms of a paradigm can be predicted by reference to rules (see Carstairs-McCarthy 1998: 332; Finkel and Stump 2007), constitute reference forms or principal parts (Ger. *Kennform*, Wurzel 1984: 208) (see Chapter 12).

Paradigm-structure conditions determine inflectional class assignment (Wurzel 1984: 123) in that paradigms with identical paradigm structure conditions form specific inflectional classes.

The sub(sub)classes of a macroclass share at least one exclusive identical paradigm-structure condition. For instance, French macroclass I of the type *parl-er* ‘speak’ with infinitive in /e/ implies past participle as well as first-person singular simple past in /e/.

Within static morphology, inflectional classes and paradigms are less relevant. Rather, similarity relations as well as the Wittgensteinian notion of family resemblances are decisive. Families of paradigms are constituted by homomorphic similarity relations. These relations are mainly formal similarities: in other words, phonological similarities superimposed on morphological ones. In contrast to dynamic morphology, the domain of these similarities is not only microclasses but also parts of microclasses and isolated paradigms. For instance the microclass of French *mouv-oir* ‘move’ and the isolated paradigms *pouv-oir* ‘can,’ *pleuv-oir* ‘rain’ form a family due to the similarities of the indicative present, imperfect, simple past, and past participle.

The central element of these phonological affinities is the prosodic rime, (i.e., nucleus plus coda), as in French *rend-re* ‘give back,’ *pend-re* hang,’ *tend-re* ‘stretch’ rather than any other type of phonological similarity (cf. Bybee 2001). Similarities are ranked on scales determining more tightly or loosely knit families. These scales predict that the more tightly knit families should be more stable and attract by analogy isolated paradigms and small microclasses (Dressler 2002, 2003; Kilani-Schoch and Dressler 2005).

3.3.3 Allomorphy

Allomorphs correspond to the multiple surface representations of the same inflectional meaning (see Chapter 5). Allomorphy can be due to phonological rules, as in the allomorphs [s] and [ɪz] of the basic allomorph /z/ of the English noun plural and the third singular present.

Or allomorphy may be due to a morphonological rule: for instance, the English verbs *sleep*, *keep*, *deal*, *feel*, *mean* with vowel [i:] have the allomorphic past stems with [ɛ]: *slept*, *kept*, *dealt*, *felt*, *meant*. The distributed past exponents are the suffix /t/ and the vowel alternation. Stem allomorphy is here the secondary signal of the inflectional meaning, the suffix /t/ the primary.

Root/stem allomorphy must be distinguished from affixal allomorphy, as in English past tense /d/ in *pay-ed* and *work-ed* (where [t] is due to phonological assimilation) and /t/ in *mean-t*, and so on. Another affixal allomorph is *-en* in *fall-en*. In these cases of affixal allomorphy, from the basic allomorph /d/ [t] is derived by a phonological rule of voicing assimilation, whereas it is substituted by the other allomorphs *-en* and /t/ (in case of *mean-t*). Affixal allomorphy is more indexical than stem-allomorphy since it refers to a base which is present in the inflectional form whereas stem-allomorphy refers to the absent base form which it replaces. In this sense, affixal allomorphy is more natural than stem-allomorphy.

Allomorphy intrinsically violates biuniqueness (see §3.1.6). Since affix allomorphy refers to different classes of bases and stem allomorphy is a

secondary index of the forthcoming signal represented by the suffix (as primary index), the secondary index of stem allomorphy represents useful redundancy (Klaus 1968). In inflecting-fusional languages it is related to the preference for indexicality (§3.1.2), insofar as a stem alternation is a secondary index. So redundancy increases indexicality and is type-adequate in inflecting-fusional languages.

3.3.4 Regularity-Irregularity/Suppletion

Instead of dichotomous models of regularity-irregularity, NM proposes a gradual continuum of regularity, subregularity, and irregularity of inflectional patterns (see Kilani-Schoch and Dressler 2005; Dressler and Kilani-Schoch 2008, 2009; Korecky-Kröll et al. 2012) of various sizes, starting with two related distinct inflection forms up to whole inflectional paradigms and inflection classes (from microclasses up to macroclasses, see Dressler et al. 2006) (cf. the generative distinctions between major rules, minor rules, and suppletion; see Chapter 21). For example, within the English macroclass of weak verbs, the productive past tense formation by a mere addition of /d/ as in *payed* is regular, the microclass of *keep*, *kept* is subregular, and the vowel change in *say*, *said* is irregular.

Suppletion (see Mel'čuk 2000) can be graded according to the relative number of identical segments, their prosodic position, and their similarity in case of non-identity (thus degree of transparency of the preserved part).

Total suppletion refers to strongest dissimilarity between the allomorphs, such as the English *go*, *went*. Strong suppletion refers to great dissimilarity in the above-mentioned dimensions, as in the names of inhabitants of the French towns *Reims* [rɛ̃s] → *rémois* [remwa] and *Fontainebleau* [fɔ̃tenblo] → *Bellifontaine* [belifɔ̃tɛ̃] (but with opacifying positional change). Less is changed in weaker suppletion, as in the English *Glasweg-ian*, inhabitant of *Glasgow*, and in weak suppletion, as in the French *bordel-ais*, inhabitant of *Bordeaux*; weakest suppletion consists in a single change as in *paris-ien* [parizjɛ̃] from *Paris* [pari].

3.3.5 Morphological Productivity

The constitutive core property of dynamic morphology is productivity defined as the capability of using rules, such as characterizing inflectional paradigms, with new words.

Productivity within the potential system is graded according to obstacles the morphology of a new word has to overcome: the greater the obstacle, the more productive a rule must be.

- 1) The morphological integration of loan-words has to overcome foreignness and is still more difficult when alien properties (phonological shape, gender, etc.) of the loan-word have to be adapted (cf. Wurzel's 1984 secondary productivity). For example, English loan-verbs do not have a thematic vowel as productive classes of many Romance languages have,

thus a thematic vowel has to be added, as in English *to dribble* > Spanish *dribl-ar*, Italian *dribbl-are*. Or the French *chaussée* ‘road’ has been loaned into Russian as phonologically and morphologically non-integrated [šo’sel], which is not inflected, whereas the phonologically integrated derivations, the relational adjective [ša’sej]-nyj and the causative verb [ša’s]-irov-at’ are also morphologically integrated by productive word-formation rules and are inflected according to productive inflectional rules (Dressler and Ladányi 2000: 119).

- 2) Integration of loan-words with already fitting properties (Wurzel’s (1984) primary productivity) is easier, such as German *das Auto* (neuter) > Polish *auto*, where -o is the default ending of neuters and the respective microclass the most productive microclass of neuter nouns, whereas in Slovenian and (most variants of) Serbo-Croatian the corresponding neuter macroclass is still the default but is unproductive: therefore *auto* is masculine in both languages (criterion 1).
- 3) Also abbreviations are, because of being extragrammatically formed, to a certain extent foreign to the morphological system and therefore present an obstacle to the application of morphological rules, for example in conversion of *sms* ‘text message’ to French *sms-er* [esemese] and German *sims-en* ‘to send a text message,’ and derivation of potential ordinal numbers with the suffix -th as in *a-th*, *b-th*, *c-th*.
- 4) A weak sign of productivity is diachronic class shift of a paradigm or change within a derivational class, typically from a recessive or less productive to a more stable and thus more productive class (§§3.2.3, 3.3.2): Italian *il pane* ‘the bread’ > plural *i pani* > substandard *il pano*, plural *i pani*; German *neid-ig* ‘jealous’ > *neid-isch* because -isch adjectives have a weak default pejorative meaning. Such diachronic change of a lexicalized word presents a higher obstruction to a novel application of a morphological rule than applying a rule to a normal lexical word without competition with an existing derived word.

4 Interfaces and Transitions

Much emphasis has been laid in NM since the 1980s on the interface of morphology with other language components, particularly on morphonology (Dressler 1985a, 1996; Wurzel 1994), with its new branch of morphonotactics (Dressler and Dziubalska-Kołaczyk 2006) and morphosyntax (Mayerthaler et al. 1998; Leiss 2000; Orešnik 2004). Other interfaces have been opened with pragmatics (Dressler and Merlini Barbaresi 1994; Dressler and Mörtz 2012), with onomastics and other areas of extragrammatical morphology (Doleschal and Thornton 2000), and with the lexicon in terms of submorphemes (Dressler 1990) (cf. Chapter 8).

The interface between adjacent components of grammar allows transitions, as in morphosyntax (§4.1), morphonology (§4.2), and in the path from

morphology to the lexicon (§4.3). This differs from the interaction between morphology and non-adjacent components such as in the interaction between morphology and discourse (§4.4) and in morphopragmatics (§4.5), where transitions do not exist.

4.1 Morphology—Syntax

Languages differ as to the delimitation between syntax and morphology and to which transitional phenomena occur, but crosslinguistic synchronic and diachronic comparison results in a graduality of transitional phenomena where turning-points must be established in the model of each transition.

Transitional phenomena/units from plain syntactic phrases (e.g., German *die hohe-n Schule-n* ‘the tall school buildings’) to plain morphological compounds (German *die Hochschule* ‘the university,’ lit. ‘high-school’), comprise at least **multilexical units** (e.g., German *die Hohe Schule* ‘the high school’ [e.g. of horse-riding], French *pommes frites* ‘French fries,’ *cerf-volant* ‘kite’ [lit. ‘flying stag’]; see Fradin 2009)—that is, syntactic phrases having an idiomatic meaning—and **juxtapositions**, which do not fit the format of syntactic phrases, according to syntactic and possibly prosodic criteria. For instance, word insertion is not possible (lexical integrity principle) into the German *der Hohe-priester* ‘the (Jewish) high-priest’ (with main stress on the first instead of the second member), or the French *chef de gare* ‘stationmaster,’ *clair de lune* ‘moonlight,’ unless it turns the lexicalized expression into a transparent syntactic phrase (*le chef de la petite gare* ‘the master of the small station,’ *le clair de la lune* ‘the light of the moon’). A further criterion is possibility or impossibility of coreference to the non-head. Hence, *elle est neuve* ‘it (lit. she) is new’ may corefer to the non-head of *chef de la gare* but not of *chef de gare*. This scale continues from compounds to suffixoids (as in English *kin-ship*, *king-dom*) to suffixes (cf. Fliedl 1999; Dressler 2005).

Since multilexical units already have a lexical function, the development from syntax to morphology is unidirectional. This shows a preference for univerbation, which follows from the most important semiotic role of the lexicon.

A further example of such morphosyntactic studies within NM are the areal typology studies of infinitives in their transition from verbal nouns in Mayerthaler et al. (1993, 1995) and in Fliedl (1999).

Interaction between syntax and morphology may explain in affix-ordering that inflectional affixes are more peripheral than derivational affixes because they refer indexically to some other syntactic constituent in the sentence (Dressler et al. 2014).

4.2 Morphology—Phonology: Morphonology, Morphonotactics

Morphonology has been defined by Dressler (1985a, 1996) as the area of interaction between morphology and phonology with gradual synchronic

and diachronic transitions from phonological rules or processes via morphophonological rules to purely allomorphic rules. For example, Polish velar palatalization before front vowel is phonological before the most palatal vowel /i/ in *Polak* ‘Pole,’ pejorative plural *Polak-i* [polak’i], morphophonological before the less palatal front vowel /e/ only before the instrumental suffix *-em*, as in *Maks Plank-iem* ‘with Max Planck’; /k/ has changed diachronically to the affricate /ts/ in the morphophonological palatalization of the normal plural *Polac-y* ‘Poles.’ Diachronic loss of the phonological context has resulted in the morphological rule of palatalization in the imperative as in *piecz* [pjɛʃ] ‘bake!’ versus the first-person singular present *piek-ę* (Dressler 1985a).

The turning-point in the gradual cline from phonology to morphonology comes when lexical exceptions start to appear. Two examples are extragrammatical abbreviations in German and Russian, where word-final devoicing does not apply. Thus in *Log*, abbreviation of German *Logarithmus*, lack of devoicing impedes neutralization with *Lok*, the abbreviation of *Lokomotive*. Lack of otherwise obligatory word-final obstruent devoicing also occurs in the Russian extragrammatical subtractive vocatives, such as *Lid* ← *Lidia*. Many grammatical and lexical exceptions occur in the German morphophonological rule of palatal umlauting [u] → [y], [a:] → [ɛ:] in the formation of denominal adjectives with *-lich*, as in *Bruder* ‘brother’ – *brüder-lich* ‘brotherly,’ *Vater* ‘father’ – *väter-lich*. There are other typical differences between the above-mentioned transitional rules of word-final devoicing and the morphophonological rule of umlauting, for instance the amount of phonetic distance involved in the alternation which is smaller in final devoicing than in umlauting (Dressler 1985a).

Morphonotactics is the subfield of phonotactics determined by the conflictual interaction between morphological operations (prototypically morphotactic concatenation) and phonotactic preferences which creates or motivates marked phonotactic structures at morpheme-boundaries: for example, consonant clusters such as word-final [xst] in German *du lach+st* ‘you laugh,’ [fs] in English *roof+s*, or [lw] by vowel deletion in Polish adjective formation: *lew* ‘lion’ versus derived adjective *lw+i* (cf. Dressler et al. 2001; Dressler and Dziubalska-Kołaczyk 2006; Dressler 2011). When the same sequence can be both morphonotactic, as in English *cap-s*, and phonotactic, as in English *lapse*, the interaction of morphology and phonology facilitates first-language acquisition of morphonological clusters by typically developing children, whereas it renders acquisition more difficult for children with specific language impairment (Marshall and van der Lely 2012).

4.3 Morphology—Lexicon

In NM there is not a dichotomy between existence and loss of a morphological boundary, as shown in diachrony by examples such as earlier

Spanish *hijo-dalgo*, pl. *hijo-s d-algo* ‘noble man [lit. ‘son of something’] (morphosemantically opaque) and modern Spanish *hidalgo*, pl. *hidalgo-s*, and in synchrony whenever native speakers waver whether to assume a morpheme-boundary and thus an affix or not, such as in *wen-t* and *go-ne*. This means that graduality in the strength of boundaries is assumed: compound boundaries are stronger than inflectional boundaries; derivational boundaries are still weaker.

But the weakest boundary separates submorphemes from the often unanalyzable rest of the word. Cases of segmentable submorphemes are, for example, *wh*-interrogatives and relative pronouns *wh-ere* (vs. *th-ere*), *wh-ence* (vs. *th-ence*), *wh-ither* (vs. *th-iver*). The contrast between *what* and *that* is only orthographic and even semantically dubious, and *which* and *why* have no demonstrative correspondent, and are thus prototypical submorphemes. Due to sound change, *who* and its inflected forms *who-m*, *who-se*, has lost (except in orthography) its link to the preceding submorphemes, and is isolated and does not contain a submorpheme anymore—in other words, it is totally undecomposable. This is the endpoint of the cline between morphology and the lexicon (Dressler 1990; Leiss 2005). For a more extensive gradual cline between morphemes and submorphemes in Latin pronouns, see Dressler (2014b).

4.4 Morphopragmatics

Morphopragmatics is the domain of the general pragmatic meanings signaled by morphological rules. Only those morphological rules whose meaning is dependent on a pragmatic variable (speech situation, speech acts, speaker and hearer strategies, etc.) are relevant for morphopragmatics (Dressler and Merlini Barbaresi 1994; Kilani-Schoch and Dressler 1999; Dressler and Mörtz 2012). For instance, diminutive, augmentative, pejorative, and excessive formation rules, feminism in morphology, or German plural doublets show specific pragmatic meanings in addition to semantic meaning (Mörtz and Dressler 2014). For instance, the diminutives in the Italian *Mi porti una birra-etta!* = German *Bringen Sie mir ein Bier-chen!* ‘Bring me a (my usual) beer!’ does not imply a small beer but modifies the illocutionary strength of the request and presupposes a familiar relation between customer and waiter.

The scope of a pragmatic diminutive is the whole speech act but the appropriate landing-site of a diminutive suffix depends on pragmatic salience and lexical restrictions. Thus in Figaro’s aria (cavatina in Mozart’s *Le nozze di Figaro* Act I, Scene 3) the sarcastic diminutive suffix is attached to the criticized person in *Se vuol ballare signor cont-ino?* ‘Would his lordship, that count, care to dance with me?’, but the German *Graf* ‘count’ cannot take a diminutive of this sense, thus in the German translation the suffix has to attach to another noun: *Will der*

Herr Graf ein Tänz-chen nun wagen? 'lit. 'wants the Lordship count a dance-diminutive particle dare?'

4.5 Morphology—Discourse

Compounds offer a typical case of interface of morphology and discourse. There is a clear tendency towards cataphorical reference of nominal compounding in titles or subtitles of texts to nouns and phrases in the following text, in contrast to the disfavored inverse relationship. Thus a title with a (transparent) compound cross-refers cataphorically to several non-compounds in the following text, whereas the inverse is scarce. This asymmetry is, at first sight, in blaring contradiction to the universal indexical preference for anaphoric over cataphoric indexicality. This preference is overturned in text titles by a motivated markedness reversal: titles or subtitles should create expectation and tension in the reader (Dressler 2000c: 766–7; Baicchi 2004). Moreover, there is a norm for titles to be short. The property of textual condensation justifies the use of compounds in titles, because compounds exhibit morphosemantic and morphotactic condensation in comparison with quasi-synonymous phrases. This makes them adequate for the use as cataphoric as well as anaphoric indexical signantia (Dressler 2011). For the division of labour between compound heads and non-heads in the interface between morphology and discourse see 3.1.5.

5 Conclusion

We have seen that NM aims at accounting for morphological preferences in the world languages on the basis of semiotic, cognitive, and other extralinguistic principles involved in language performance.

Universal and typological predictions are made by the three subtheories of system-independent or universal naturalness, typological naturalness, and system-dependent naturalness, which evaluate morphological properties, and can be expressed on various gradual scales. Universal scales, based on semiotics, are specified on the parameters of indexicality, iconicity, transparency, biunivocity, figure and ground, and binarity. Other gradual clines are established between morphology and adjacent components of grammar, and also within morphology between compounding, derivation, and inflection, between regularity, subregularity, and irregularity/suppletion, and for degrees of productivity.

Emphasis on interfaces of morphology with other linguistic components has led to establishing the new fields of morphopragmatics, morphonotactics (as special part of morphonology) and extragrammatical morphology.

For theoretical constructs NM always searches for external evidence, especially from diachrony and psycholinguistics.

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Distributed Morphology

Martha McGinnis-Archibald

The theory of Distributed Morphology (DM) originated as an effort to address empirical problems facing both incremental and inferential theories of morphology. In the years since Halle and Marantz (1993) first laid out the architecture and mechanisms of the theory, a substantial array of results has emerged to support and build on their initial proposals. This paper explores a range of theoretical issues raised by the DM approach, and reviews an extensive, but by no means exhaustive, selection of studies that address these issues empirically. The central concept of DM is that a single generative engine governs sound/meaning correspondences, making no distinction between word-level and phrase-level syntax. This guiding principle means that syntactic evidence bears on morphological analysis, and morphological evidence on syntactic analysis; thus, important insights can be gained from investigating their interactions.

Distributed Morphology departs from the traditional notion of the Saussurean sign, which directly associates a phonological form with a meaning. Instead, the theory postulates that the stored knowledge of a language is distributed across three separate lists. One list is the Lexicon, the repository of elements that constitute the terminal nodes of a syntactic derivation. A functional morpheme, whether inflectional or derivational, corresponds to a bundle of syntactic/semantic features, while a content morpheme corresponds to a category-neutral lexical root. Phonological content is added by means of another list, the Vocabulary, whose items undergo late insertion (after Spell-out) into terminal nodes of the syntactic

I hereby express my thanks to a number of colleagues who provided comments on an outline of this paper, particularly Daniel Siddiqi and Jonathan Bobaljik. The original goal of this paper was to describe and illustrate the theoretical mechanisms of Distributed Morphology. However, following a suggestion from Jonathan Bobaljik, it developed instead into an overview of some key empirical achievements of the theory. I am immeasurably grateful to the volume editors for their patience with this more ambitious project. Due to time and space restrictions, this overview represents a somewhat arbitrary selection of informative results, rather than a comprehensive survey.

derivation. Still another list is the Encyclopedia, which associates lexical roots post-syntactically with special, non-compositional aspects of meaning.

For example, an expression like *tenacity* could be generated syntactically from a category-neutral lexical root ($\sqrt{\text{ }}$) in combination with a nominal syntactic head (*n*).¹ The Vocabulary items corresponding to the bound root ($\sqrt{\text{tenac-}}$) and the nominal head (*-ity*) would be inserted into these nodes post-syntactically, and any necessary phonological rules would apply (for example, realizing the second vowel as /æ/) to yield the surface form. An Encyclopedic meaning for the root would also be inserted post-syntactically, which would combine with the meaning of the *n* head and any other elements within *nP* to produce a compositional meaning for the nominal expression, roughly equivalent to “persistence.”

The syntax combines abstract units, lacking phonological content, to form interpretable structures. Feature bundles are phonologically abstract syntactic objects, distinct from the Vocabulary items that realize them; even a semantically vacuous feature bundle can be realized by a variety of Vocabulary items, subject to contextual allomorphy (Marantz 2013: 115, n.9). A Vocabulary item is the closest analogue in DM to the traditional morpheme: it associates a phonological exponent with an array of syntactic/semantic features. This exponent may be free, bound, or phonologically null. Unlike items from the Lexicon, which supply the content manipulated by the syntax and interpreted at Logical Form, Vocabulary items often have underspecified syntactic/semantic features, since these features serve only to match syntactic terminal nodes with their phonological exponents. Vocabulary items compete for insertion into a given terminal node; the competition is generally won by the most highly specified item whose features are a subset of those of the terminal node.² The late insertion of Vocabulary items in DM makes it possible to capture morphological identity without postulating syntactic/semantic identity. Like an incremental Lexicalist approach (such as that of Lieber 1992), DM postulates that words have internal syntactic structure. However, DM departs from the view that morphemes with phonological content are building blocks from which words are constructed in a pre-syntactic Lexicon. A Vocabulary item is, instead, a post-syntactic realization of certain syntactic/semantic features, which may be underspecified. This separation of features from their phonological realization is also found in inferential approaches (Anderson 1992; Aronoff 1994; Beard 1995).

The chapter is organized as follows. Section 1 addresses the DM principle that morphemes correspond to the terminal nodes of a syntactic structure,

¹ Distributed Morphology leaves open various possibilities for the abstract semantics of an *n* head: it may ensure simply that the nominal phrase refers to a function from individuals to truth values, or that it specifies a subtype of such individuals—for example, a quality or fact, rather than an object or an animate being.

² This is an important point of difference between DM and nanosyntax (Caha 2009; Starke 2009), which postulates that the items inserted into terminal nodes bear a superset of their features, rather than a subset.

not to idiosyncratic pre-syntactic lexical rules, or amorphous post-syntactic word-formation rules. Section 2 focuses on the late insertion hypothesis, whereby the Vocabulary items bearing phonological features are inserted into these nodes post-syntactically. Section 3 presents the DM approach to the relation between morphology, syntactic structure, and semantic interpretation.

1 Morphemes as Syntactic Nodes

Distributed Morphology postulates that complex words are not simply stored in memory, but constructed from a combination of syntactic nodes.³ This perspective derives initial plausibility from polysynthetic languages, in which a single complex word often expresses the semantic content of a full sentence. The possible combinations of morphemes in such languages is so vast that it is extremely unlikely that speakers need to store them in memory in order to use them; and word formation itself is syntactically constrained. Baker (1988, 1996) and Hale and Keyser (1993) make parallel claims about English word formation.

The claim that words are syntactically constructed has a variety of consequences. For example, it means that paradigms are epiphenomenal, as discussed in Section 1.1 (see also Boyé and Schalchli, Chapter 9 in this volume). It blocks multiple exponence arising from indiscriminate realization of the same feature, but allows contextual allomorphy within a local domain, an issue addressed in Section 1.2. Section 1.3 notes that it also allows for the possibility of zero morphology realizing syntactic terminal nodes. As Section 1.4 shows, it restricts competition and blocking to the Vocabulary items eligible to realize a given syntactic node; thus, there is no blocking between words, or between words and phrases.

1.1 Paradigm-free Morphology

If words are constructed syntactically, as DM postulates, then the paradigm space is a virtual one, derived via the generative system from the inventory of functional heads, and cross-cutting word and sentence formation. On this view, paradigms themselves play no role in morphology. The evidence suggests that this conclusion is correct. Some proposed paradigm-based theories, such as Carstairs' (1987) Paradigm Economy and Carstairs-McCarthy's (1994) No Blur principle, have been argued to be empirically unsuccessful (Müller 2007; Halle and Marantz 2008; Bonet and Harbour 2012). Bobaljik (2002a) likewise argues against Williams' (1994) Instantiated Basic Paradigm requirement. In more recent work, Bobaljik (2008)

³ This is not to deny that complex words can be stored in memory, as is demonstrably the case. Psycholinguistic evidence indicates that the language faculty maximizes opportunities for both storage and computation (see Libben 2006).

argues against McCarthy's (2005) Optimal Paradigms (OP) theory, under which the surface form of a word depends on the form of other words in its inflectional paradigm (see Ackerman and Malouf, Chapter 12 in this volume, for a similar claim). There would be no way to formulate such a generalization in DM, which lacks paradigms. McCarthy's OP theory is expressed by means of optimality-theoretic output-output faithfulness constraints, which are violated when a stem displays alternations within its inflectional paradigm.

For example, in Arabic, nominal stems, but not verbal stems, can end in CV:C] or CVCC], as in *xabaaz* 'baker' or *fiʔl* 'act_N' (Douaa Alkubti, personal communication). McCarthy derives this contrast from the fact that verbal inflections include consonant-initial suffixes, such as the second-person feminine singular *-ti*, while nominal inflectional suffixes happen to be only vowel-initial. Before a C-initial suffix, a stem ending in CV:C] or CVCC] requires phonological "repair" to avoid a super-heavy medial syllable, which Arabic phonology rules out. For example, given the verb stem *faʕa:l* 'do' (McCarthy 2005: 195), the repaired form of **faʕa:l-ti* would be *faʕal-ti*. Such metrical considerations would not apply before V-initial syllables, such as masculine singular *-a*; but, under McCarthy's analysis, the phonologically well-formed **faʕa:l-a* nevertheless appears as *faʕal-a* to avoid a surface alternation between two stem forms, *faʕal* and *faʕa:l*, as expected under OP. In other words, OP favours an overapplication of the repair strategy. Since nominal inflectional suffixes are all vowel-initial, they require no phonological repair, so a nominal stem can end in CV:C] or CVCC] without yielding alternations in its inflectional paradigm.

Bobaljik argues that the differences between Arabic verbs and nouns are tied to their syntactic category, not to the presence or absence of consonant-initial stems in their inflectional paradigm. He notes that, in Arabic, the split between phonological classes of suffixes (V-initial, and optionally C-initial) happens to coincide with the split between syntactic categories (verb and noun). In Itelmen, a similar split exists between V-initial and optionally C-initial suffixes. Here, however, the split does not coincide with the noun/verb distinction. Instead, both nouns and transitive verbs optionally take C-initial suffixes, while intransitive verbs only take V-initial suffixes. In Itelmen, sonorant consonants {m, n, ŋ, r, l, z} cannot occur medially in a consonant cluster; such clusters are repaired by epenthesis of a schwa immediately before the sonorant. Since both nouns and transitive verbs optionally take C-initial suffixes, OP predicts that overapplication of this repair strategy will occur with V-initial suffixes to avoid stem alternations in both nouns and transitive verbs. By contrast, depending on the paradigmatic ontology assumed, OP might predict epenthesis not to apply at all in intransitive verbs, since these have only V-initial suffixes.

These predictions are not fulfilled. There is indeed overapplication of the epenthesis repair strategy—but only in verbs, not in nouns. It even applies to intransitive verbs. The overapplication of epenthesis in verbs is

illustrated in (1), where the cluster *zl* is broken up by an epenthetic schwa before a C-initial suffix (1a), but also before a V-initial suffix (1b); thus ‘You gave it’ is *zəlen*, not the phonologically well-formed **zlen*. According to Bobaljik, all verb stems with a schwa in the environment for epenthesis preserve that schwa even when the conditions requiring epenthesis are not met.

(1)	a.	t-zəl-čən	b.	zəl-en
		1sg-gave-1sg>3sg		give-2sg>3sg
		‘I gave it’		‘You gave it’

If OP were responsible for the nonalternating stem in (1), nouns would also be expected to show nonalternating stems, but they do not. The selective nature of epenthesis in nouns is illustrated in (2), where the consonant cluster **tχz* is broken up by an epenthetic schwa before a C-initial suffix (2a), but remains intact before a V-initial suffix (2b).

(2)	a.	*tχəz-xʔal	b.	*tχz-enk
		road-ABL		road-LOC

Moreover, if OP were responsible for the nonalternating stem in transitive verbs like (1), sonorant-medial clusters would also be expected to remain intact in intransitive verbs, which have only V-initial inflectional suffixes – just as CV:C| and CVCC| syllables remain intact in Arabic nouns, which also have only V-initial inflectional suffixes. Again, the prediction is not fulfilled. The examples in (3) illustrate overapplication of epenthesis in two intransitive verbs: the forms are *iləzin* and *spələzin*, not the phonologically well-formed **ilzin* and **spləzin*.

(3)	a.	il-əz-in	b.	spəl-əz-in
		drink-PRES-3sg		windy-PRES-3sg
		‘He drinks’		‘It is windy’

The evidence supports Bobaljik’s analysis that overapplication of the repair strategy in Itelmen is tied to syntactic category, rather than to the phonological characteristics of the suffixes in a stem’s inflectional paradigm. Bobaljik proposes that the same is true in Arabic, although the role of syntactic category is obscured by the overlap of the two factors. Of course, it is impossible to demonstrate the non-existence of paradigms; however, their role in the grammar has not been convincingly established.

1.2 Contextual Allomorphy

As noted above, DM postulates that words are syntactically constructed. Thus, in the simplest case, the positions of morphemes will correspond to syntactic nodes, and disjunctivity between Vocabulary items will be restricted to items competing for insertion into the same syntactic node. At the same time, the choice of Vocabulary item can be determined, not

only by the intrinsic features of the node into which it is inserted, but also by features in its local syntactic context (Noyer 1992; Embick 2010, *inter alia*). As a result, while DM only permits a given feature to be realized once, a feature on one node can also trigger contextual allomorphy on vocabulary items inserted into other nodes in its local environment.

For example, in DM, the alternating forms of the English plural shown in (4a–c) are taken to realize the same syntactic nodes – minimally, a lexical root and a node bearing number features, which has several possible morphological realizations. (4a) shows the unrestricted default plural allomorph, which is also subject to phonologically conditioned variation (as in *cat*-[s], *dog*-[z], *horse*-[əz]). (4b–c) show stem-conditioned (irregular) plural allomorphs, one of which is a zero morpheme, and one of which is an overt suffix, whose distribution is highly restricted. In DM, these irregular plural items are specified for insertion only in the context of a listed set of lexical roots. They are therefore more highly specified than the default item, and thus win the competition for insertion into the syntactic node bearing the plural feature in the context of these roots, ruling out forms such as **oxes*. Inserting one item blocks the insertion of additional items (except in cases of Fission; see Section 2.3 below), so forms such as **oxens* are also correctly ruled out.

- (4) a. *cat* ~ *cat*-s
 b. *ox* ~ *ox*-en (cf. *box* ~ *box*-es)
 c. *sheep* ~ *sheep*-Ø (cf. *beep* ~ *beep*-s)

Anderson's (1984, 1992) A-morphous Morphology (AMM) postulates instead that regular inflected forms are generated by the application of a word formation rule (WFR), while irregular forms are suppletive stems. For example, *cats* would be generated by the application of the regular plural WFR adding -s to the stem *cat*, while *oxen* would be analyzed as a suppletive plural noun. A suppletive plural stem is more highly specified than its singular counterpart, so, in a plural context, *oxen* prevents the insertion of *ox* by Pāṇinian disjunctivity; thus, overregularizations like **ox-es* are blocked. On the other hand, irregular plural suppletive stems are not listed in the same block of WFRs as the regular plural rule, so they do not directly compete with it to realize the plural feature specification. To rule out forms like **oxens*, Anderson proposes that disjunctivity also applies across WFR blocks:

- (5) When a rule R of the grammar would apply to a stem S on the basis of the features F of a given position to be interpreted, application of R is blocked, if F constitutes a subset of the lexical specifications of S.

Thus, on the AMM analysis, double-marked forms like **oxens* are ruled out because the features triggering the regular plural rule are a subset of the lexical specifications of the suppletive plural stem *oxen*.

However, as Halle and Marantz (1993) point out, affixation is often associated with irregular stem changes of the type AMM treats as

suppletive. For example, the voicing of a final stem fricative represents a subregularity in English plurals, but departs from the regular pattern of plural formation, which leaves a final stem fricative unchanged (6). On an AMM analysis, the irregular plural stems would be treated as suppletive, predicting that (like *oxen*) they will block the addition of the regular plural suffix, following (5). The prediction is not fulfilled.

- (6) a. life ~ live-s (cf. fives)
 b. bath ~ bath-s (cf. maths)
 c. house ~ house-s (cf. flounces)

On a DM analysis, double marking is possible in (6) because the lexical root does not compete disjunctively with the number-marking suffix. The plural suffix discharges the plural feature intrinsic to the node into which it is inserted, while the stem alternation is merely conditioned by this feature. Thus, DM distinguishes between the intrinsic features of the syntactic node into which a Vocabulary item is inserted, and features in its local syntactic context. In this way, DM is able to capture blocking effects, while still correctly predicting the possibility of locally conditioned contextual allomorphy.

1.3 Zero Morphology

Since syntactic nodes do not consistently correspond to overt morphology, the view that words are constructed from syntactic nodes implies the existence of zero morphology. For example, Halle and Marantz (1993) argue that some roots in English, like those in (7a–b), condition the insertion of a zero past-tense item that blocks the insertion of the regular past-tense item /-d/. Unspecified roots take the regular item instead (7c–d).⁴

- (7) a. hit ~ hit-Ø
 b. drive ~ drove-Ø
 c. knit ~ knitted
 d. sell ~ sold

In other cases, the zero allomorph is the default item in the competition for insertion. For example, Halle and Marantz argue that this is the case for present-tense marking in English: the third-person singular present-tense /-s/ is more highly specified than the zero allomorph, which occurs in all other regular present-tense environments. Halle and Marantz propose that the Tense node in English combines with the verb by a process of Merger under structural adjacency (8a). *Do*-support occurs if an intervening

⁴ The regular item is also used if a root conditioning the zero allomorph is deeply embedded within the verb's structure, like *sell* in *Alex really hard-selled those T-shirts*. A reviewer points out that such examples have been interpreted as evidence for the Lexicalist view that words are syntactic atoms — presumably on the assumption that the syntactic atom here is *hard-sell*, to which *-ed* is added by a syntax that cannot look into the internal structure of the word to identify *sell*. However, the correct results follows from locality considerations, whether words are treated as syntactic atoms or not.

element blocks this operation, as in matrix interrogatives (8b) and negated clauses (8c). *Do*-support follows the same pattern in all person/number combinations, whether or not an overt Vocabulary item is used to realize the features of Tense (9). By hypothesis, this is because the Tense node systematically merges with a structurally adjacent main verb even if it is subsequently realized by a zero item.

- (8) a. She sleep-s late.
 b. Do-es she sleep late?
 c. She do-es not sleep late.
- (9) a. We sleep-Ø late.
 b. Do-Ø we sleep late?
 c. We do-Ø not sleep late.

Another source of evidence for zero morphology concerns the relation between “rich” verb agreement in Germanic languages and overt verb movement to a higher functional projection, such as Infl (Bobaljik 2002b). In Icelandic (10a), the verb raises to Infl over negation, while in Danish (10b), it does not:

- (10) a. ...að hann keypti ekki bókina.
 ...that he bought not the.book
 ‘...that he did not buy the book’
- b. ...at han ikke købte bogen.
 ...that he not bought the.book
 ‘...that he did not buy the book’

Icelandic verbs show both tense marking and subject agreement, while Danish verbs show only tense marking:

(11)	Icelandic: <i>heyra</i> ‘hear’		Danish: <i>høre</i> ‘hear’	
	<i>Present</i>	<i>Preterite</i>	<i>Present</i>	<i>Preterite</i>
1 sg	heyr-i	heyr-ði	hør-er	hør-te
2 sg	heyr-ir	heyr-ði-r	hør-er	hør-te
3 sg	heyr-ir	heyr-ði	hør-er	hør-te
1 pl	heyr-um	heyr-ðu-m	hør-er	hør-te
2 pl	heyr-ið	heyr-ðu-ð	hør-er	hør-te
3 pl	heyr-a	heyr-ðu	hør-er	hør-te

Originally considered a biconditional, this relation between verb raising and rich agreement turns out to be a one-way implication. Languages with rich agreement have overt verb movement, but as Bobaljik notes, diachronic evidence suggests that Swedish and Danish lost rich agreement one to two centuries before they lost verb movement. Moreover, contemporary varieties such as Tromsø Norwegian and Kronoby Swedish have verb movement with little or no subject-verb agreement.

Early formulations of the rich agreement hypothesis typically make reference to paradigm structure; for example, Rohrbacher (1999) posulates that agreement is rich in the relevant sense if regular subject-verb agreement distinguishes first and second person in at least one number of one tense. Bobaljik argues that the rich agreement hypothesis requires no reference to paradigmatic structure, as expected on a paradigm-free theory like DM. Bobaljik proposes instead that agreement is rich if finite verbs bear multiple distinct inflectional morphemes. This analysis receives support from Faroese, which distinguishes first- and second-person singular, but optionally lacks verb movement—an unexpected outcome if rich agreement entails verb movement. Under Bobaljik’s analysis, however, Faroese lacks rich agreement, since its finite verbs bear only a single tense/agreement morpheme. Thus, it is correctly predicted to allow, but not require, verb movement.

(12) Faroese: *kasta* ‘throw’

	<i>Present</i>	<i>Preterite</i>
1 sg	kast-i	kasta-ði
2 sg	kasta-r	kasta-ði
3 sg	kasta-r	kasta-ði
1 pl	kast-a	kasta-ðu
2 pl	kast-a	kasta-ðu
3 pl	kast-a	kasta-ðu

Evidence for zero morphology comes from the unidirectional nature of the implicational relation between rich agreement and verb raising. Bobaljik argues that this relation receives a principled account if verb raising is mediated by “split Infl”—that is, separate functional projections for subject agreement and tense, a parametric option that also has implications for the range of available subject positions (Bobaljik and Jonas 1996; Bobaljik and Thráinsson 1998). The separation of the two projections allows for rich agreement, but does not require it, since one or both heads may be realized by zero morphology. If zero morphology were impossible, then languages without rich agreement would be incorrectly predicted to disallow main verb raising. Thus, the availability of zero morphology in DM allows it to capture important empirical generalizations about the distribution of syntactic heads.

1.4 Competition and Blocking

In DM, morphological competition involves two or more ranked Vocabulary items that are compatible with the features of a syntactic node. The highest-ranked item whose features are a subset of those of the node wins the competition and is inserted. The ranking of Vocabulary items is determined in part by featural specificity: one item is ranked above others with a subset of its features. It has been argued that a morphosyntactic feature hierarchy

affects Vocabulary ranking as well (Noyer 1992; Harley 1994). Items may also be extrinsically ordered, though this analysis implies a greater burden for acquisition.

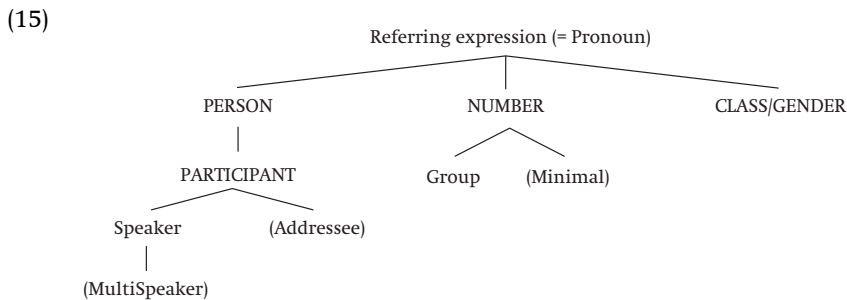
Vocabulary competition can be illustrated by person marking in Georgian (13). Georgian verbs bear a proclitic or prefix reflecting features of either the subject or object, with preference given to the highest internal argument, marked with dative case.⁵ Béjar (2003) attributes this preference to competition for syntactic agreement, which arises when the agreeing node is specified to seek a particular feature value, if available.

- (13) a. *gv-xedav* 'You see us (DAT)'
 b. *m-xedav* 'You see me (DAT)'
 c. *g-xedav* 'I see you (DAT)'
 d. *v-mušaob* 'I (NOM) work'
 e. *Ø-mušaob* 'You (NOM) work'

McGinnis (2013) proposes that the items in (14) compete for insertion into the node bearing person agreement.

- (14) a. [MultiSpeaker, DAT] ↔ /gv-/ 1pl.DAT
 b. [Speaker, DAT] ↔ /m-/ 1sg.DAT
 c. [Participant, DAT] ↔ /g-/ 2.DAT
 d. [Speaker] ↔ /v-/ 1sg.NOM
 e. [Participant] ↔ /x-/ in env. *ar* 'be' 2.NOM
 f. elsewhere ↔ Ø 2.NOM/3

This analysis assumes the feature geometry in (15) (see Harley and Ritter 2002; McGinnis 2005).



(14a) is ranked higher than (14b) because [MultiSpeaker], a corporate (plural) first-person feature, depends on the first-person feature [Speaker].⁶

⁵ "Dative" here means either dative or accusative. The two cases are morphologically identical in Georgian, and are usually glossed as dative. McGinnis (2008a) argues that dative subjects in Georgian are "internal" arguments in the relevant sense.

⁶ Treating *gv-* as the realization of [MultiSpeaker] permits a successful account of plural marking in Georgian, which is otherwise suffixal (McGinnis 2013). This feature also accounts for a cross-linguistic tendency to indicate first-person plural by means of a distinct person marker. Besides Georgian, this pattern has been reported in Semitic languages

Likewise, [Speaker] depends on [Participant], so (14b) and (14d) are ranked higher than (14c) and (14e), respectively. On Béjar's analysis, (14c) and (14d) need not be ranked morphologically, since syntactic competition for agreement allows only one. All other items outrank the default item (14f).

In DM, a word like *bent* does not block **bended*; instead, the Vocabulary item *-t* blocks the insertion of *-ed* in the context of a set of roots including $\sqrt{\text{BEND}}$. Embick and Marantz (2008) argue against blocking at the word and phrase level, revisiting Aronoff's (1976) proposal that a word like *glory* blocks **gloriosity*. They argue that the item *-ity* is inserted into a nominalizing head, in the immediate context of either a restricted set of lexical roots (as in *tenacity*) or the adjectival suffixes *-al* and *-able* (Baayen and Renouf 1996). With other lexical roots, a zero suffix may be used instead (*glory*); with *-(i)ous*, the default nominalizer *-ness* is inserted (*gloriousness*).

Similarly, Embick and Marantz (2008) argue that there is no competition between words and phrases (contra Andrews 1990; Poser 1992; Bresnan 2001; Hankamer and Mikkelsen 2002, 2005; Kiparsky 2005). For example, on their analysis, the synthetic forms of the English comparative and superlative are derived by a morphological operation, Local Dislocation, which combines the Degree node (Deg) with a phonologically adjacent adjective meeting certain phonological criteria. When the operation applies, Deg takes the synthetic form (16a); when it does not, Deg takes the analytic form. The operation applies whenever its conditions are met, so the analytic form in (16b) is ungrammatical. However, the adjective in (17a) does not meet the necessary phonological conditions, so the analytic form in (17b) appears instead. On this analysis, there is no competition between synthetic and analytic forms – only one is generated in each case, with the choice governed by the conditions on the Local Dislocation rule.

- (16) a. smarter
b. * more smart
- (17) a. * intelligenter
b. more intelligent

Poser (1992) argues that competition between words and phrases occurs only when the participating nodes form a syntactic constituent. However, Embick and Marantz (2008) demonstrate that synthetic forms can be formed from adjectives that take a complement, as in (18).⁷

- (18) a. *Raising*: John_i is [likeli-er [t_i to win the race]]. . .
b. *Control*: Mary_i is [quick-er [PRO_i to spot counterexamples]]. . .

(Noyer 1992; Halle 2000; Tourabi 2002), Yucatec Mayan (Gonzalez-Poot and McGinnis 2006), Basque (Arregi 2001), and Kadiwéu (Nevins and Sandalo 2011); a similar phenomenon occurs in Maxakalí and K'wak'wala pronouns (Harley and Ritter 2002).

⁷ Bobaljik (2012) also argues against "Poser blocking," but interprets cross-linguistic patterns of suppletion in comparatives and superlatives as evidence that the synthetic forms are generated via morphological Merger, not Local Dislocation. Matushansky (2013) argues that they are generated via head-movement.

- c. *Transitive adjectives*: Bill is [proud-er [of his accomplishments]]...
- d. *Tough-construction*: Susan is [easi-er [to understand]]...

In such cases, Deg does not form a constituent with the adjective. Nevertheless, the usual alternation arises between synthetic and analytic forms. Embick and Marantz (2008) argue that this is because the rule of Local Dislocation requires linear adjacency, not syntactic constituency, so a following complement makes no difference. Similar arguments apply to Hankamer and Mikkelsen's (2002, 2005) analysis of Danish definite determiners. In short, blocking appears to be restricted to items competing for insertion into a single syntactic node. While other approaches could stipulate such a restriction, in DM it follows naturally from the architecture of the grammar.

2 Late Insertion of Vocabulary Items

In DM, syntactic terminal nodes consist of category-neutral roots and bundles of fully specified syntactic/semantic features. Following the Spell-out operation (Chomsky 2000, 2001), featurally underspecified Vocabulary items compete for insertion into each of these bundles. Late insertion makes it straightforward to account for the observation that inflectional morphology depends on relations that are established by the syntactic component. For example, on a minimalist syntactic analysis, the third-person singular feminine pronouns in (19a) and (19b) originate in the same position. Their case, and thus their morphological form, is determined only after they have entered into an Agree relation with a higher head. The pronoun in (19a) is nominative because it Agrees with finite matrix Tense, while the one in (19b) is accusative because it Agrees with active agentive *v*/Voice.

- (19) a. He was considered to have made a crucial observation.
- b. Many considered him to have made a crucial observation.

On a Late Insertion analysis, the case-marked pronominal Vocabulary item is inserted after the Agree relation has taken place. By contrast, on a Lexicalist approach, a case-marked pronoun form must be inserted into the syntax before it is licensed or checked by Agree. This entails a more computationally complex case mechanism, involving "look-ahead" to a relation established later in the derivation, or late filtering of derivations in which the wrong pronoun form has been inserted.

This section identifies a number of domains in which Late Insertion makes successful empirical predictions. Section 2.1 outlines a morphology/syntax asymmetry: morphological form cannot influence syntactic operations, but syntactic relations can influence morphological form, even for lexical roots. Section 2.2 reviews the successful prediction that syncretism can arise from the featural underspecification of Vocabulary items,

while the syntactic nodes they realize are fully specified. Late Insertion also correctly predicts that operations before and after Vocabulary insertion will have different characteristics, as discussed in Section 2.3. On a Late Insertion analysis, the locus of idiosyncratic sound/meaning correspondences cannot be a pre-syntactic Lexicon; Section 2.4 discusses evidence that it is instead a syntactic domain, namely the local context of a lexical root.

2.1 Morphology Interprets Syntax

The DM architecture predicts that syntactic operations are blind to phonological form. Morphology interprets the syntactic derivation, rather than motivating or blocking it – although the occasional surface gap may occur, as with *stride*/**stridden* or *am*/**amn't* (Marantz 2001; Embick and Marantz 2008). Distributed Morphology maintains that any operations referring to phonological entities are post-syntactic, following Vocabulary insertion.

For example, DM conflicts with the view that zero morphology can block the construction of an otherwise grammatical structure, like a nominalized causative object-experiencer predicate (20a) (cf. Pesetsky 1995). On a DM account, the zero causative in (20a) cannot block the addition of a nominalizing head, which occurs in gerunds and “mixed” nominalizations (Chomsky 1970; Kratzer 1996; Marantz 1997). The causative head merely blocks the nominal Vocabulary item *-ance* from being inserted. The verb-attaching item *-ing* is inserted instead, yielding the grammatical (if stylistically marked) example in (20b).

- (20) a. * Our constant [[annoy- $\emptyset_{\text{CAUSE}}$]-*ance*] of Mary got on her nerves.
 b. Our constant [[annoy- $\emptyset_{\text{CAUSE}}$]-*ing*] of Mary got on her nerves.

The insertion of *-ance* is not blocked by the zero form of the causative head; Fabb (1988) claims that *-ance* never attaches outside any other suffix. An examination of online dictionary entries (using the OneLook® Dictionary Search, www.onelook.com) supports the claim: although hundreds of roots combine with verb-defining suffixes such as *-ize*, *-ify*, and *-en*, there are virtually no examples of the form $\sqrt{\text{root}}\text{-[suffix]-ance}$.⁸ In any case, the facts support the core prediction of Late Insertion, that the phonological form of a morpheme will neither license nor block syntactic operations.

If Vocabulary items are inserted into functional categories post-syntactically, it is a separate question whether the same is true for lexical roots. Marantz (1995) proposes that the syntax manipulates only one type of lexical root, whose phonological and Encyclopedic content is inserted late. Other authors maintain that individual lexical roots are present in the

⁸ An isolated exception is *cognizance*. Given the general impossibility of adding *-ance* to *-ize*, it is reasonable to analyze this example as involving a monomorphemic root *cognize*, not complex *cogn-ize*. Historically, the Oxford English Dictionary identifies *cognize* as a back-formation from *cognizance*, which developed from an Old French stem *conniss-*, not from a stem with *-ize*. The suffix *-ance* also attaches to one stem ending in *-ific-* (*significance*); it is unclear whether this ending is suffixal, or part of the root.

syntax with their phonological features intact (Embick 2000; Embick and Halle 2005). The timing of root insertion is connected with the analysis of irregular phonological alternations in lexical roots. In A-morphous Morphology, as discussed in Section 1.2, all irregular stem alternations are treated as cases of suppletion. Such an approach provides no account of the phonological subregularities in *knife/knives*, *lead/led*, and so forth. Nevertheless, there is some debate in the DM literature as to whether irregular alternations in lexical roots arise from suppletion (Siddiqi 2009) or phonological readjustment rules (Halle and Marantz 1993; Embick and Halle 2005). In DM, suppletion arises from post-syntactic competition for Vocabulary insertion. Thus, root suppletion is possible only if root items are inserted late. If root items are inserted early, then irregular variation in lexical roots must arise from readjustment rules; true suppletive items, like *be/were* and *go/wen-t*, must correspond to functional categories with abstract featural content, not lexical roots with Encyclopedic content.⁹

Credible evidence for root suppletion exists, for example in the Uto-Aztecan language Hopi (Haugen and Siddiqi 2013; see also Paster, Chapter 5 in this volume). Number marking in Hopi nominals is regularly marked by affixation, as (21) illustrates (Hill and Black 1998: 870).

(21)

	SINGULAR	DUAL	PLURAL
‘person’	sino	sinot	sinom
‘horse’	kawayo	kawayot	kawayom
‘Navajo’	Tasavu	Tasavut	Tasavum

As (22) illustrates, the plural form of some roots is indicated both by affixation and suppletion – and sometimes by reduplication, another regular plural marking (Hill and Black 1998: 865). Haugen and Siddiqi argue that these nominals, particularly *pöösa* ‘house mouse,’ are unlikely to be functional morphemes.

(22)

	SINGULAR	DUAL	PLURAL
‘woman’	wùuti	wùutit	momoyam
‘boy, young man’	tiyo	tiyot	tootim
‘house mouse’	pöösa	pöösat	pövöyam

Many Hopi verbs also show suppletion conditioned by a plural argument, for example between *wunima* (sg/du) and *tiiva* (pl) ‘be dancing.’

Within the DM framework, if suppletion applies to lexical roots, this implies that they are inserted post-syntactically, like functional items.¹⁰ If

⁹ There is some evidence that these verbs constitute functional categories. Like an auxiliary verb, copula *be* raises to a position before negation. It has been argued that *go* serves as an aspectual head in expressions like *Go jump in the lake!* (Jaeggli and Hyams 1993, *inter alia*).

¹⁰ The suppletion facts also suggest that Vocabulary insertion is conditioned by the root’s Encyclopedic content. Otherwise, suppletive root items would incorrectly block nonalternating root items; for example, if the item *√pöösa*

so, then in any given case, irregular stem alternations can be analyzed either as suppletion or as phonological readjustment, depending on the facts. Indeed, Harley and Tubino Blanco (2013) argue that readjustment rules do apply in Hiaki. In any case, the available evidence appears to support the hypothesis that all phonological content is inserted post-syntactically.

2.2 Underspecification of Vocabulary Items

Perhaps the strongest evidence for Late Insertion is its ability to capture syncretism effectively. Syncretism often arises in the absence of matching morphosyntactic features. Under Late Insertion, syntactic terminal nodes are specified with the features required for syntactic operations and semantic interpretation; however, the Vocabulary items that realize these terminal nodes can be underspecified. Thus, the same item can be inserted into featurally distinct nodes without postulating homophony.

This property is illustrated by Halle and Marantz's (1994) analysis of Spanish pronominal clitics (see also Bonet 1991; Harris 1996). In Latin American Spanish, second-person plural pronouns are systematically realized as third-person masculine plural pronouns. To capture this syncretism, Halle and Marantz propose an Impoverishment rule that deletes the second-person feature in the context of a plural feature. Third-person Vocabulary items lack person specifications, so they can be inserted into the Impoverished node.¹¹

As an added complexity, while third-person dative pronouns are usually realized as singular *le* or plural *les*, in the local environment of an accusative pronoun they are realized as the default clitic *se*. The second-person plural dative pronoun is also subject to this alternation, as shown in (23).

- (23) *Se* *lo* *di*.
 2pl.DAT 3.ACC gave
 'I gave it to you (pl)' (also: 'I gave it to him/her/them')

Halle and Marantz account for the alternation with a second Impoverishment rule, which deletes dative Case from a pronoun in the local context of an accusative pronoun. The usual third-person forms (such as *le/les*) can only realize a pronoun with an intact Case feature, while *se* is a default item that lacks person, number, and Case specifications. Thus, when dative Case is deleted, *se* is inserted.

'house mouse' is contextually specified for a [Minimal] feature, present in the singular and dual (Harley and Ritter 2002; cf. Cowper 2005), in these contexts it would block the unspecified item */kawayo* 'horse.'

¹¹ This discussion glosses over important details of the analysis, in particular the treatment of clitics as a combination of Vocabulary items; for example, *les* involves three items, */-e-s* (Harris 1996).

A Late Insertion analysis makes it possible to account for the surprising distribution of third-person pronouns in Latin American Spanish without postulating accidental homophony. By contrast, in an incremental Lexicalist framework such as that of Lieber (1992), the lexicon of Latin American Spanish would need to include at least five entries for *se*, including the third-person reflexive *se*, a second-person plural reflexive *se*, singular and plural third-person dative non-reflexive *se* items used only in the context of an accusative pronoun, and a second-person plural dative non-reflexive *se* used only in the context of an accusative pronoun.¹² Spanish *se* also has a variety of other uses – for example, with impersonal passives, nominative impersonal *se*, and unaccusatives (Aissen and Perlmutter 1976). This wide distribution is correctly predicted by the DM account, which treats *se* as a default element, but would require additional stipulations on a Lieber-style Lexicalist account. In short, Late Insertion effectively captures both morphological syncretisms and their underlying distinctions.

2.3 Operations Before and After Vocabulary Insertion

Distributed Morphology predicts that any operations that precede Vocabulary insertion, such as morphological Merger (lowering) or Impoverishment, target abstract syntactic/semantic features within structurally defined domains. By contrast, post-insertion operations include readjustment rules that refer to sets of Vocabulary items, and operations like Local Dislocation, which applies under phonological rather than structural adjacency (Embick and Noyer 2001).¹³

Bobaljik (2000) argues that Vocabulary insertion itself proceeds step by step, from the root outward. As a consequence, only the syntactic/semantic features of an outer node can influence contextual allomorphy on an inner node, while the choice of Vocabulary item for an inner node can influence contextual allomorphy on outer nodes.¹⁴ As Bobaljik shows, evidence for the root-outward analysis can be found in Bulgarian examples discussed by Stump (1997). The person and number features of the subject condition an alternation in the aorist tense suffix ($-x/\emptyset$), even though the subject agreement suffixes, underlined in (24), are outside tense. Crucially, the alternation in the tense allomorph is conditioned by the features, not the phonological realizations, of the person/number suffixes. Thus, the $-x$ allomorph co-occurs with a variety of different subject agreement suffixes, one of which ($\emptyset$) is also compatible with the $\emptyset$ tense allomorph.

¹² In an inferential-realizational Lexicalist model, Aronoff (1994) instead attributes such phenomena to a level of representation he calls the *morphome* (see O'Neill, Chapter 10 in this volume).

¹³ Embick and Noyer (2001) and Arregi and Nevins (2012) offer different accounts of the order of morphological operations.

¹⁴ Svenonius 2012 argues for phase-by-phase insertion, rather than root-outward insertion.

(24) Aorist of *pek*- ‘bake’ and *igra*- ‘play’

	Singular	Plural	Singular	Plural
1st person	pék-o-x-Ø	pék-o-x-me	igrá-x-Ø	igrá-x-me
2nd person	pék-e-Ø-Ø	pék-o-x-te	igrá-Ø-Ø	igrá-x-te
3rd person	pék-e-Ø-Ø	pék-o-x-a	igrá-Ø-Ø	igrá-x-a

The timing of particular morphological operations is a matter of some debate in the DM literature. For example, Halle and Marantz (1993) propose that an operation of Fission can apply post-syntactically, to split one syntactic node into a pair of sister nodes. Halle and Marantz (1993) treat Fission as applying before Vocabulary insertion, but Halle (2000) argues instead that Fission is interleaved with insertion. Evidence for the latter approach comes from Yucatec Mayan (Gonzalez-Poot and McGinnis 2006). Yucatec transitive verbs are typically described as conforming to the morphological template in (25) (Krämer and Wunderlich 1999, *inter alia*):

(25) [Aux-AGR_{SBJ} [[[[Verb] Voice] Aspect] AGR_{OBJ}] AGR_{SBJ}]]

The template postulates that object agreement precedes subject agreement. This analysis makes the correct predictions for the examples in (26), but not for other examples.

- (26) a. k-a w-á:nt-ik-oʔon-é:f
 IMPV-2.ERG PSE.ERG-help-INCOMPL-1.NOM.pl-2.ERG.pl
 ‘You (pl) help us’
 b. k-u j-á:nt-ik-é:f-oʔob
 IMPV-3.ERG 3.ERG-help-INCOMPL-2.NOM.pl-3.ERG.pl
 ‘They help you (pl)’

In (26b), second-person object agreement precedes third-person subject agreement, as predicted by the template. However, the same suffix order occurs even when the subject is second-person (triggering ergative agreement on the auxiliary) and the object is third-person, as in (27a). Here the object-subject suffix order predicted by the template is impossible (27b).

- (27) a. k-a w-á:nt-ik-é:f-oʔob
 IMPV-2.ERG PSE.ERG-help-INCOMPL-2.ERG.pl-3.NOM.pl
 ‘You (pl) help them’
 b. *k-a w-á:nt-ik-oʔob-é:f
 IMPV-2.ERG PSE.ERG-help-INCOMPL-3.NOM.pl-2.ERG.pl
 ‘You (pl) help them’

Gonzalez-Poot and McGinnis (2006) argue that the order of suffixes in (26) and (27) is determined, not by syntactic roles, but by featural specifications. The items in (28) compete for insertion into an agreement node that bears the features of both the subject and the object.¹⁵ The most specified item

¹⁵ Gonzalez-Poot and McGinnis use Halle’s (2000) binary features, not the privative features adopted here.

compatible with the features of the agreement node is inserted, and the features it discharges are deleted from the node. Any undischarged features fission off to create a sister node into which the remaining items compete for insertion. Thus, *-é:f* and *-oʔob* are always inserted in the same order, regardless of grammatical roles.

(28)	<i>/-oʔon/</i>	↔	[PARTICIPANT, SPEAKER, nom]	1pl.nom
	<i>/-é:f/</i>	↔	[PARTICIPANT, GROUP]	2pl
	<i>/-oʔob/</i>	↔	[GROUP]	3pl
	<i>-Ø</i>	↔	[]	elsewhere

The examples in (27) also provide evidence for the interleaving of Fission with Vocabulary insertion. If the subject features were to fission onto a separate (rightward) node before Vocabulary insertion, then each node would then undergo Vocabulary insertion separately, and the third-person plural item would precede the second-person one, as in the ungrammatical (27b). If, instead, Fission applies to the features remaining after Vocabulary insertion into the node, the correct results in (27a) are obtained.

Late Insertion of Vocabulary items correctly predicts that pre-insertion operations refer only to abstract syntactic/semantic objects, while post-insertion operations may also refer to the morphological or phonological specifications of particular Vocabulary items. It is not clear how an early insertion theory could account for this distinction.

2.4 Cyclicity and Domains

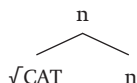
As a Late Insertion theory, DM rejects the Lexicalist view that the sound and meaning of complex words are stored or constructed in a pre-syntactic lexicon, and seeks alternative accounts of the empirical observations that motivated the Lexicalist hypothesis (see Anderson, Chapter 21 in this volume). For example, the form and meaning of the derived nominalizations in (29) vary idiosyncratically from those of the corresponding verbs (Chomsky 1970), while the form and meaning of gerundive nominalizations (*my laughing*, *my marrying*, *my constructing*, etc.) are predictable.

- (29) *laughter, marriage, construction, actions, activities, revolution, belief, doubt, conversion, permutation, trial, residence, qualifications, specifications*

In DM, this distinction between idiosyncratic and transparent morphology is attributed, not to a lexicon/syntax split, but to syntactic locality domains.

Distributed Morphology adopts Chomsky's (1970) proposal that open-class words contain a category-neutral lexical root (Marantz 1997, 2001). While Chomsky proposes that the root is inserted into a categorized syntactic node such as N or V, DM maintains that the root combines syntactically with a category-defining functional head such as *n* or *v* (see also Pesetsky 1995; Borer 2013). Thus, the noun *cat* is analyzed as syntactically complex, consisting of a root and a category-defining *n* (30).

(30)



There is evidence for distinct “inner” and “outer” domains of a lexical root. The distinction corresponds to one conception of productivity, corresponding to the variety of lexical roots compatible with a given affix (see Dal and Namer, Chapter 4 in this volume, for other conceptions). Unproductive items—those restricted to a small class of lexical roots—are inserted in the inner domain, while items inserted in the outer domain are unrestricted by the choice of root, and thus are comparatively productive. Arad (2003) postulates that the inner domain contains the root and a root-attached category-defining head; any category-defining head outside this domain is in the outer domain (see also Embick and Marantz 2008). The inner domain defines a context in which a root can be assigned an idiosyncratic Encyclopedic meaning, and can condition the choice of Vocabulary item realizing the category-defining head. This analysis correctly predicts the contrast between gerunds and derived nominalizations. The nominalizing suffixes in (29) (*-ter*, *-age*, *-al*, *-ence*...) are root-attaching, and therefore part of the inner domain. By contrast, the gerundive suffix (*-ing*) realizes an *n* head merged in the outer domain, outside a category-defining *v* head. As such, it is correctly predicted to be both semantically regular and morphologically transparent.

On the other hand, a lexical root can condition the choice of item realizing the Tense node, which is also outside *v* (*beat-Ø*, *bough-t*, *shelve-d*). Embick (2010) proposes that the crucial distinction between gerundive nominalizations and these past tense forms is that the *n* head realized by gerundive *-ing* is the head of a phase, while the Tense head is not. This analysis draws on Marantz’s (2001) proposal that the inner domain of the root is its phasal spell-out domain, in the sense of Chomsky (2000). According to Chomsky, the domain of a phase (the complement of the phase head) is spelled out when the phase is complete, while its head and edge (specifiers and adjuncts) are not. Thus, a lexical root that adjoins to *v* will occupy the same spell-out domain as the Tense head—indeed, Tense combines with the verb in *v* via morphological Merger/lowering (Marantz 1988, 1989; Halle and Marantz 1993; Embick and Noyer 2001). Supposing that the root always adjoins to *v*, the boundary of its inner domain will be defined, not by *v* itself, but by the complement of the next higher phase head. Thus the *vP* complement of the gerundive *n* phase head will be the inner domain of the root, while the *n* head itself will be in the outer domain. By contrast, the non-phase head *T* will be in the root’s inner domain.

Embick argues that, within a spell-out domain, contextual allomorphy also requires phonological adjacency. If the *v* head is null, the lexical root is phonologically adjacent to *T*, so it can condition the choice of *T* item. By contrast, verbs marked with an overt verbalizing suffix (*-ize*, *-ify*, *-en*, and so forth) will

always take the default past-tense form. This prediction appears to be correct. Given that phases are complex syntactic objects, there is no obvious way to capture this analysis of contextual allomorphy in an early-insertion theory, where allomorphic choices would precede syntactic operations.

3 Syntactic Composition and Semantic Interpretation

It is a core assumption of DM that the grammatical operations involved in generating inflectional and derivational morphology are largely the same as those involved in generating arguments, adjuncts, and functional categories. This approach correctly predicts the close relationship between syntax and morphology that motivates Baker's (1985) Mirror Principle:

- (31) Morphological derivations must directly reflect syntactic derivations (and vice versa).

If the morphological derivation is largely accomplished by the syntax, no matching principle like (31) need be specified. While morphological operations and readjustment rules may partly obscure the effects of syntactic derivation, these are sufficiently constrained that morphology can be used as evidence to decide among possible syntactic analyses, and vice versa. Such an approach has solid empirical and methodological justification, as will be discussed in Section 3.1.

Unlike a lexicalist approach, which designates a pre-syntactic lexicon as a single domain for idiosyncratic sound-meaning correspondences, DM allows for the possibility of different syntactic locality domains for contextual allomorphy and contextual variation in meaning, which Marantz (2013) calls *allosemy*. There is reason to believe that this prediction is correct. Section 3.2 explores this issue.

3.1 Morphology/Syntax Interactions

The single-engine approach to word and phrasal construction correctly predicts that morphological complexity corresponds to syntactic complexity. An extended argument for this view comes from Pylkkänen (2008). Pylkkänen argues that causatives involve a functional category (a causative verbal head, *v*) that selects a particular type of constituent: a category-neutral lexical root; a higher *v*P projection; or a full VoiceP that can license an external argument. The syntactic differences between these types of causatives are indicated by their argument structures, adjunct modification possibilities, and morphological properties.

In root-selecting causatives, the caused event cannot be transitive, since the root cannot introduce an external argument. The root also cannot be modified by a manner adverb. For example, the sentence in (32a) describes a situation where Bill's awakening was grumpy; it is true only if Bill was

grumpy. On the other hand, the English root-selecting causative in (32b) can only describe a situation where John's awakening of Bill was grumpy; this sentence can only be true if John was grumpy, and can still be true even if Bill was not grumpy.

- (32) a. Bill awoke grumpily.
b. John awoke Bill grumpily.

Root-selecting causatives do not show evidence of verbal morphology between the causative morpheme and the root. For example, while Japanese verbs have inchoative morphology, root-selecting causatives show only the causative suffix, not a combination of the causative and inchoative suffixes (Jacobsen 1992):

- (33) a. ag-a-ru 'rise' ag-e-ru 'raise' *ag-a-e-ru
b. hazu-re-ru 'come off' hazu-s-u 'take off' *hazu-re-s-u
c. ta-ri-ru 'suffice' ta-s-u 'supplement' *ta-ri-s-u
d. kog-er-u 'scorch_{intr}' kog-as-u 'scorch_{tr}' *kog-er-as-u
e. ok-i-ru 'get up_{intr}' ok-os-u 'get up_{tr}' *ok-i-os-u

By contrast, the examples below illustrate the Finnish verb-selecting *-tta* causative (Pylkkänen 2008). In verb-selecting causatives, the caused event can be modified by a manner adjunct (34). Surprisingly, given the absence of VoiceP, the caused event can be interpreted as transitive. Nevertheless, the causee does not behave like an external argument, since it does not permit an agent-oriented modifier (35); it may be introduced by an applicative head (Kim 2011; Legate 2014).

- (34) Opettaja laula-tt-i kuoro-a kauniisti.
teacher.NOM sing-CAUS-PAST choir-PTV beautifully
'The teacher made the choir sing beautifully.'
(The teacher's action does not need to be beautiful.)
- (35) Ulla rakenn-utt-i Mati-lla uude-n toimistopöydä-n innokkaasti.
Ulla build-CAUS-PAST Matti-ADRESS new-ACC office.table-ACC enthusiastically
'Ulla, enthusiastically, had Matti build her a new office desk.'
* 'Ulla had Matti, enthusiastically, build her a new office desk.'

Pylkkänen shows that, in these causatives, verbal morphology can intervene between the causative morphology and the root:

- (36) a. raivo- 'rage'
b. raivo-stu- 'become enraged'
c. raivo-stu-tta 'cause to become enraged'

Finally, in phase-selecting causatives, such as the Venda causative (Pylkkänen 2008), the caused event can contain an external argument in the specifier of VoiceP, which can be modified by an agent-oriented adjunct

(37). As predicted, Voice and high applicative morphology can intervene between the causative morphology and the root (38).

- (37) Muuhambadzi o-reng-is-a Katonga modoro nga dzangalelo.
 salesman 3sg.PAST-buy-CAUS-FV Katonga car with enthusiasm
 'The salesman made Katonga *buy the car eagerly*.'
- (38) a. -tshimbila 'walk'
 b. -tshimbila-dza 'make walk'
 c. -tshimbila-el-a 'walk for'
 d. -tshimbila-e-dz-a 'make [walk for]'

Analyzing the caused event as corresponding to a syntactic constituent of a particular type correctly predicts not only the distribution of arguments and adjuncts associated with the caused event, but also the distribution of affixes associated with it. This finding strongly supports the view that word structure is syntactically derived.

Further evidence of isomorphism between morphology and syntax can be seen in Hiaki (Harley 2013). The Hiaki *-tua* causative can embed unergative and transitive predicates, as well as high applicatives. According to Pylkkänen (2008), this indicates that it is a phase-selecting causative.¹⁶

- (39) a. Uu avion ne'e-k.
 The plane fly-PPV
 'The plane flew.'
- b. Nee uka avion-ta ni'i-tua-k.
 I the.ACC plane-ACC fly-CAUS-PRF
 'I made the (model) airplane fly.'

Hiaki also has a benefactive applicative, marked by the suffix *-ria*. The beneficiary is an accusative nominal that precedes the theme, if any (40a). The Hiaki benefactive is a high applicative, in Pylkkänen's (2008) sense, as it can combine with an unergative VP (40b).

- (40) a. Inepo Hose-ta pueta-ta eta-ria-k
 I Jose-ACC door-ACC close-APPL-PPV
 'I closed the door for Jose.'
- b. U'u maaso uusi-m yi'i-ria-k
 The deer.dancer the.children-PL dance-APPL-PPV
 'The deer dancer danced for the children.'

Interestingly, Harley observes that the order of causative and applicative suffixes varies with the interpretation. When the causative suffix appears closer to the verb root, the verb expresses an applicative of a causative (41a). Note, for example, that an applicative based on the embedded predicate

¹⁶ On the other hand, Kim (2011) argues that a Korean causative can embed a high applicative, but not a full VoiceP. Her findings suggest that, in fact, some verb-selecting causatives can embed high applicatives.

alone is strange (41b), suggesting that the applicative in (41a) takes scope over the causative.

- (41) a. Nee usi-ta avion-ta ni'i-tua-ria-k.
 I child-ACC plane-ACC fly-CAUS-APPL-PFV
 'I made the (model) plane fly for the child.'
 b. # Uu avion ili usi-ta ni'i-ria-k.
 The plane little child-ACC fly-APPL-PFV
 'The plane flew for the child.'

On the other hand, when the applicative suffix appears closer to the verb root, the verb expresses a causative of an applicative (42). Note also that in (42), the applied argument follows the causee, as expected if it scopes below the causative, while in (41a) it precedes the causee. Evidently, the order of the causative and applicative suffixes in Hiaki directly reflects the relative syntactic positions of the corresponding heads and their arguments.

- (42) Nee ili usi-ta Mala-ta aa=tu'ute-ria-tua-k.
 I little child-ACC Mother-ACC it=clean-APPL-CAUS-PFV
 'I made the child [clean it for Mother].'

Although syntactic word-formation correctly derives Mirror Principle effects, Halle and Marantz (1993) emphasize that DM does not predict perfect isomorphism between morphology and syntax. In fact, they argue that the exceptions to such isomorphism constitute an argument against a Lexicalist theory of morphology constrained by the Mirror Principle, and in favour of DM, where the overlap between syntactic and morphological structure arises from their shared derivational basis, subject to additional post-syntactic morphological processes. For example, as we saw in Section 1.4, Local Dislocation can reverse the order of a pair of linearly adjacent morphological exponents following Vocabulary insertion (Embick and Noyer 2001). Phonologically motivated infixation can also yield mismatches between syntactic structure and morpheme order.

A Bantu language, Cibemba, provides evidence for such a reordering operation in applicative causatives. Cibemba has two types of causatives; I focus here on the short causative, which has been analyzed as involving an underlying superclosed vowel *-i* that triggers mutation (spirantization) of a preceding consonant (Kula 2002). Mutation on the root is shown in (43), while mutation on the "intransitive reversive" suffix *-uk* is shown in (44) (Hyman 2003).

- (43) -lub- 'be lost' -luf-i- 'lose'
 -fiit- 'be dark' -fiis-i- 'darken'
 -buuk- 'get up' -buus-i- 'get (someone) up'
- (44) -kak-uk- 'become untied' -kak-us-i- 'cause to become untied'
 -ang-uk- 'be light' -ang-us-i- 'make light'
 -sup-uk- 'be quick' -sup-us-i- 'quicken'

Interestingly, in an applicative (45), both the applicative suffix and the root show mutation. In such cases, Hyman argues that the causative suffix attaches directly to the root, triggering the first mutation. The applicative suffix then attaches outside it. McGinnis (2008b) postulates that the applicative suffix infixes to the left of the causative suffix to maintain CV syllable structure.¹⁷ The causative then triggers a second mutation, on the applicative suffix itself.

- (45) -lub-il- 'be lost for/at' -luf-is-i- 'lose for/at'
 -fiit-il- 'be dark for/at' -fiis-is-i- 'darken for/at'
 -buuk-il- 'get up for/at' -buus-es-i- 'get (someone) up for/at'

Mutation on a preceding root can also occur when the causative follows the reciprocal suffix *-an* (46). This is predicted if the reciprocal suffix also attaches outside the causative suffix, but infixes to its left. The reciprocal suffix itself shows no mutation, since nasals do not mutate.

- (46) pit-an- 'pass each other' pis-an-i 'make each other pass'

This analysis correctly predicts that both the root and an applicative suffix will undergo mutation even if the reciprocal suffix is present. The causative-applicative-reciprocal sequence is correctly predicted to undergo two successive operations of infixation after mutation of the root. The first will apply to the applicative suffix, yielding applicative-causative order and triggering mutation of the applicative suffix. The second will apply to the reciprocal suffix, yielding the surface reciprocal-causative order.

- (47) pit-il-an- 'pass for each other' pis-is-an-i 'make pass for each other'

On this analysis, the infixation of the applicative and reciprocal suffixes is a purely morphophonological phenomenon, with no implications for syntactic structure. DM allows for such alterations to the output of the syntactic derivation, via constrained local operations.

Reordering operations aside, however, the syntactic approach to word generation in DM predicts that morpheme order will reflect syntactic structure. Thus, most scholars in the DM tradition treat morphological systems described as templatic (see Mithun, Chapter 7 in this volume) as a *prima facie* empirical challenge for DM to address. For example, Halle and Marantz (1993) implicitly argue against the traditional templatic analysis of verbal and possessive morphology in Potawatomi, an Algonquian language; Gonzalez-Poot and McGinnis (2006) argue against Krämer and Wunderlich's (1999) templatic analysis of Yucatec Mayan verbs; and McGinnis (2013) argues against Lomashvili and Harley's (2011) templatic analysis of Georgian verbs.

¹⁷ This analysis, like Hyman's, predicts that no mutation will be triggered on the root when the causative takes semantic scope over the applicative (see McGinnis 2008b). However, Hyman provides no examples of this kind. Pytkäinen (2008) cites evidence from Givón (1976) that the Cibemba causative actually cannot take semantic scope over a benefactive applicative.

3.2 Late Insertion of Encyclopedic Meaning

In DM, Encyclopedic meaning is inserted post-syntactically into lexical roots. Since the insertion of Vocabulary items and Encyclopedic meaning are separate processes, it is not necessarily the case that contextual allomorphy and contextual allosemy will apply in the same syntactic domains. Indeed, Marantz (2013) argues that they do not.

As discussed in Section 2.4, a verb root can condition allomorphy among the items competing to realize the Tense node. Nevertheless, Tense cannot condition allosemy among Encyclopedic meanings for the root: a verb has the same range of interpretations, regardless of its Tense context. Indeed, this is a key reason why tense morphology is considered inflectional, not derivational. The English past tense, then, is one case suggesting that the locality conditions on idiosyncratic form and idiosyncratic meaning diverge, contrary to the predictions of a theory in which the Lexicon constitutes the domain for both. Marantz (2013) proposes that the two locality conditions are indeed distinct, yet parallel: contextual allomorphy requires phonological adjacency, while contextual allosemy requires semantic adjacency. A phonologically null *v* head does not interrupt phonological adjacency between the verb root and T, but since it introduces an event variable, its semantic content interrupts semantic adjacency.

Marantz investigates several apparent exceptions to the generalization that only heads in the root's inner domain can condition special meanings for the root (Volpe 2005; Anagnostopoulou and Samioti 2014). He argues that these exceptions are correctly predicted by an analysis parallel to Embick's analysis of contextual allomorphy in the English past tense. First, the spell-out domain of the root includes non-phasal heads merged outside the root-attaching category head, up to (but not including) the next higher category head. Second, contextual allosemy is restricted by semantic adjacency, but is not blocked by intervening heads if they are semantically null.

As an illustration, Marantz reviews Anagnostopoulou and Samioti's (2014) discussion of Greek stative participles in *-t-os*. These stative participles allow special meanings for the root that are not present in the verbal context, even though they sometimes contain the verbalizing suffix, underlined in (48).

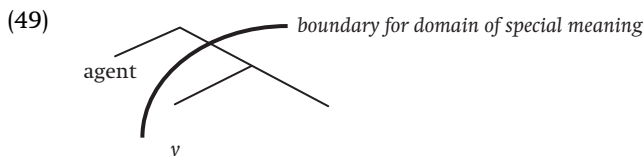
- (48)
- | | | | | |
|----|----------|------------------------|-------------|-------------------|
| a. | axn-iz-o | 'steam _v ' | axn-is-t-os | 'steaming hot' |
| b. | kol-a-o | 'glue _v ' | kol-i-t-os | 'close friend' |
| c. | xtip-a-o | 'hit _v ' | xtip-i-t-os | 'striking' |
| d. | xon-ev-o | 'digest _v ' | xon-ef-t-os | 'inside the wall' |

The stative participle morpheme *-t* usually attaches directly to the root, with no intervening verbal head. According to Anagnostopoulou and Samioti, such roots have verbal semantics, while the roots in (48) have nominal, adjectival, or uncategorized semantics. As such, these roots must be categorized as verbs in order for the *-t* participle morpheme to combine with them. If all heads outside the root-attaching category-defining head

were excluded from the inner domain of the root, the stative participial head would be expected to be unable to condition a special meaning for the root, since it is outside the *v* head. On the other hand, if the root undergoes head-movement to *v*, and the participial head is non-phasal, the two will be in the same spell-out domain—just as the verb root and Tense are in the same spell-out domain.

Yet, as noted above, the adjacency requirement on contextual allosemy prevents T from conditioning a special meaning for the verb root in English. Why, then, can a stative participle head condition a special meaning for the verb root in Greek? Anagnostopoulou and Samioti observe that stative participles lack an eventive interpretation: thus, the verbal category-defining head does not introduce an event variable. For example, when the participle *kolitos* (lit. ‘glued’) is interpreted as ‘close friend,’ it does not imply that the friend is a consequence of a glueing event (or of any event). Marantz (2013) interprets this absence of an event interpretation as evidence that the *v* head in stative participles is semantically null, playing a purely syntactic role. As such, it does not interrupt semantic adjacency between the verb’s root and the participle head. The participle head can therefore condition an idiosyncratic semantic interpretation of the root. If this analysis is correct, it means that Greek stative participles constitute only an apparent counterexample to the claim that only elements within the root’s spell-out domain can condition special root meaning.

Marantz (2013) proposes that there is a principled distinction between the root allosemy discussed above, and phrasal idioms. These too are subject to syntactic locality conditions, however. Marantz (1997) gives several arguments that the domain of idiomatic meaning can include a causative *v* head, but not an agentive external argument (49). The best-known evidence for this view is that a phrasal idiom can consist of a verb and its internal argument, but not a verb and its external argument (see Marantz 1984; Kratzer 1996). Thus, there are no idioms with a fixed agent. Idioms with fixed subjects generally turn out to be stative passives (*X’s goose is cooked*), intransitive unaccusatives (*the roof caved in on X*), or transitive clauses with non-agentive subjects, such as a theme (*the shit hit the fan*), possessor (*the cat’s got X’s tongue*), or causer of an object-experiencer predicate (*What’s eating X?*).



Marantz also notes that there are also no idioms requiring an agentive passive, though idioms requiring a stative passive do occur. Moreover, while there are causative idioms (50), and non-idiomatic causatives of

agentive VPs (51), there appear to be no causative idioms containing an agentive VP.¹⁸

- (50) a. make oneself scarce
b. make ends meet
- (51) a. make oneself face the facts
b. make the children tidy their rooms

Unlike contextual allomorphy, idiomatic meaning does not appear to be defined over spell-out domains. If the root undergoes syntactic head-movement to *v*, it will share a spell-out domain with this *v*, but not with a higher phase head. Some idioms appear to consist of a unit larger than a spell-out domain. As Marantz notes, a special meaning is possible for a complex word like *nationalize*, even though it involves at least two (presumably phasal) category-defining heads: [[[*nation*] -*al*_a] -*ize*_v] (Harley 2014). This suggests that, while phasal spell-out domains are the units relevant for contextual allomorphy and allomorphy, idioms are defined within a domain bounded by eventive *v*, but still potentially including multiple phases.

Marantz observes that the domain of special meaning corresponds neither to the phonological word, nor to the syntactic terminal node. Moreover, the structural aspects of meaning remain compositional even in phrasal idioms (Marantz 1997; McGinnis 2002). Thus, an internally complex noun like *transmission* cannot have the same range of meanings as a simple noun like *blick*. Similarly, an idiom like *kick the bucket* cannot simply mean *die*, since it retains the aspectual semantic properties of transitive *kick* with a singular definite object. On balance, the evidence supports the view that domains of special meaning are syntactic locality domains relative to a lexical root, rather than the domain of a pre-syntactic Lexicon.

4 Conclusion

Distributed Morphology presents a conception of the organization of the grammar that progresses beyond the traditional notion of the word as a unit of sound, meaning, and syntactic properties, stored or generated in a mental Lexicon. Nevertheless, it retains the important insight that the concatenation of morphemes is a structured, hierarchical operation, sensitive to locality conditions. Furthermore, it makes the bold hypothesis that the structures and locality domains that influence morphology are

¹⁸ Pykkänen (2008: 120–1) discusses an idiomatic causative of an unergative verb in Japanese, *nakasiru* ‘trouble’ (literally, ‘cause to cry’). She argues that it involves a root-selecting causative, which embeds neither a *vP* nor an external argument. By contrast, Bruening (2010) maintains that true agentive idioms are possible in certain circumstances, as in *fortune smiled on X*, which he analyzes as unergative (see also Ruwet 1991: 248–50). Like many unergatives, however, *smile* also permits a non-agentive reading, which may indicate an unaccusative usage.

syntactic ones. Word-level phenomena are entwined with phrase-level phenomena, and thus cannot be effectively investigated in isolation. The realization of particular syntactic structures as words or phrases varies cross-linguistically and language-internally, yet the underlying domains of contextual allomorphy and allosemy remain the same. As this chapter suggests, there has been considerable success in establishing the core empirical predictions of the DM framework, and in further clarifying the nature of the domains and operations in play. Equally importantly, DM has provided an effective set of theoretical tools for interpreting morphological and semantic evidence for syntactic structure both at and above the word level. As such, the theory's contribution extends far beyond the field of morphology.

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16

Construction Morphology

Geert Booij

1 Introduction

Morphology deals with the structure of words. Language users can assign internal structure to a word if there is a systematic correlation between its form and meaning, based on the comparison of two sets of words. Compare the following two sets of words:

- (1) a. dancer, fighter, singer, walker
- b. dance, fight, sing, walk

In the words in (1a), we recognize a verbal base (*dance*, *fight*, *sing*, *walk*) followed by the suffix *-er*, and a corresponding systematic meaning pattern ‘one who Vs,’ where V stands for the meaning of the verb. This recognition is based on a systematic form difference between the words in (1a) and those in (1b) that correlates with a systematic meaning difference: the words in (1a) have the additional form component *-er*, and the additional meaning component ‘agent of.’ Therefore, the nouns (1a) are considered deverbal agent nouns. Hence, we call these words complex, and assign an internal structure to them: [V-*er*]_N. On the other hand, there is no reason to assign internal structure to nouns like *brother* and *father* that end in the same sequence /ər/, because we cannot correlate these nouns to verbs like *to broth*, *to fath*, and so on. In other words, assignment of word structure is based on systematic paradigmatic relationships between sets of words.

Another example of a set of complex words are the English adjectives in *-less* that denote the property of being without something:

- (2) airless, beerless, breadless, colourless, spineless, wineless, wireless

These adjectives stand in a paradigmatic relationship to the nouns *air*, *beer*, *bread*, *color*, *spine*, *wine*, and *wire*, respectively. Hence, they can be assigned an internal word structure: [[*air*]_N*less*]_A, etc.

The form-meaning correlations that we observe in the words in (1a) and (2) can be represented as constructional schemas, schematic representations of morphological constructions, as in (3):

- (3) a. $\langle [x]_{Vi} \text{ er} \rangle_{Nj} \leftrightarrow [\text{Agent of SEM}_i]_j$
 b. $\langle [x]_{Ni} \text{ less} \rangle_{Aj} \leftrightarrow [\text{Property of being without SEM}_i]_j$

In these schemas, the double arrow indicates the correlation between form and meaning. By means of co-indexation the systematic relationship between form and meaning is specified. The index i in these examples serves to indicate that the meaning of the base word (SEM) recurs in that of the corresponding complex word. The index j indicates that the meaning of the construction as a whole correlates with the form as a whole. The angled brackets demarcate a constructional schema. This way of accounting for morphological patterns has been developed in the theory of Construction Morphology (henceforth CM) as outlined in Booij (2010), which is the topic of this chapter. The variables x in these schemas stand for the phonological content of the base word, and thus indicate an empty slot. When we fill this variable position with a concrete word, we get a complex word, for instance *facebook-er* based on the verb *to facebook*, or *facebook-less* based on the noun *facebook*. These words are hence instantiations of these schemas. We may refer to these fully concrete instantiations of constructional schemas as (morphological) constructs (Booij 2010).¹

Our discussion of these word formation patterns started with sets of concrete words. This is a fundamental point of the CM approach. Language users first acquire words, and only once they have acquired a sufficiently large set of words of a certain type can they conclude by abstracting morphological patterns. This pattern will be memorized beside the set of memorized words on which it is based, and the abstract pattern serves as a recipe for coining new complex words. We thus avoid the rule-list fallacy, the idea that having rules in the grammar excludes storing their outputs as well (Langacker 1987). For morphology, this idea has already been made explicit in Jackendoff (1975), who argues that word-formation rules function as redundancy rules with respect to existing, listed, complex words. This view does justice to the way language users acquire word formation patterns: first they come across individual complex words, and it is only after sufficient exposure to a number of types of a particular morphological pattern that the abstract morphological pattern can be discovered.

The form side of a construction comprises both morphosyntactic and phonological properties (in the schemas (3) these two levels have been conflated for ease of exposition). Therefore, the grammar of natural languages has a tripartite parallel architecture: phonology, morphosyntax,

¹ However, some Construction Grammarians call an individual complex word type also a “construction,” and reserve the term “construct” for individual tokens of these types (Traugott and Trousdale 2013), or for instantiations of a word formation schema that do not (yet) form part of the conventional lexicon (Hilpert 2014).

and meaning (Jackendoff 2002). The phonological representation of a complex word is not necessarily isomorphic to its morphosyntactic representation, and concerns its phonological properties. For instance, the word *dancer* has the morphosyntactic structure $[[danc]_V er]_N$, and is a phonological word that consists of two syllables of which the first carries the main stress of the word: $(\text{'dæ:n.sər})_\omega$ (the dot indicates a syllable boundary, the ω stands for “phonological word”). Note that the word-internal syllable boundary does not coincide with the word-internal morphological boundary, which is located after the /s/: $/dæ:ns-ər/$. The suffix *-er* is a cohering suffix that forms one domain of syllabification with its verbal stem. Hence, the suffix boundary is ignored in syllabification. On the other hand, the word internal boundary of English compounds coincides with a syllable boundary, as can be seen in the compound *dance-act* $[dæns.ækt]$, where the /s/ is not syllabified as the onset of the second syllable, because this compound consists of two phonological words: $(dæ:ns)_\omega (\ækt)_\omega$. These types of interface will be specified by the relevant general schemas for words with cohering suffixes and compounds respectively.

Phonological representations may also be correlated with specific morphological or syntactic constructions. That is, constructions may have holistic phonological properties, as expected in Construction Morphology (Inkelas 2014). For instance, in Ngiti, a language spoken in Congo, the plural forms of nouns that denote inalienable possession are always characterized by the tone pattern mid-high, whatever the tone pattern of the singular forms (Kutsch Lojenga 1994: 135).²

Morphosyntactic properties are the word class of the complex word, and that of its base; inflectional properties for number, tense, and aspect; agreement properties such as gender; and morphological properties such as inflectional class. For instance, the gender of a complex word may be determined by the kind of suffix it ends in, as is the case for German deverbal nouns in *-ung* that always have feminine gender.

The meaning side of a construction comprises more than one aspect: not only semantic properties (conceptual structure), but also pragmatic properties (Kiefer 1998) and discourse properties. That is, the level of meaning in a parallel architecture comprises various sublevels. A classic example of a morphologically expressed pragmatic property is that diminutive words may be used for expressing endearment, as in *doggy* and *pussy*. Discourse properties relate to text and style. For instance, Bauer et al. (2013: 235) observe that “[t]he suffix *-ster* [as used in *dealster* ‘dealer, trader,’] is more colloquial than *-er*. It appears frequently in journalistic writing, often with a jocular tone. In novel forms it often carries an undertone of admiration or approval.” Another type of morphology that has to do with the pragmatics of communication is

² This also holds for syntactic constructions. For instance, in Dogon, tonal patterns mark specific syntactic constructions, the phenomenon of “tonosyntax” (Heath and McPherson 2013).

evidentiality, the grammatical marking of the source of evidence (Aikhenvald 2004). This type of grammatical information may also acquire pragmatic meaning. For instance, in Turkish, the evidential suffix *-miş* is used to convey hearsay and inference, but can also be used to express surprise (Kiefer 1998: 278).

This array of levels of information for constructions is summarized in (4) (Croft 2001: 18):

(4) Constructions as pairings of FORM and MEANING:

form	Phonological information (phon)
	Morphological information (morph)
	Syntactic information (syn)
	Symbolic correspondence (link)
meaning	Semantic information (sem)
	Pragmatic information (prag)
	Discourse information (disc)

Morphological construction schemas have two roles: they indicate how new words or—in the case of inflection—word-forms of a certain type can be formed, and they have the function of motivation with respect to the set of existing complex words of a language, the conventional lexicon. Motivation means reduction of the degree of arbitrariness between form and meaning. In a simplex word like the verb *sing* the relation between form and meaning is completely arbitrary, but this is not the case for *singer*, whose meaning can be motivated on the basis of the meaning of its base verb and the meaning contribution of the word-formation schema.

The creation of a new complex word can be formalized as the unification of the relevant word-formation schema and the base word(s). When we unify schema (3b) with the noun *beer*, we get the adjective *beerless* with the meaning ‘without beer.’ Creating a new complex word is possible when a schema is productive, which is the case for the schemas (3): it is easy to coin a new noun in *-er* (*facebooker*, *skyper*, *whatsapp*) or a new adjective in *-less*, as an internet search will reveal, where we find recently coined adjectives such as *ageless*, *airless*, *beerless*, *bosomless*, *captionless*, *dairyless*, *spineless*, *visionless*, and *wineless* (some examples are from Bauer et al. (2013)).

When a schema is not productive, it can still have the function of motivation for the properties of a set of existing complex words. We therefore need to assign a productivity index to schemas. The issue of productivity is a complex one, and cannot be dealt with in any detail in this chapter. The degree of productivity of a schema correlates with the number of types by which it is instantiated, and in particular with the occurrence of new types of a low frequency. This gives the language user a cue that a morphological pattern can be used productively (Barðdal 2008) (see also Chapter 4).

2 Holistic Properties of Morphological Constructions

One of the motivations for using the notion “construction” in morphological analysis is that constructions, as envisaged in Construction Grammar (Hoffmann and Trousdale 2013), may have properties that do not derive from their constituents—that is, are holistic in nature. This can be deduced from the fact that bound morphemes do not have a meaning of their own. For instance, the suffix *-er* in (3a) does not carry a meaning of its own in isolation (note that there are also other bound morphemes *-er*, as in the comparative form of English adjectives). It is the constructional schema as a whole—that is, *-er* in combination with a verb—that evokes the agent meaning.

Reduplication, the repetition of words, is a prototypical example of a construction with a holistic property. For instance, Spanish nouns can be reduplicated in order to express the meaning ‘real x,’ as in *café café* ‘coffee-coffee, real coffee’ and *lana lana* ‘wool-wool, real wool’ (Feliú Arquíola 2011). Similar facts can be found in English (Ghomeshi et al. 2004)—such as *salad-salad* ‘real salad’ and *book-book* ‘real book’—and in Dutch—such as *vakantie-vakantie* ‘holiday-holiday, real holiday’ and *leuk-leuk* ‘nice-nice, really nice.’ This meaning contribution of reduplication can be accounted for in a constructional schema, as proposed in Feliú Arquíola (2011: 117) for Spanish:

- (5) $\langle [N_i N_i]_{N_j} \leftrightarrow [\text{Prototypical interpretation of SEM}_{i,j}] \rangle$

A second example of a holistic property in word formation is the use of reduplication of verbs in Romance languages for the creation of action nouns that express repeated or intense action (Italian) or instruments (French) (Thornton 2008):

- (6) *Italian*
fuggi-fuggi ‘run.away-run.away, stampede’
pigia-pigia ‘push-push, stampede’
French
coupe-coupe ‘cut-cut, machete’
pousse-pousse ‘push-push, rickshaw’

There are two holistic properties involved here. First, the category of the complex word (V) is different from that of its base words (N). Hence, the lexical category of these reduplicated nouns cannot be derived from its constituents, and is a property of the reduplication construction itself. We therefore call it an exocentric construction. Secondly, the meaning of intense activity in the Italian words, and that of repeated activity in the French words, is a type of meaning often evoked by reduplication, and cannot be derived from one of the constituents: it is the copying configuration as such that carries the meaning of intensity or repetition. Therefore, reduplication can be accounted for by schemas of the

following type, in which the form consists of two identical constituents (that carry the same index), and the meaning is specified on the right hand side of the schema:³

- (7) $\langle [V_i V_i]_{NJ} \leftrightarrow [\text{Intensive/Repetitive Action of SEM}_{ij}] \rangle$

Exocentric compounding implies the presence of a holistic constructional property. In Italian, for instance, we find compounds such as *porta-lettere* ‘carry-letters, postman’ and *carica-batteria* ‘charge-battery, battery charger’ that consist of a verbal stem followed by a noun, and function as (agent or instrument) nouns (Von Heusinger and Schwarze 2013). It is not the case that the noun constituent is the head of the compound from which its nominal character can be derived since there is no head: *porta-lettere* is not a subtype of *lettere* ‘letters.’ Similar exocentric compound constructions occur in most other Romance languages (Scholz 2012) and there are also many exocentric compounds in Mandarin Chinese (Ceccagno and Basciano 2007) and Japanese (Kageyama 2010).

Holistic properties of a construction can be observed in coercion effects. An example is the possibility of constructing comparative and superlative form of Dutch adjectives that do not denote a gradable property in their standard interpretation. For instance, the adjective *dodelijk* ‘deadly, fatal’ is normally used in an absolute sense, as in *een dodelijk ongeluk* ‘a fatal accident.’ However, it is also used in the superlative form as in:

- (8) De twintigste eeuw is een van de dode-lijk-ste eeuwen uit de geschiedenis
The 20th century is one of the dead-li-est centuries from the history
‘The 20th century is one of the deadliest centuries of history.’

Since superlative forms are only available for gradable adjectives, the adjective *dodelijk* is forced to be interpreted here as a gradable property: centuries can be put on a scale of deadliness. Thus, the superlative construction imposes the interpretation of ‘gradable property’ on the adjective *dodelijk*. The same applies to English, as in Bauer et al. (2013: 105):

- (9) [...] Mr. Jeremy looked deader than any of them.
The more pregnant that I got, the worse the beatings got.

Another example of type coercion in English is the prefixation of *un-* to stative verbs like *to see* and *to have*. In the $[un-V]_V$ construction, these verbs are coerced to denote telic achievements, as observed in Bauer et al. (2013: 375):

- (10) And once you’ve seen it, you can never unsee it.
The other big difference is once you have AIDS, you can’t unhave it.

³ See Khanjan and Alinezhad (2010); Orié (2012); Caballero and Inkelas (2013); Lúis (2013) for further discussion of reduplication as a doubling configuration in CM.

unproductive, as new verbal compounds cannot be coined in Dutch. Therefore, we need at least the following subschemas of (12) for Dutch compounds, in which these differential properties are specified:

- (13) $\langle [N_i N_j]_{Nk} \leftrightarrow [SEM_j \text{ with some relation to } SEM_i]_k \rangle$ Productive, recursive
 $\langle [A_i N_j]_{Nk} \leftrightarrow [SEM_j \text{ with some relation to } SEM_i]_k \rangle$ Productive, A = simplex
 $\langle [X_i V_j]_{Vk} \leftrightarrow [SEM_j \text{ with some relation to } SEM_i]_k \rangle$ Unproductive

A word formation schema may also have subschemas in which one of the slots is filled by a lexical item, because the use or meaning of the general schema may be conditioned by the presence of specific word constituents. If a schema contains both open and lexically filled positions, we call it a constructional idiom. In Japanese, various word formation patterns depend for their use on the presence of specific lexical items. Complex verbs can be formed by combining a verbal noun with the verb *suru* 'to do' (Kageyama 1999). Complex adjectives can be formed by combining a noun with the adjective *na* 'null, without,' as in (Kishimoto and Booij 2014):

- (14) *otonage-na-i* *darasi-na-i*
adult-null-PRS *tidiness-null-PRS*
 'childish' 'untidy'

The use of these word formation patterns depends on the presence of a specific lexical item. Hence, for the construction of the negative adjectives in (14), the following schema, a constructional idiom, is required:

- (15) $\langle [[X]_{Ni} [na]_{Aj}]_{Ak} \leftrightarrow [WITHOUT_j SEM_i]_k \rangle$

A second example of the role of specific lexical items in the use of word formation schemas comes from Dutch. The noun *gang-er* 'goer' does not occur in isolation. Yet, it can be used productively in compounds such as *kerk-ganger* 'church goer,' *congres-ganger* 'conference goer,' and *Utrecht-ganger* 'Utrecht-goer.' That is, *ganger* is a bound word, only to be used in compounds. Hence, the grammar of Dutch contains a productive N + N compounding subpattern of the following type:

- (16) $[N_i [ganger]_{Nj}]_{Nk} \leftrightarrow [[one \text{ who goes}]_j \text{ to } SEM_i]_k$

In other words, the use of the NN compound pattern depends partially on the presence of specific lexical items. Thus, it does not suffice to postulate an abstract N + N compound pattern for Dutch, and we need additional subschemas as well.

The necessity of subschemas is also shown by the phenomenon that constituents of compounds may have a specific meaning that is bound to the compound construction, and yet can be used productively (Booij 2005). For instance, in English compounds of the form $[[top]N]_N$, the noun *top* has the specific meaning 'of the highest level,' as in *top-achievement*, *top-experience*, and *top-secret*. The Dutch word *hoofd* 'head,' as in *hoofd-probleem* 'main problem' has acquired the bound meaning 'main' in compounds. This use

of *hoofd* is productive, and this is expressed by the following subschema for Dutch NN compounds:

$$(17) \quad <[[hoofd]_{Ni} [x]_{Nj}]_{Nk} \leftrightarrow [Main_i SEM_j]_k>$$

Because of their bound meaning such compound constituents are referred to as affixoids: they are not affixes, as they occur as independent words, but they are similar to affixes in having a morphologically bound meaning. Such affixoids can be the source of new affixes. For instance, the German equivalent of Dutch *hoofd*, the noun *Haupt* has developed into a prefix with the meaning ‘main,’ and the meaning of ‘head’ is now expressed by the noun *Kopf*. Another example of a word constituent that developed into an affix is the English adverb *out* which has acquired a specific meaning ‘to surpass in’ when combined with a verb, as in *outdance* ‘to surpass in dancing’ and *outperform* ‘to surpass in performance.’ This bound meaning of *out-* has become productive with adjectives and nouns as well, as shown in Bauer et al. (2013: 343):

- (18) He didn’t out-smart himself.
She soon out-Cosmoed even “Cosmo.”

The category-changing, verbalizing power of this use of *out* suggests its having become separated from the adverb *out*, and having acquired the status of a prefix.

An example from Japanese of this kind of language change is given in Namiki (2010). The original meaning of the noun *hoodai* is ‘being free and selfish.’ In present-day Japanese it has acquired the compound-specific meaning ‘at will,’ as in *tabe-hoodai* ‘to eat at will’ and *katte-hoodai* ‘to do what you want.’ Hence, we have to assume that Japanese has or had a subschema for XN compounds with the N slot filled by *hoodai*. Some grammarians of present-day Japanese therefore treat this word as a suffix, as it is no longer used as a word by itself.

The English word *bar* ‘drinking place’ has been borrowed in Chinese as the word *bā*. It occurs as the right-hand constituent of many Chinese compounds, and has acquired the more abstract meaning ‘place where some service is provided’ (Arcodia 2011). Hence, we need a specific schema

$$(19) \quad <[N_i-bā]_{Nj} \leftrightarrow [Place \text{ for } SEM_i]_j>$$

to account for this productive more abstract meaning of this word.

The necessity of subschemas for compounds is confirmed by the phenomenon of elative compounds (Booij 2010: Chapter 3; Hoeksema 2012) in which the first N functions as an intensifier, with negative or positive evaluation. Here are some Dutch examples of nominal (20a) and adjectival compounds (20b):

- (20) a. *tering-wijf* ‘consumption-wife, bitch,’ *kanker-wijf* ‘cancer-wife, bitch’
b. *reuze-leuk* ‘giant-nice, very nice,’ *bloed-serieus* ‘blood-serious, bloody serious’

The modifier nouns in these compounds do not carry their literal meaning, but a more abstract meaning of intensification, which has to be specified in subschemas for Dutch compounds, because the intensifier use of these nouns is often productive. The word *reuze* is a combination of the Dutch word for giant, *reus*, followed by a linking element *-e*. In compounds, this word has acquired the more abstract meaning ‘very’ in combination with adjectives of positive evaluation. This has led to the emergence of a new adjective *reuze* that can be used as an adjective of positive evaluation (Van Goethem and Hilgsmann 2014).⁵

4 Schema Unification

The use of a word-formation schema for coining a complex word may depend on the simultaneous use of another word-formation process. The Dutch negative prefix *on-* is attached to all kinds of adjectives including those ending in *-baar*. However, for quite a number of Dutch negative adjectives of the form *on-V-baar* there is no existing base adjective of the form *V-baar*. This is the case for adjectives such as:

(21)	<i>negative adjective</i>	<i>base verb</i>
	on-aantast-baar ‘un-assail-able’	aantast ‘assail’
	on-afwend-baar ‘un-avert-able’	afwend ‘avert’
	on-uitstaan-baar ‘un-bear-able’	uitstaan ‘bear’
	on-verslijt-baar ‘in-destruct-ible’	verslijt ‘wear out’

Adjectives such as *aantastbaar* ‘assailable’ are not ungrammatical, but they have not been coined. The same observation can be made for English adjectives of the form *un-V-able*: in quite a number of cases there is no corresponding adjective of the form *V-able*. This applies to adjectives such as *unputdownable* and *uncomeatable*: the positive adjectives *putdownable* and *comeatable* are well formed but do not belong to the established English vocabulary.

Construction Morphology provides a straightforward account of such facts: schemas can be unified, and these unified schemas can give rise to a multiply complex word without the intermediate step being necessarily available as an existing word. The form parts of the two schemas involved here can thus be unified:

- (22) $[on-A]_A + [V-baar]_A = [on [V-baar]_A]_A$

The amalgamated complex schema can give rise to this type of adjective directly, and we are not forced to assume a discontinuous affix *on . . . baar* in

⁵ Detailed studies of affixoids in some Germanic languages can be found in Ascoop and Leuschner (2006); Leuschner and Decroos (2008); Van Goethem (2008). In Hilpert (2013), Traugott and Trousdale (2013: Chapter 4), Booij and Hüning (2014), and Hüning and Booij (2014) the diachronic dimension of affixoids and the relation with grammaticalization and lexicalization are discussed.

addition to the prefix *on-* and the suffix *-baar*. A similar schema can be assumed for English adjectives of the type *un-V-able*. This analysis also holds for verbs of the type *de-caffein-ate* and *de-stalin-ize* where both the prefix *de-* and the suffix *-ate* or *-ize* are used simultaneously to create a multiply complex word, as there are no verbs *caffein-ate* and *stalin-ize*.⁶

5 Paradigmatic Relationships and Second-order Schemas

As observed in Section 1, the English deverbal nouns in *-er* (1a) stand in a systematic paradigmatic relationship to the corresponding base verbs:

- (23) dancer-dance, fighter-fight, singer-sing, walker-walk

The words in these pairs differ in their degree of morphological complexity, as the base words have one morphological constituent fewer than the corresponding derived words. However, words may also be related paradigmatically when they have the same degree of complexity. For instance, *walker* is also related to *walking*: they belong to the same word family and share a constituent *walk*. They have the same degree of morphological complexity: stem + suffix. Paradigmatic relationships are the source of paradigmatic word formation, in which a word is formed by replacing one of its constituents. For instance, English has the word family *impress*, *impression*, *impressive*. The derived noun and adjective share the verbal base *impress*. Given this word family, a language user might also assume that the *-ive* adjective has been created by replacing the suffix *-ion* with *-ive*, a morphological shortcut in establishing morphological relations between words. Given this option, (s)he may also relate *aggressive* to *aggression* in the same way, and this is in particular an option for those users of English who do not have a verb *to aggress* in their individual lexicon. Similarly, since we have triples of the type *walk-walker-walking*, we may also assume a direct relation between a noun in *-er* and a noun in *-ing*. This may give to paradigmatic word formation as in *crowd-butch-ing* ‘buying the meat of one identifiable cow together from a butcher’ based on a relationship with *butcher* and recent compounds like *crowd-funding*. This formation is possible even though there is no verb *to butch* in English with the relevant meaning, once *butcher* has been analyzed as *butch-er*. Another example is the Dutch compound *huisman*, coined on the basis of the following set of words:

- (24) vrouw ‘wife’ huis-vrouw ‘house-wife, wife without outdoor job’
man ‘husband’ huis-man ‘house-man, husband without outdoor job’

⁶ More examples of schema unification can be found in Booij (2010: 41–50).

In this example, the second constituent of *huis-vrouw* has been replaced with *man*, thus producing the specific interpretation of the compound *huis-man*.

These examples of paradigmatic word formation have a marked status, and are often seen as a case of word creation rather than word formation. However, paradigmatic word formation is quite normal in the non-native stratum of the English lexicon. Consider the following set of non-native adjectives and nouns:

- (25) *altru-ism* *altru-ist*
 aut-ism *aut-ist*
 fasc-ism *fasc-ist*
 solips-ism *solips-ist*

Note that the roots of these words do not exist as words by themselves in English. An English language user does not know what *altru*, *aut*, *fasc*, or *solips* mean in isolation. It is only the meaning of words as a whole that is accessible. However, once you know what fascism is, you also know what a fascist is—namely, an adherent of fascism. Words in *-ism* denote a philosophy, ideology, disposition, and so on, and words in *-ist* denote the corresponding person with a relation to this philosophy, ideology, or disposition. The relationship also holds in the inverse direction: autism is what an autist suffers from, fascism is the ideology of a fascist, and so forth. Hence, there is a systematic correspondence between the schema for words in *-ism* and those in *-ist* (Booij 2010: 33).

- (26) $\langle [x\text{-ism}]_{Ni} \leftrightarrow \text{SEM}_i \rangle \approx \langle [x\text{-ist}]_{Nj} \leftrightarrow [\text{person with property Y related to SEM}_i]_j \rangle$

This schema (26) is a second-order schema (Neset 2008; Kapatsinski 2013), as it is a schema of schemas. The symbol $\approx$ denotes this paradigmatic relationship. Note, however, that this schema should not be taken to imply that each word in *-ist* can have a corresponding word in *-ism*. For instance, there is no word *linguism* besides *linguist*, since there is already an alternative word, *linguistics*.

We thus see that the lexicon is a complex web of relations between words and morphological schemas: words are instantiations of schemas and may contain other words as building blocks; they are paradigmatically related in word families, and belong to morphological classes (like deverbal nouns in *-er*); schemas can be instantiated by subschemas, and there are second-order schemas as well. This makes the lexicon a well-structured whole of words and classes of words.

Second-order schemas also serve to account for bracketing paradoxes, mismatches between the form and meaning of complex words. This can be illustrated by nominalization of particle verbs in Dutch. A number of Dutch simplex verbs have an irregular form of nominalization (the

regular form is suffixation of the verb with *-ing*). Particle verbs have the same type of irregular nominalization as their base verbs. This is predicted if the nominalization of a particle verb is analyzed as the combination of the particle and the nominalized form of its base verb—that is, a nominal compound.⁷ Semantically, however, it is the nominalization of a particle verb, which often has an idiosyncratic meaning. For instance, the meaning of the particle verb *aan-val* ‘to attack’ cannot be derived from the meaning of *aan* ‘at’ and that of *val* ‘to fall.’ This idiosyncratic meaning recurs in the corresponding nominal. There is a bracketing paradox here, as the formal structure of these nouns is not isomorphic to their semantic structure. This pattern is illustrated in (27):

(27)	<i>verb</i>	<i>nominalized form</i>
a.	val ‘to fall’ aan-val ‘to attack’	val ‘fall’ aan-val ‘attack’
b.	kom ‘to come’ aan-kom ‘to arrive’	kom-st ‘arrival’ aan-kom-st ‘arrival’
c.	bied ‘to offer’ aan-bied ‘to offer’	bod ‘offer’ aan-bod ‘offer’
d.	slaan ‘to hit’ op-slaan ‘to store’	slag ‘hit’ op-slag ‘storage’
e.	geef ‘to give’ uit-geef ‘to publish’	gav-e ‘gift’ uit-gav-e ‘publication’
f.	zien ‘to see’ toe-zien ‘to survey’	zicht ‘sight’ toe-zicht ‘surveyance’

The examples (27) show that the idiosyncratic meaning of the particle verb recurs in the corresponding compound, even though the particle verb as such is not a formal constituent of these nominalizations. The mismatch can be taken care of by assuming a second-order schema that specifies the relationship between particle verbs and particle + deverbal noun compounds:

$$(28) \quad \langle [\text{Part}_i \text{V}_j]_k \leftrightarrow \text{SEM}_k \rangle \approx \langle [\text{Part}_i [\text{V}_j\text{-x}]_N]_{Nm} \leftrightarrow [\text{NOM} [\text{SEM}_k]]_m \rangle$$

In the schema on the right, NOM stands for the semantic effect of nominalization. This second-order schema thus specifies that the meaning of the particle verb is a subpart of the particle + nominalized base verb, even though particle and verb do not form a formal constituent in these nominalizations.

⁷ Another possible analysis is to assume that nominalization is a head operation that applies to the verbal heads of particle verbs. However, the relevant word formation rules are all unproductive. The nominalized forms of the simplex verbs are all stored in the lexicon. The compounding interpretation does justice to this fact: the particles are combined with stored deverbal nouns.

6 Morphological and Syntactic Constructions (Periphrastic Word Formation)

A basic idea of Construction Grammar and CM is that there is no sharp demarcation of grammar and lexicon. The lexicon contains both words and the abstract schemas that they instantiate. However, it does not suffice to only have constructional schemas for words, because various type of phrasal constructions have the same role as morphological constructions: they serve to create lexical items, conventionalized signs for denoting entities, events, or properties. They are therefore referred to as “phrasemes” (phrasal lexemes). This conclusion is in line with the general hypothesis of Construction Grammar that all kinds of constructions, both at the word and the phrase level, and their instantiations form part of the grammar. This claim is argued for in detail in Booij (2010: Chapters 4–8) as far as phrasal lexical items are concerned.

One of the phenomena discussed in that book is that of particle verbs in Dutch.⁸ Particle verbs cannot be considered as (complex) words because the two parts can be split in main clauses. The syntactic distribution of particles in main and embedded clauses is illustrated by the following two sentences with the particle verb *op-voeden* ‘lit. to up-feed, to bring up, to raise’:

- (29) a. Suzanne voedt twee kinderen op main clause
 Suzanne feeds two children up
 ‘Suzanne raises two children.n’
 b. ... dat Suzanne twee kinderen op-voedt subordinate clause
 that Suzanne two children up-feeds
 ‘that Suzanne raises two children’

These sentences show that a particle verb, a combination of a particle (adposition or adverb) and a verb, is a sequence of two words, because complex words cannot be split (the principle of Lexical Integrity, Booij (2009)) (cf. Chapter 10). Their multi-word status is also clear from their morphological behaviour. For instance, the past participle of Dutch particle verbs is different from that of prefixed verbs: the participial prefix *ge-* follows the particle, whereas prefixed verbs have a past participle without the prefix *ge-*; here is a minimal pair:

(30)		<i>verbal stem</i>	<i>past participle</i>
	particle verb	op-voed ‘raise’	op-ge-voed ‘raised’
	prefixed verb	onder-voed ‘under-feed’	onder-voed ‘underfed’

⁸ A more detailed treatment of Dutch and English particle verbs can be found in Los et al. (2012). This book also refers to the literature on particle verbs in other Indo-European languages.

More examples of phrasemes in various European languages are given by Masini (2009). These conventionalized multi-word units of various sizes are stored in the memory of language users, and this type of knowledge is an important precondition for full mastery of a language (Wray 2002). Such phrases in their turn can also feed word formation, as is the case for Russian where they are abbreviated into so-called stump compounds, for instance (Benigni and Masini 2009: 173):

(34) gorodskij sovet ‘city-_{Adj} council’ > gorsovet ‘city council’

These observations imply that phrasal constructional schemas are listed in the grammar, in combination with those instantiations of these schemas that form conventionalized lexical items. For instance, the phrasal schema [A N]_{NP} of English is instantiated by many lexical units of the type *dark room*, *red flag*, and *yellow fever*. Thus, the lexicon becomes a “constructicon,” as it contains both phrasal and morphological constructions, together with their conventionalized instantiations.

7 Inflectional Schemas

So far, this chapter has focused on the CM approach to word formation patterns. Since morphology also comprises inflection, the question is now how inflection should be accounted for. Let us take a simple case of inflection, the pluralization of English nouns. The default option is suffixation with /-z/ (a suffix with three allomorphs, [s], [z], [ɪz]). The default form part of the schema for plural nouns is therefore:

(35) $\langle [(x_i-z)_{\omega-j} \leftrightarrow [N_i, +pl]_j \leftrightarrow [PL [SEM_i]]_j] \rangle$

The schema in (35) specifies the phonological form, the morphosyntactic form (word class and the morphosyntactic feature value for number [+pl (ural)]), and the meaning of plural nouns. Recall that we need at least two formal levels of representation, the phonological level and the morphosyntactic level (Jackendoff’s tripartite parallel architecture (2002)). At the phonological level we find a prosodic word ω that consists of the string x of the stem followed by /z/. The semantic correlate of the feature [+pl] is represented here as the semantic operator PLU, which might be interpreted as ‘more than one.’ However, this is an oversimplification: in certain syntactic contexts the operator PLU may receive a generic interpretation. Consider the dialog in (36):

(36) Do you have children? Yes, one.

The answer in this dialog makes clear that the question is not whether the addressee has more than one child. If the answer had been *No*, *one*, this would have coerced the default meaning ‘more than one’ of PLU. There are also English nouns like *scissors* and *trousers* that have a plural form and

trigger the selection of plural verb forms in subject-verb agreement, but do not receive a semantically plural interpretation. Similar observations can be made for the semantic interpretation of tense features of verbs. For instance, [present tense] does not always mean ‘at the moment of speaking,’ as it can also be used in a story about the past, the so-called *praesens historicum*, in order to achieve a certain liveliness and dramatic style in one’s narrative.⁹

In most cases, a noun has a singular form. In English, this form has no overt morphological realization. Hence, the schema for singular nouns is as follows:

$$(37) \quad \langle [(x_i)_{\omega-j} \leftrightarrow [N_i, +sg]_j \leftrightarrow [SG [SEM_i]]_j] \rangle$$

This schema expresses that the stem form of English nouns (x_i) also functions as *sg* (= singular) form. Again, the SING property may require further interpretation, as it may also refer to a category of entities, not just to a single entity, in generic statements such as:

$$(38) \quad \text{A thing of beauty is a joy for ever.}$$

The correlation between singular and plural forms is expressed by a second-order schema, a combination of the schemas (35) and (37).

$$(39) \quad \begin{aligned} \langle (x_i)_{\omega-j} \leftrightarrow [N_i, +sg]_j \leftrightarrow [SG [SEM_i]]_j \rangle \approx \\ \langle (x_i-z)_{\omega-j} \leftrightarrow [N_i, +pl]_j \leftrightarrow [PL [SEM_i]]_j \rangle \end{aligned}$$

The assumption of a schema for plural nouns is motivated by the fact that plural nouns of sufficient frequency are stored in the mental lexicon, even if they are fully regular, as has been shown for Dutch and Italian (Baayen et al. 1997, 2003). That is, storage does not imply that these plural nouns are irregular, and so they will be linked to schema (35). This plural schema also has a motivating role with respect to *pluralia tantum*, nouns that only have a plural form, such as *(the) Alps*, *darts*, and *measles*. Some of these nouns trigger plural agreement on verbs; others do not. For instance, *linguistics* is a plural form but selects singular verb forms, whereas *measles* requires a plural verb form. That is, such plural forms may not possess all the properties predicted by the relevant schema. They will be linked to that schema, but we assume that default inheritance (cf. Chapter 11) applies – that is, the individual plural nouns inherit all properties from the schema unless specified otherwise in the relevant lexical entry for that plural noun.

Just like word formation schemas, inflectional schemas possess holistic properties. This can be concluded from coercion effects. Pluralization presupposes that the noun involved is a count noun. Mass nouns, abstract non-count nouns, and proper nouns can be coerced into being interpreted as count nouns with a “type of” interpretation by means of pluralization:

⁹ This point is also discussed in Booij (2012: 215), in Bauer et al. (2013: 122–3), and in Spencer (2013: 219–49).

- (40) a. cheeses, rices, wines
 b. Romanticisms, Englishes
 c. We have four Marys in our family.

In (40a) we coerce the meaning ‘type of,’ in (40b) the plural form implies that there are different types of Romanticism and English, and in (40c) we coerce the proper name *Mary* which normally has a unique referent in a specific discourse to be interpreted as ‘person with the name *Mary*.’ These forms of type coercion thus support a constructional analysis of inflectional patterns.

The concept of second order schemas is very useful for the treatment of inflection because the choice of a specific ending may depend on the choice of an ending for another form of the same word (see also Chapter 12). This can be illustrated by the way in which Italian nouns are pluralized. The basic patterns are as follows (*x* is a variable for the phonological content of the stem):

(41)	<i>singular</i>	<i>plural</i>	<i>example</i>
a.	x-a	x-e	porta ‘door’
b.	x-o	x-i	amico ‘friend’
c.	x-e	x-i	sede ‘seat’

This means that there are three inflectional classes of nouns, as far as pluralization is concerned. These three inflectional classes can be identified by their singular forms. Hence, we do not need arbitrary indices for these classes in order to select the right pluralization process for a noun, if we assume the following second-order schemas for Italian nouns (with omission of the semantic level, for ease of exposition). These schemas reflect the way in which the morphology of Italian nouns is taught in second-language education:

- (42) a. $\langle (x_i\text{-}a)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{sg}]_j \rangle \approx \langle (x_i\text{-}e)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{pl}]_j \rangle$
 b. $\langle (x_i\text{-}o)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{sg}]_j \rangle \approx \langle (x_i\text{-}i)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{pl}]_j \rangle$
 c. $\langle (x_i\text{-}e)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{sg}]_j \rangle \approx \langle (x_i\text{-}i)_{\omega\text{-}j} \leftrightarrow [N_i, +\text{pl}]_j \rangle$

The necessity of second-order schemas for the domain of inflection is obvious in the Word-and-Paradigm approach to inflection (Blevins 2006). In this approach, the forms in the cells of an inflectional paradigm are not computed on the basis of an abstract stem to which the inflectional endings are added. Instead, these forms are computed on the basis of principal parts of the paradigm. A schoolbook example is the way in which Latin noun declensions work. The nominative plural of *rex* ‘king,’ for instance, is computed by starting from the genitive singular form *reg-is*, which is the revealing form: we compute the correct form *reges* ‘kings, nominative, pl’ by replacing *-is* with *-es*.

A particular inflectional form may play two different roles in accounting for the construction of inflectional forms. First, particular inflectional

forms or a combination thereof may be used to identify the inflectional class to which a word belongs (Finkel and Stump 2007, 2009). For instance, the genitive singular form of the Latin noun *rex* ‘king,’ *reg-is*, identifies this noun as belonging to the third declension. That is, *reg-is* is a “principal part” of the inflectional paradigm of *rex*. Secondly, an inflectional form may be used to compute the form of other cells in the same inflectional paradigm (Blevins 2006; Ackerman et al. 2009). For instance, the Saami first-declension nouns exhibit a pattern based on two principal parts, the genitive singular and the nominative singular. These noun forms are subject to gradation, a phonological alternation between strong and weak forms. If the nominative singular form is strong, and hence has a geminate, the illative singular and the essive form are also strong. In that case, the genitive singular has a weak form, with a single consonant (as in *bihtttá* vs. *bihta* ‘piece, nom sg/gen sg’). Conversely, if the nominative singular form is weak, the corresponding illative singular and the essive are weak as well, whereas in that case the genitive singular form is strong (as in *bargu* vs. *barggu* ‘work, nom sg/gen sg’ (Blevins 2006: 546). In other words, morphological generalizations about such paradigms can only be made in terms of systematic paradigmatic relationships between cells of these paradigms. The relations between the nominative singular, the illative singular, and the essive can be expressed as paradigmatic correspondence relations between morphological schemas (given here in a simplified form)—that is, a second-order schema:

$$(43) \quad [x-\acute{a}]_{\text{NOM SG}} \approx [x-\acute{a}i]_{\text{ILL SG}} \approx [x-\acute{a}n]_{\text{ESSIVE}}$$

If the variable *x* stands for a strong stem with a geminate consonant, as in *bihtttá*, this geminate consonant will be predicted to recur in all three forms. Inversely, if *x* stands for a weak stem, as in *bargu*, it is predicted that this weak stem also shows up in these three inflectional forms. That is, these mutually implicative relationships between paradigm cells can be expressed straightforwardly by making use of schemas for fully specified inflectional forms and paradigmatic relationships between such schemas.

Inflectional schemas are also extremely helpful in dealing with the phenomenon that in many cases there is no one-to-one correspondence between form and meaning in inflectional morphology. One ending may express more than one property (= feature value), the phenomenon of cumulative exponence, and schemas can express this straightforwardly, because a form with a specific ending can be specified as corresponding to a multiple set of morpho-syntactic features, for instance a combination of a case property and a number property. Inversely, in the case of extended exponence one morpho-syntactic property is expressed by more than one word constituent.¹⁰ In the Latin verb form *amavi* ‘I have loved,’ for

¹⁰ See also Harris (2009) for a CM analysis of an interesting case of exuberant exponence in Batsbi, a Nakh-Dagestanian language.

instance, the property of perfect tense is expressed both by the *v*, and by the choice of *i* as the first-person singular ending. This can easily be expressed in a schema:

$$(44) \quad \langle (x_i-v-i)_{\omega-j} \leftrightarrow [V_i, \text{perfect, first-person singular}]_j \rangle$$

The schematic representation of inflectional forms of word can also be used to deal with the phenomenon that a combination of inflectional elements may carry a different meaning from that which they have in isolation. For example, in Totonac, a language spoken in Mexico, the prefix *ik-* indicates a first-person singular subject, and the suffix *-w* the first-person plural inclusive subject. However, together they indicate another grammatical category, the first-person plural exclusive (Beck and Mel'cuk 2011). This can be expressed by assuming an inflectional subschema for this combination of inflectional affixes of the form:

$$(45) \quad [ik-[V-ASPECT]_i-w]_{Vi} \leftrightarrow [SEM_i, \text{first-person plural exclusive subject}]_j$$

The phenomenon of inflectional periphrasis also throws light on the architecture of the grammar and the form of grammatical generalizations. In many languages with inflection, some inflectional categories are expressed by word combinations rather than by words. In English the category of perfect tense is a periphrastic category, as it is expressed by the combination of an auxiliary (a form of *to have*) and a past participle. Similarly, passive voice is expressed by the combination of a form of *to be* and a past participle. Similar phenomena can be observed for most Germanic and Romance languages. Auxiliaries are words that may have an independent existence as lexical verbs, but have a specific grammatical meaning in a periphrastic construction. For instance, the verb *to have* means 'to possess' when used as a lexical verb, but carries the grammatical meaning of perfect tense when combined with a past participle. The perfect meaning is a property of the construction as a whole, as it is neither derivable from the auxiliary as such nor from the past participle (which combines with present tense as well, in the passive construction with *to be*). Hence, we need schemas such as the following for the English perfect tense:

$$(46) \quad \langle [[have]_{Vi} [x-ed]_{Vj, PST\ PTCP}]_{V'k} \leftrightarrow [PRF [SEM_j]]_k \rangle$$

This schema illustrates that words may have meanings bound to specific phrasal constructions, just as was the case of certain words as parts of compounds. Schema (46) is again a constructional idiom because it contains both a lexically filled slot, and an open slot for the lexical verb.¹¹ The English progressive form is another example of a periphrastic constructional idiom, in which the verb *to be* combines with a word of the form

¹¹ For more discussion of the implications of periphrasis for the architecture of grammar, see Sadler and Spencer (2001); Ackerman and Stump (2004); Chumakina and Corbett (2013).

[V-*ing*] in order to express progressive aspect. In this constructional idiom the suffix *-ing* plays a specific role, different from that in gerunds (Lee 2007). The Dutch progressive form has the form of a prepositional phrase, with the slots for the preposition and the determiner fixed, followed by the infinitival form of the verb (Booij 2008, 2010: Chapter 6):

- (47) Mijn broer is aan het fiets-en
 My brother is at the cycle-INF
 ‘My brother is cycling.’

These examples all show that phrasal constructional idioms serve to express periphrastic inflectional patterns.

8 Summary and Conclusions

In this chapter we have seen how the notion “construction,” as it has been developed in the framework of Parallel Architecture (Jackendoff 2002) and Construction Grammar (Goldberg 2006; Hoffmann and Trousdale 2013) is a very fruitful concept for an insightful analysis of morphological phenomena. The model of morphological analysis developed here, that of Construction Morphology (Booij 2010), appears to be able to do justice to generalizations across words of various degrees of abstraction. The model is in accordance with the requirement of “graceful integration” (Jackendoff 2011)—in other words, the requirement that grammatical models should be in harmony with findings in related domains such as language change (see Chapter 26), language acquisition (see Chapter 27), and psycholinguistics (see Chapter 28).

This chapter also pointed out that morphological and syntactic structures can be quite similar, and accounted for by constructional schemas. This does not mean that we give up the difference between syntax and morphology (cf. Chapter 8). We do need a distinction between word-level constructions and phrase-level constructions for an adequate account of the data (Booij 2009). The similarities suggest that the acquisition mechanism for syntax and morphology may be in essence the same: abstraction based on an increasing number and range of inputs. The notion of a hierarchical lexicon with subschemas also provides insight into how new affixes may emerge from compound constituents (cf. Chapter 26). The development of particles into prefixes shows how syntactic constructions can develop into morphological ones.

Construction Morphology also does justice to psycholinguistic findings concerning the balance and relationship between computation and storage. Human lexical memory has vast storage capacities, and storage does not compete with computation. On the contrary, the computational competence of language users, and hence their creativity, is strengthened by their having a rich and well-organized construction.

In sum, CM offers an interesting and fruitful avenue of research into the structure of the lexicon, the architecture of the grammar, and the nature of linguistic generalizations.

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Paradigm Function Morphology

Olivier Bonami and Gregory Stump

1 What is Paradigm Function Morphology?

“Paradigm Function Morphology” is a name, and like many names, it has more than one referent. On one hand, it refers to a collection of leading ideas for morphological (especially inflectional) theory; on the other hand, it refers to a collection of formal theories that have been proposed since the early 1990s to embody these leading ideas. In this paper we elucidate both senses of the term, explicitly separating the contingent from the essential in Paradigm Function Morphology (PFM). Section 2 presents the core assumptions that are shared by all instantiations of the theory. In Section 3, we present a streamlined version of the instantiation of PFM presented in Stump (2001). As this is the first fully articulated version of PFM, we will call it PFM1. In Section 4 we discuss a range of new approaches and directions for PFM; many of these necessitate modifications of the system of principles and formalisms that we present, but all are consonant with the leading ideas that are at the theory’s core.

2 Core Assumptions of PFM

The leading ideas of PFM are fairly few in number, but they impose important constraints on any formal instantiation of the theory. Some of these leading ideas are shared with other morphological theories, but no other theory shares the full set of core assumptions constituting PFM.¹

2.1 Core Assumption: Morphology is an Autonomous System

This autonomy is manifested in two ways.

¹ Notwithstanding its uniqueness with respect to this combination of core assumptions, it should be clear to all that PFM owes a considerable debt to the work of Peter H. Matthews, Stephen Anderson, and Arnold Zwicky; see Stump (2001) for discussion and references.

2.1.1 Purely Morphological Representations and Categories

While there are interface representations and categories that a language's morphology shares with its syntactic, phonological, and semantic components, it also has purely morphological representations and categories to which these other components are blind. For instance, rules of morphology may be sensitive to (a) an expression's syntactic category and morphosyntactic properties, (b) an expression's segmental and prosodic properties, and (c) aspects of its denotation, as in the respective examples in (1).

- (1) a. In English, verbs take the suffix *-s* as an expression of third-person, singular number, present tense, and indicative mood.
- b. In English, syncretism of a verb's infinitive and past-tense forms is limited to verbs that end in an oral dental stop (e.g., *beat*, *cast*, *shed*, *spread*); English morphology defines a correspondence between nouns with trochaic stress and verbs with iambic stress (e.g., *conflict*, *record*, *suspect*).
- c. In Breton, the suffix *-enn* joins with nouns lacking individual reference (including collectives, which are syntactically plural, and mass nouns, which are syntactically singular) to produce singulatives (count nouns capable of individual reference): *kelien* 'flies,' *nez* 'nits,' *plouz* 'straw,' *glav* 'rain' → *kelienenn* 'fly,' *nezenn* 'nit,' *plouzenn* 'piece of straw,' *glavenn* 'raindrop.'

But rules of morphology may also be sensitive to, for instance, (a) inflection-class membership or (b) a word's headedness, as in the examples in (2); no other grammatical component is sensitive to categories or representations of these sorts.

- (2) a. English morphology treats the verbs *knit*, *hit*, and *sit* as members of different conjugation classes, distinguishable by their past-tense forms *knitted*, *hit*, and *sat*.
- b. In English morphology, the verb *understand* (unlike its synonym *comprehend*) functions as a headed structure, whose irregular past tense *understood* follows from that of its head *stand* (past tense *stood*).

2.1.2 Internal Architecture

A language's morphology has its own internal architecture, whose structure is not reducible to that of any independent component(s) of grammar, whose internal workings are not accessible to other components, and many of whose properties can be motivated and investigated independently of other grammatical components. At the foundation of this architecture are the concepts of "lexeme," "paradigm," and "realization." A lexeme is a meaningful lexical unit belonging to a syntactic category which may be associated with sets of morphosyntactic properties; each such association ordinarily has a realization, a phonological embodiment. A lexeme's full inventory of realizable associations of this sort is its paradigm. Different

kinds of morphology are distinguished according to how they build on this conceptual foundation: rules of inflection determine a lexeme's realizations; rules of derivation derive one lexeme from another; and rules of compounding combine lexemes to produce compound lexemes.

2.2 Core Assumption: The Definition of a Language's Inflectional Morphology is the Definition of its Paradigm Function

A language's paradigm function (PF) is a function from any cell in the paradigm of any lexeme in that language to the realization of that cell. In our formal articulation of this notion, a cell in the paradigm of a lexeme L is the pairing of L with a well-formed and complete set of morphosyntactic properties appropriate to L .² In addition, we follow Stewart and Stump (2007) in assuming that the value of a paradigm function applying to a cell $\langle L, \sigma \rangle$ is the pairing of this cell's realization R with the morphosyntactic property set σ : $PF(\langle L, \sigma \rangle) = \langle R, \sigma \rangle$. The latter assumption facilitates the definition of PF in terms of realization rules, whose output is always a $\langle \text{form, property set} \rangle$ pairing; see Section 3.3.

For concreteness, consider the inflection of verbs in modern Icelandic. Icelandic verbs inflect for the twenty-seven morphosyntactic property sets in (3);³ the verbs in Table 17.1 illustrate. Given these facts, the Icelandic paradigm function PF must clearly be defined so that it produces values such as those in (4).⁴

- (3) {ind prs 1sg} {ind pst 1sg} {sbjv prs 1sg} {sbjv pst 1sg}
 {ind prs 2sg} {ind pst 2sg} {sbjv prs 2sg} {sbjv pst 2sg} {imp 2sg}
 {ind prs 3sg} {ind pst 3sg} {sbjv prs 3sg} {sbjv pst 3sg}
 {ind prs 1pl} {ind pst 1pl} {sbjv prs 1pl} {sbjv pst 1pl} {imp 1pl}
 {ind prs 2pl} {ind pst 2pl} {sbjv prs 2pl} {sbjv pst 2pl} {imp 2pl}
 {ind prs 3pl} {ind pst 3pl} {sbjv prs 3pl} {sbjv pst 3pl}
- (4) a. $PF(\langle KALLA, \sigma:\{\text{ind pst 2sg}\} \rangle) = \langle kallaðir, \sigma \rangle$
 b. $PF(\langle \text{ÆTLA}, \sigma:\{\text{ind prs 1pl}\} \rangle) = \langle \text{ætlum}, \sigma \rangle$
 c. $PF(\langle \text{GRÍPA}, \sigma:\{\text{imp 2sg}\} \rangle) = \langle \text{gríp}, \sigma \rangle$
 d. $PF(\langle \text{FLJÚGA}, \sigma:\{\text{ind pst 1sg}\} \rangle) = \langle \text{flaug}, \sigma \rangle$

² A morphosyntactic property set is well formed only if it doesn't contain incompatible properties (*{singular plural}) and is complete if no property can be added to it without producing ill-formedness. Whether a morphosyntactic property set σ is appropriate to lexeme L may depend on L 's syntactic category membership (e.g., properties of tense and mood are appropriate to verbal lexemes in English, but not to nominal lexemes) or on L 's membership in some subcategory (e.g., properties of degree are appropriate to adjectival and adverbial lexemes that have gradable semantics). In the slightly different definition assumed by Stump (2001), a cell in the paradigm of lexeme L is a pairing of L 's root with a well-formed and complete set of morphosyntactic properties appropriate to L .

³ Here we restrict our attention to verb forms that are both finite and synthetic, leaving aside the infinitive, the participles, and periphrastic realizations; see Section 3.8 for discussion of periphrasis.

⁴ Here and below, we use the notation $\sigma:\{X\}$ to restrict the possible values of σ (a metalinguistic variable over well-formed and complete morphosyntactic property sets) to (proper or improper) supersets of $\{X\}$.

Table 17.1. *Finite synthetic realizations of four Icelandic verbs*

		Indicative		Subjunctive		Imperative
		Present	Past	Present	Past	
KALLA ‘shout’ (Conjugation WEAK. 4.A)	1sg	<i>kalla</i>	<i>kallaði</i>	<i>kalli</i>	<i>kallaði</i>	
	2sg	<i>kallar</i>	<i>kallaðir</i>	<i>kallir</i>	<i>kallaðir</i>	<i>kalla</i>
	3sg	<i>kallar</i>	<i>kallaði</i>	<i>kalli</i>	<i>kallaði</i>	
	1pl	<i>köllum</i>	<i>kölluðum</i>	<i>köllum</i>	<i>kölluðum</i>	<i>köllum</i>
	2pl	<i>kallið</i>	<i>kölluðuð</i>	<i>kallið</i>	<i>kölluðuð</i>	<i>kallið</i>
	3pl	<i>kalla</i>	<i>kölluðu</i>	<i>kalli</i>	<i>kölluðu</i>	
ÆTLA ‘intend’ (Conjugation WEAK. 4.B)	1sg	<i>ætla</i>	<i>ætlaði</i>	<i>ætli</i>	<i>ætlaði</i>	
	2sg	<i>ætlar</i>	<i>ætlaðir</i>	<i>ætlir</i>	<i>ætlaðir</i>	<i>ætlaðu</i>
	3sg	<i>ætlar</i>	<i>ætlaði</i>	<i>ætli</i>	<i>ætlaði</i>	
	1pl	<i>ætlum</i>	<i>ætluðum</i>	<i>ætlum</i>	<i>ætluðum</i>	<i>ætlum</i>
	2pl	<i>ætlið</i>	<i>ætluðuð</i>	<i>ætlið</i>	<i>ætluðuð</i>	<i>ætlið</i>
	3pl	<i>ætla</i>	<i>ætluðu</i>	<i>ætli</i>	<i>ætluðu</i>	
GRÍPA ‘grasp’ (Conjugation STRONG. 1.A)	1sg	<i>gríp</i>	<i>greip</i>	<i>grípi</i>	<i>gripi</i>	
	2sg	<i>grípur</i>	<i>greipst</i>	<i>grípir</i>	<i>gripir</i>	<i>gríp</i>
	3sg	<i>grípur</i>	<i>greip</i>	<i>grípi</i>	<i>gripi</i>	
	1pl	<i>grípum</i>	<i>gripum</i>	<i>grípum</i>	<i>gripum</i>	<i>grípum</i>
	2pl	<i>grípið</i>	<i>gripuð</i>	<i>grípið</i>	<i>gripuð</i>	<i>grípið</i>
	3pl	<i>grípa</i>	<i>gripu</i>	<i>grípi</i>	<i>gripu</i>	
FLJÚGA ‘fly’ (Conjugation STRONG. 2.B)	1sg	<i>flýg</i>	<i>flaug</i>	<i>fljúgi</i>	<i>flygi</i>	
	2sg	<i>flýgur</i>	<i>flaugst</i>	<i>fljúgir</i>	<i>flygir</i>	<i>fljúg</i>
	3sg	<i>flýgur</i>	<i>flaug</i>	<i>fljúgi</i>	<i>flygi</i>	
	1pl	<i>fljúgum</i>	<i>flugum</i>	<i>fljúgum</i>	<i>flygjum</i>	<i>fljúgum</i>
	2pl	<i>fljúgið</i>	<i>fluguð</i>	<i>fljúgið</i>	<i>flygjuð</i>	<i>fljúgið</i>
	3pl	<i>fljúga</i>	<i>flugu</i>	<i>fljúgi</i>	<i>flygju</i>	

Source: Jörg (1989)

2.3 Core Assumption: The Definition of a Language’s Paradigm Function Is Inferential and Realizational

The definition of an inflectional system is realizational if it is formulated as deducing a word’s form from its content; the opposite of a realizational definition is one that is incremental, which constructs a word’s content on the basis of its form. The definition of an inflectional system is inferential if it employs rules for deducing morphologically complex word-forms from more basic stems; the opposite of an inferential definition is one that is lexical, which portrays morphologically complex word-forms as arising through the combination of lexically listed formatives, including both stems and affixes. A core assumption of PFM is that inflectional morphology is both inferential and realizational in its definition. Thus, the content of the cell ⟨KALLA, {ind pst 2sg}⟩ is logically prior to its realization; it is this content that determines the form of its realization. In particular, the realization of ⟨KALLA, {ind pst 2sg}⟩ arises from KALLA’s stem *kall* by means of a succession of realization rules, rules of exponence that license the inference of forms of progressively greater complexity marked by the suffixes *-a*, *-ði*, and *-r*; each of these rules has a role in the definition of the Icelandic PF.

Table 17.2. *Partial declensional paradigms of three nouns in Sanskrit*

	DĀNA ‘gift’ (neut.)			JAGAT ‘world’ (neut.)			AŚVA ‘horse’ (masc.)		
	SG	DU	PL	SG	DU	PL	SG	DU	PL
NOM	<i>dānam</i>	<i>dāne</i>	<i>dānāni</i>	<i>jagat</i>	<i>jagatī</i>	<i>jaganti</i>	<i>aśvaḥ</i>	<i>aśvau</i>	<i>aśvāḥ</i>
VOC	<i>dāna</i>	<i>dāne</i>	<i>dānāni</i>	<i>jagat</i>	<i>jagatī</i>	<i>jaganti</i>	<i>aśva</i>	<i>aśvau</i>	<i>aśvāḥ</i>
ACC	<i>dānam</i>	<i>dāne</i>	<i>dānāni</i>	<i>jagat</i>	<i>jagatī</i>	<i>jaganti</i>	<i>aśvam</i>	<i>aśvau</i>	<i>aśvān</i>
GEN	<i>dānasya</i>	<i>dānayos</i>	<i>dānānām</i>	<i>jagatas</i>	<i>jagatos</i>	<i>jagatām</i>	<i>aśvasya</i>	<i>aśvayoḥ</i>	<i>aśvānām</i>
LOC	<i>dāne</i>	<i>dānayos</i>	<i>dāneṣu</i>	<i>jagati</i>	<i>jagatos</i>	<i>jagatsu</i>	<i>aśve</i>	<i>aśvayoḥ</i>	<i>aśveṣu</i>

2.4 Core Assumption: The Definition of a Language’s Paradigm Function May Include Implicative Rules

In many paradigms, two or more cells share the same realization; that is, they exhibit syncretism. In some instances, syncretism simply stems from a kind of poverty in a language’s system of exponents: two cells have the same realization because there is no exponent for the morphosyntactic properties that distinguish them; an example of this sort from Icelandic is the syncretism of $\langle \text{KALLA}, \{\text{ind pst 2sg}\} \rangle$ and $\langle \text{KALLA}, \{\text{sbjv pst 2sg}\} \rangle$. In other instances, $\langle L, \sigma' \rangle$ is parasitic on cell $\langle L, \sigma \rangle$ in that it takes on a realization that the rules of exponence supply for $\langle L, \sigma \rangle$ but not for $\langle L, \sigma' \rangle$. In Sanskrit, for example, a neuter noun’s nominative forms are invariably the same as its accusative forms, regardless of the morphology involved; the partial paradigms of the neuter nouns DĀNA ‘gift’ and JAGAT ‘world’ in Table 17.2 illustrate this. Moreover, *a*-stem nouns such as DĀNA ‘gift’ reveal that it is the nominative that patterns after the accusative, since the *-m* suffix of *dānam* is restricted to the accusative singular in the paradigms of *a*-stem masculines, such as AŚVA.

It is a core assumption of PFM that such parasitism is to be modeled by **implicative** rules, which explicitly relate the realization of one cell in a paradigm to that of another cell. Implicative rules may take the form of clauses in the definition of a language’s paradigm function; for instance, the nominative-accusative syncretism may be modeled by clause (5) in the definition of the Sanskrit paradigm function.

- (5) If L is a neuter nominal and $\text{PF}(\langle L, \sigma: \{\text{acc NUM:}\alpha\} \rangle) = \langle Y, \sigma \rangle$, then $\text{PF}(\langle L, \sigma': \{\text{nom NUM:}\alpha\} \rangle) = \langle Y, \sigma' \rangle$.

The use of implicative rules like (5) clearly puts PFM in the family of Word and Paradigm approaches to morphology (Hockett 1954), as such rules describe the realization of one cell in a lexeme’s paradigm by reference to that of another cell in that paradigm.

2.5 Core Assumption: Competition among Inflectional Rules Is Invariably Resolved by Pāṇini’s Principle

Pāṇini’s principle is the principle that if two rules are in competition, then it is the rule that is applicable in a narrower class of cases that “wins.” This principle can be appealed to in order to account for the distribution of 2sg

exponents in Icelandic: in the general case, the exponent is *r*, but this is overridden by the absence of any exponent in the imperative 2sg, which is itself overridden by the exponent *ðu* for verbs belonging to weak conjugation 4.b (e.g. ÆTLA ‘intend’ in Table 17.1).

Pāṇini’s principle is central to PFM, not simply because it is appealed to in order to account for the resolution of rule competition in specific cases, but because it is hypothesized to be the only principle for the resolution of rule competition (= the Pāṇinian Determinism Hypothesis; Stump 2001: 23). This is in sharp contrast to the hypotheses of other realizational theories such as A-morphous Morphology (Anderson 1992) or Distributed Morphology (Halle and Marantz 1993).⁵

2.6 Core Assumptions about Word Formation, Heads, and the Head-application Principle

Recent work in morphological theory reveals considerable disagreement over the question of whether lexemes have heads; some have argued that all lexemes are headed, and others that no lexeme is headed. Stump (1995, 2001:118) argues for a kind of middle ground, according to which a lexeme is headed if and only if it arises through the operation of a category-preserving rule of lexeme formation;⁶ on this view, UNLOAD is headed by LOAD and DOG HOUSE is headed by HOUSE, but DOG, WRITER, and RIP-OFF are unheaded, as are inflected word-forms such as *dogs* and *loaded*. A category-preserving rule of word-formation is one which allows properties of the base lexeme to which it applies to persist as properties of the complex lexeme that it defines; thus, UNLOAD is a verb because LOAD is, DOG HOUSE is a noun because HOUSE is.

In PFM, the inflection of a headed lexeme is regulated by the Head-application Principle: where lexeme L_1 with root X_1 arises from lexeme L_2 with root X_2 through the application of a category-preserving rule R (so that $R(X_2) = X_1$), lexeme L_1 inflects through the inflection of L_2 – that is, for any cell $\langle L_1, \sigma \rangle$ in the paradigm of L_1 , if $\text{PF}(\langle L_2, \sigma \rangle) = \langle Y, \sigma \rangle$, then $\text{PF}(\langle L_1, \sigma \rangle) = \langle R(Y), \sigma \rangle$. This principle entails (i) that any irregularities inhering in the inflection of a lexeme L will also appear in the inflection of any lexeme headed by L (as in the case of *understood*, *rewrote*, and *grandchildren*) and (ii) that a headed word’s inflectional markings will appear “inside of” its marking of category-preserving word formation. Entailment (ii) is clearly confirmed in Sanskrit, where verbs such as PRATI-GAM ‘go back’ (which is headed by GAM ‘go’) have imperfect forms such as *praty-a-gacchat* ‘s/he went back,’ in which the preterite prefix *a-* is “inside of” the compounded adposition *prati* ‘towards.’ But entailment (ii) is also confirmed by the fact

⁵ Network Morphology (Brown and Hippisley 2012) adheres to Pāṇinian Determinism, though it is interpreted quite differently from the way it is interpreted in PFM, because of the use of ordered features.

⁶ We use “lexeme formation” as a cover term for both derivation and compounding.

that the headed adjective UNHAPPY inflects as *unhappier*: although the rule for comparatives in *-er* only applies to short adjectives (*friendlier*, **gentlemanlier*), UNHAPPY inflects through the inflection of its head HAPPY, hence *unhappier* is fully as acceptable as *happier*.

The Head-application Principle has a number of desirable consequences; for instance, it entails that the verbs UNDERSTAND and GRANDSTAND should inflect differently (*understood*, but *grandstanded*), because the former is headed while the latter is not. For detailed discussion of the Head-application Principle and its consequences, see Stump (1993a, 1995, 2001).

3 The Standard Version of Paradigm Function Morphology: PFM1

Stump (2001) contains an intricate system of principles, modeling decisions, and analytic techniques that amount to a formally explicit instantiation of the leading ideas from Section 2. In the interest of clarity we will call this particular formal theory PFM1. In this section, we outline a streamlined version of PFM1, which differs minimally from Stump (2001) in adopting simpler notations and terminology.

The main design property of PFM1 is that the specification of a paradigm function takes the form of a set of realization rules organized in successive blocks. For instance, the analysis of KALLA's {ind pst 2sg} form *kallaðir* in Icelandic involves four successive steps:

- (6)
 - a. Choosing a basic stem *kall* (Initial step: basic stem choice)
 - b. Suffixing the theme vowel *a* (Block I)
 - c. Suffixing the {pst sg} exponent *ði* (Block II)
 - d. Suffixing the {2sg} exponent *r* (Block III)

Rules in the same block are in paradigmatic opposition (only one of the rules in a block may apply) and choice among rules is arbitrated by narrowness, the PFM1 implementation of Pāṇini's principle. Rules in different blocks are in syntagmatic opposition (one rule from each block must apply), and the order of blocks is stipulated rather than following from independent principles.

3.1 Rule Types

Paradigm Function Morphology distinguishes three kinds of realization rules which, conceptually, do three different things. If a lexeme *L* has more than one basic stem, a rule of basic stem choice specifies which of these is to be used in the realization of a particular cell in *L*'s paradigm. A rule of exponence specifies how the basic stem chosen for *L* is to be marked in the realization of a particular cell in *L*'s paradigm. A rule of referral specifies that the realization of one cell in *L*'s paradigm patterns after the realization

of a different cell in L's paradigm. Realization rules of these three sorts are supplemented by morphological metageneralizations: generalizations about the phonological effects of rules of exponence.

3.1.1 Rules of Basic Stem Choice

We must be clear at the outset about the two senses of “stem” relevant to PFM. To distinguish these, consider the inflection of GRÍPA ‘grasp’ in Table 17.1. In the analysis that we will propose, we assume that this lexeme has six stems, that is, six strings that serve as input to rules of exponence: *gríp*, *greip*, *grip*, *gríp-i*, *grip-i*, and *grip*. At the same time, the first three are “basic” in the sense that they are directly associated with the lexeme GRÍPA by rules of stem choice; “nonbasic” stems are inferrable from basic ones by means of rules of exponence. We use “stem” in the more general, inclusive sense, and “basic stem” in the more restrictive sense.

We formulate rules of basic stem choice as clauses in the definition of a function *Stem* which applies to a cell $\langle L, \sigma \rangle$ in the paradigm of lexeme L to yield the pair $\langle W, \sigma \rangle$, where W is the basic stem choice for the realization of $\langle L, \sigma \rangle$. For the Icelandic verbs in Table 17.1, we propose the rules of basic stem choice in (7). Because σ is a variable over well-formed and complete morphosyntactic property sets, the rules in (7) are in fact rule schemata: each specifies the value of *Stem* for a set of cells. In the case of rule (7a), this is the full set of twenty-seven cells in the (finite synthetic) paradigm of KALLA; rule (7c), by contrast, specifies the value of *Stem* for only three cells (the singular past indicative cells in the paradigm of GRÍPA).

(7) Rules of basic stem choice for the Icelandic verbs in Table 17.1

a. <i>Stem</i> ($\langle KALLA, \sigma:\{\} \rangle$)	= $\langle kall, \sigma \rangle$
b. <i>Stem</i> ($\langle \text{ÆTLA}, \sigma:\{\} \rangle$)	= $\langle \text{ætl}, \sigma \rangle$
c. <i>Stem</i> ($\langle \text{GRÍPA}, \sigma:\{\text{ind pst sg}\} \rangle$)	= $\langle greip, \sigma \rangle$
d. <i>Stem</i> ($\langle \text{GRÍPA}, \sigma:\{\text{pst}\} \rangle$)	= $\langle grip, \sigma \rangle$
e. <i>Stem</i> ($\langle \text{GRÍPA}, \sigma:\{\} \rangle$)	= $\langle gríp, \sigma \rangle$
f. <i>Stem</i> ($\langle \text{FLJÚGA}, \sigma:\{\text{ind pst sg}\} \rangle$)	= $\langle flaug, \sigma \rangle$
g. <i>Stem</i> ($\langle \text{FLJÚGA}, \sigma:\{\text{ind pst}\} \rangle$)	= $\langle flug, \sigma \rangle$
h. <i>Stem</i> ($\langle \text{FLJÚGA}, \sigma:\{\text{pst}\} \rangle$)	= $\langle flyg, \sigma \rangle$
i. <i>Stem</i> ($\langle \text{FLJÚGA}, \sigma:\{\text{ind prs sg}\} \rangle$)	= $\langle flýg, \sigma \rangle$
j. <i>Stem</i> ($\langle \text{FLJÚGA}, \sigma:\{\} \rangle$)	= $\langle fljúg, \sigma \rangle$

There are occasional conflicts among the rules in (7). For instance, the value of *stem*($\langle \text{GRÍPA}, \sigma:\{\text{ind pst 1sg}\} \rangle$) is $\langle greip, \sigma \rangle$ according to (7c), $\langle grip, \sigma \rangle$ according to (7d), and $\langle gríp, \sigma \rangle$ according to (7e). Which is right? Because (7c) is narrower in its application than both (7d) and (7e) ((7c) applies to three cells, (7d) to twelve, and (7e) to twenty-seven), Pāṇini's principle dictates that (7c) overrides its competitors.

It is often the case that lexemes belonging to a given class pattern alike in terms of stem alternation (see, e.g., Aronoff 1994; Pirelli and Battista 2000; Stump 2001; Bonami and Boyé 2002). For instance, the verb BÍTA ‘bite’

belongs to the same conjugation as GRÍPA ‘grasp’ (Conjugation STRONG.1.A, in Jörg 1989); such implicative patterns are captured by metarules of basic stem choice, as illustrated in (8) (in which X and Y serve as variables over phonological expressions).

- (8) If verbal lexeme L belongs to Conjugation STRONG.1.A and $\text{Stem}(\langle L, \sigma: \{\} \rangle) = \langle XiY, \sigma \rangle$,
 then $\text{Stem}(\langle L, \sigma: \{\text{ind pst sg}\} \rangle) = \langle XeiY, \sigma \rangle$
 $\text{Stem}(\langle L, \sigma: \{\text{pst}\} \rangle) = \langle XiY, \sigma \rangle$.

Given the default basic stem specification in (7e), rules (7c) and (7d) are theorems of (8), and therefore needn’t be stipulated; similarly, if we specify the default basic stem for BÍTA ‘bite’ as in (9), then we derive the rules in (10) as theorems of (8).

- (9) $\text{Stem}(\langle \text{BÍTA}, \sigma: \{\} \rangle) = \langle bít, \sigma \rangle$
 (10) a. $\text{Stem}(\langle \text{BÍTA}, \sigma: \{\text{ind pst sg}\} \rangle) = \langle \text{beit}, \sigma \rangle$
 b. $\text{Stem}(\langle \text{BÍTA}, \sigma: \{\text{pst}\} \rangle) = \langle \text{bit}, \sigma \rangle$

As (7)–(10) suggest, we regard stems as morphologically unstructured expressions. We do, however, assume that all stems are covertly indexed with the name of the lexeme that they realize; this assumption is necessitated by the fact that rules of exponence applying to a stem sometimes need to access information about the lexeme that it realizes. Thus, though we refer to the singular indicative past-tense stem *greip* by means of its phonological representation, we assume that this expression carries the covert index GRÍPA. When necessary, a function *L-index* makes a stem’s lexemic index overt: $L\text{-index}(\text{greip}) = \text{GRÍPA}$. The convention in (11) guarantees the compatibility of the rules of basic stem choice with basic stems’ lexemic indexing:

- (11) If $\text{Stem}(\langle L, \sigma \rangle) = \langle X, \sigma \rangle$, then $L\text{-index}(X) = L$.

3.1.2 Rules of Exponence

We assume that both rules of exponence and rules of referral have the form in (12), where n is the number of the rule block to which the rule belongs; X is a variable over stems; C is the category to which $L\text{-index}(X)$ must belong (i.e., the category of lexemes in whose inflection the rule applies); τ is the set of morphosyntactic properties (well formed but not necessarily complete) that the rule realizes; and f is a function from stems to stems or word-forms.

- (12) $n, X_C, \tau \rightarrow f(X)$

Given a pair $\langle W, \sigma \rangle$, where W is a stem and σ is (as above) a well-formed and complete set of morphosyntactic properties, a rule of exponence or rule of referral having the form in (11) applies to $\langle W, \sigma \rangle$ only if (i) $L\text{-index}(W)$ belongs to class C and (ii) τ is a subset of σ . If these requirements are met, then the rule applies to $\langle W, \sigma \rangle$ to yield the value $\langle f(W), \sigma \rangle$, where

Table 17.3. Rules of exponence for the Icelandic verbs in Table 17.1

Block I	Block III
I, $X_{V[WEAK.4]}, \{pst\ pl\} \rightarrow Xu$	III, $X_{V[WEAK.4.B]}, \{imp\ 2sg\} \rightarrow X\ddot{u}$
I, $X_V, \{sbjv\ prs\} \rightarrow Xi$	III, $X_V, \{imp\ 2sg\} \rightarrow X$
I, $X_{V[WEAK.4]}, \{\} \rightarrow Xa$	III, $X_V, \{2sg\} \rightarrow Xr$
I, $X_U, \{\} \rightarrow X\ [IFD]$	III, $X_V, \{ind\ prs\ 3sg\} \rightarrow Xr$
Block II	III, $X_V, \{1pl\} \rightarrow Xum$
II, $X_{V[weak]}, \{pst\ sg\} \rightarrow X\ddot{o}i$	III, $X_V, \{2pl\} \rightarrow X\ddot{o}$
II, $X_{V[weak]}, \{pst\ pl\} \rightarrow X\ddot{o}u$	III, $X_V, \{ind\ prs\ 3pl\} \rightarrow Xa$
II, $X_U, \{\} \rightarrow X\ [IFD]$	III, $X_{V[STRONG]}, \{ind\ pst\ 2sg\} \rightarrow Xst$
	III, $X_U, \{\} \rightarrow X\ [IFD]$

$L\text{-index}(f(W)) = L\text{-index}(W)$.⁷ Because realization rules in format (12) apply to $\langle \text{form}, \text{property set} \rangle$ pairings to produce $\langle \text{form}, \text{property set} \rangle$ pairings, a rule of this sort may apply to the output of (a) a rule of stem choice or (b) another rule in format (12); a language's paradigm function may therefore be formulated as the composition of a series of realization rules whose output is itself a $\langle \text{form}, \text{property set} \rangle$ pairing.

Employing the notation in (12), we formulate the rules of exponence for the Icelandic verbs in Table 17.1 as in Table 17.3.

These rules are organized into three blocks. As noted earlier, members of the same block are mutually exclusive in their application and the sequence in which members of separate blocks apply is determined by an ordering relation defined over these blocks. This ordering is specified by clause (13) in the definition of the Icelandic PF.⁸

- (13) Where L is a verbal lexeme having $\langle L, \sigma \rangle$ as a cell in its paradigm,
 $PF(\langle L, \sigma \rangle) = [III : [II : [I : \text{Stem}(\langle L, \sigma \rangle)]]]$.

Definition (13) also guarantees the disjunctivity of rules belonging to the same block by means of the 'Nar notation' in (14). The conception of narrowness relevant in (14) is the Pāṇinian conception, according to which the more constrained rule overrides its competitor(s); as it applies to the definition in (14), we define this conception of narrowness as in (15).

- (14) **Nar** [narrowest applicable rule] **notation**. Where $\langle W, \sigma \rangle$ is the pairing of a stem W with a well-formed and complete morphosyntactic property set σ , $[n : \langle W, \sigma \rangle]$ is the result of applying the narrowest applicable realization rule in Block n to $\langle W, \sigma \rangle$.
Example: $[III : \langle \text{atla}, \sigma : \{imp\ 2sg\} \rangle] = \langle \text{atla}\ddot{u}, \sigma \rangle$

⁷ The stipulation that $L\text{-index}(f(W)) = L\text{-index}(W)$ enforces the persistence of L-indexing from a basic stem to all of the inflected forms inferred from it; see Stump (2001: 45).

⁸ The definition of the Icelandic PF has other clauses accounting for the inflection of nominal categories; these are not at issue here.

- (15) **Narrowness.** Where (a) and (b) are realization rules, (a) is narrower than (b) if either (i) $C = C'$ and τ_2 is a proper subset of τ_1 or (ii) C is a proper subset of C' .

$$(a) \quad n, X_C, \tau_1 \rightarrow f_1(X)$$

$$(b) \quad n, X_{C'}, \tau_2 \rightarrow f_2(X)$$

$$\begin{array}{lll} \text{Example:} & \text{more narrow} & \text{III, } X_{V[\text{WEAK}, 4, B]}, \{\text{imp 2sg}\} \rightarrow X\dot{o}u \\ & \uparrow & \text{III, } X_V, \{\text{imp 2sg}\} \rightarrow X \\ & \text{less narrow} & \text{III, } X_V, \{2\text{sg}\} \rightarrow Xr \end{array}$$

Consider how this analysis accounts for the definition of a verbal lexeme's paradigm in Icelandic; consider, specifically, the second-person singular indicative past-tense form of KALLA 'shout.' The paradigm of KALLA includes the cell $\langle \text{KALLA}, \{\text{ind pst 2sg}\} \rangle$, as required by the inventory of property sets for verbs in (3). The Icelandic PF applies to the cell $\langle \text{KALLA}, \{\text{ind pst 2sg}\} \rangle$ to determine its realization. According to (13),

$$\text{PF}(\langle \text{KALLA}, \sigma: \{\text{ind pst 2sg}\} \rangle) = [\text{III} : [\text{II} : [\text{I} : \text{Stem}(\langle \text{KALLA}, \sigma \rangle)]]].$$

The rule of basic stem choice in (7a) has as one of its theorems the equation

$$\text{Stem}(\langle \text{KALLA}, \sigma: \{\text{ind pst 2sg}\} \rangle) = \langle kalla, \sigma \rangle.$$

By (13) and Table 17.3,

$$\begin{array}{lll} [\text{I} : \langle kalla, \sigma: \{\text{ind pst 2sg}\} \rangle] & = & \langle kalla, \sigma \rangle, \\ [\text{II} : \langle kalla, \sigma: \{\text{ind pst 2sg}\} \rangle] & = & \langle kalla\dot{o}i, \sigma \rangle, \text{ and} \\ [\text{III} : \langle kalla\dot{o}i, \sigma: \{\text{ind pst 2sg}\} \rangle] & = & \langle kalla\dot{o}ir, \sigma \rangle. \end{array}$$

In summary,

$$\text{PF}(\langle \text{KALLA}, \sigma: \{\text{ind pst 2sg}\} \rangle) = \langle kalla\dot{o}ir, \sigma \rangle,$$

or in plain English: "*kallaðir* is the second-person singular indicative past-tense realization of KALLA."

Each rule block n in Table 17.3 has a rule having the form in (16) as its least narrow member. In (16), U represents the class of all lexemes; accordingly, a rule of exponence in this form causes a stem X to remain unchanged in the default case. The notion that every rule block contains a rule in this form is assumed as a universal principle ("the Identity Function Default") in formal analyses in PFM; thus, the rules of exponence marked "[IFD]" in Table 17.3 needn't be stipulated, but may be seen as theorems of this principle.

$$(16) \quad n, X_U, \{\} \rightarrow X$$

3.1.3 Rules of Referral

The formalism of PFM allows rules of referral, like rules of exponence, to have the form in (12). As Stump (2001: 217) shows, rules of referral are necessary to account for the phenomenon of **block syncretism**, in which a pattern of syncretism is clearly confined to a specific rule block. An example of this sort is the Sanskrit vocative. The case suffix exhibited by a vocative form (regardless of number and gender) is, by default,

the suffix exhibited by the corresponding nominative form, in accordance with the rule of referral in (17).⁹ (In (17), the notation “ $\sigma/\{\text{nom}\}$ ” refers to that property set that is like σ except that its case specification is nominative.)

(17) Rule of referral for Sanskrit vocatives

$\text{I}, \text{X}_{\text{Nominal}}, \sigma/\{\text{voc}\} \rightarrow \text{Y}$, where $[\text{I} : \langle \text{X}, \sigma/\{\text{nom}\} \rangle] = \langle \text{Y}, \sigma \rangle$.

The syncretism modeled by (17) is confined to the rule block in which case suffixes are specified (Block I, we assume); it is absent from the block specifying rule-governed accentuation of case forms (Block II). Vocatives exhibit a special pattern of accentuation distinct from that of the corresponding nominatives: vocatives are unaccented unless they appear sentence-initially, in which case they are accented on their first syllable (Whitney 1889: §314); thus, nominative dual *dātārau* ‘two givers,’ vocative dual *dātārau* (sentence-initially *dātārau*). Unlike this vocative-nominative syncretism, the nominative-accusative syncretism exemplified in Table 17.2 is not confined to a single block; there is therefore no obstacle to modeling it as a clause in the definition of the Sanskrit paradigm function, as in (5) above.

Thus, there are at least two kinds of implicative rules in PFM: rules of referral such as (17) and rules which, like (5), function as clauses in the definition of a language’s paradigm function. The two kinds of rules are conceptually distinct: (17) models the nominative-accusative syncretism by means of a realization rule belonging to Block I, where it potentially competes with that block’s other realization rules; (5), on the other hand, defines the syncretism as a whole-word phenomenon, not confined to a single block and not entering into competition with any realization rule.

3.1.4 Morphological Metageneralizations

In formal analyses in PFM1, it is often assumed that the definition of a form by a rule of exponence R incorporates the effects of a set of morphological metageneralizations for which R is indexed (Zwicky 1994; Stump 2001: 47ff). We assume, for example, that each of the rules of exponence in Table 17.3 is indexed for the morphological metageneralizations in (18). The effects of these metageneralizations are illustrated in Table 17.4.

- (18) a. Stem-final *a* is lost prevocally.
 b. A stem-final vowel coalesces with an identical suffix-initial vowel.
 c. Stem-final or suffix-initial *i* is lost when adjacent to *u*.
 d. Stem-internal *a* mutates to *ō* before a syllable whose nucleus is rounded.

⁹ This default is overridden in some declensions (e.g., those of *a-*, *i-*, and *u-* stems), in which the nominative and vocative singular have distinct morphology; cf. Tables 17.2 and 17.10.

Table 17.4. *Effects of the morphophonological metageneralizations in (18)*

Morphological metageneralization	Without the effect of the metageneralization	With the effect of the metageneralization
(18a)	<i>ætla-um</i> <i>ætla-ið</i>	<i>ætlum</i> <i>ætlið</i>
(18b)	<i>ætluðu-um</i> <i>ætli-ið</i>	<i>ætluðum</i> <i>ætlið</i>
(18c)	<i>ætluðu-ið</i> <i>ætli-um</i>	<i>ætluðuð</i> <i>ætlum</i>
(18d)	<i>kall-um</i>	<i>köllum</i>

3.2 Templatic morphology in PFM1

PFM1 embodies an important set of assumptions about combinations of inflectional affixes; these assumptions are summarized in (19).

- (19) a. The ordering of a word's inflectional affixes is not determined by syntactic or semantic considerations; to the extent that inflectional systems exhibit correlations between the ordering of a word's inflectional affixes and its syntax or semantics, these correlations are an effect of diachronic or functional pressures that have no necessary place in the formal synchronic definition of a language's grammar (Stump 2001: 17–27).¹⁰
- b. Inflection is a-morphous (Janda 1983; Anderson 1992); the input and output of realization rules are simply pairings of a phonological representation with a morphosyntactic property set.
- c. The ordering of an inflectional affix Y is determined entirely by (i) the rule of exponence that introduces Y, which specifies Y's invariant status as a prefix, suffix, or infix relative to the phonological structure of the stem with which it combines; and (ii) the membership of that rule of exponence in a particular rule block, whose ordering with respect to other rule blocks determines the ordering of Y with respect to affixes introduced by those other blocks.
- d. The default ordering of a language's inflectional rule blocks is specified by the definition of its paradigm function.¹¹

¹⁰ This is in sharp contrast to the position eloquently articulated by Rice (2000). Thus, the claim (Aronoff and Xu 2010: 401–2) that PFM cannot capture “universal scope generalizations” begs the question: do such generalizations constitute synchronic principles regulating the semantic composition of inflected words, or are they purely an observational reflex of diachronic or functional tendencies? See Spencer (2003) for discussion of this issue.

¹¹ This default ordering is subject to override, as in the case of reversible position classes. In some languages, certain affixes vary freely in their ordering. In Chintang, for example, the order of a verb's prefixes is apparently unconstrained (Bickel et al. 2007), and comparable facts have been reported in other languages, such as Mari (Luutonen 1997) and Filomeno Mata Totonac (McFarland 2009). Such cases can be accommodated within PFM1 by relaxing the expectation that a language's paradigm function invariably specifies a default ordering of its rule blocks.

These assumptions afford a straightforward account of a variety of templatic phenomena, including parallel, reversible, ambifixal, and portmanteau position classes (Stump 1993b; 2001: Chapter 5).

Position classes m and n are **parallel** if an affix Y_1 belonging to class m has a phonologically identical counterpart Y_2 belonging to class n such that the content realized by Y_1 differs in a systematic way from the content realized by Y_2 . For example, in the inflection of Swahili verbs, the affixes expressing subject agreement in one affix position are mostly parallel to the affixes expressing object agreement in a distinct affix position. In a PFM1 analysis, this parallelism can be accounted for by means of default rules of referral, according to which the subject-agreement and object-agreement rule blocks refer the realization of person, number, and noun class to the same block of rules (cf. the analysis of Lingala proposed by Stump 2001: 144–9).

Position classes m and n are **reversible** if the affixes belonging to m are, in the default case, ordered before affixes belonging to n , but this ordering is reversed in the realization of specific morphosyntactic property sets. For example, in the relative past tense inflection of Fula verbs, subject-agreement suffixes ordinarily precede object-agreement suffixes, but they appear in the reverse order when first-person singular subject agreement coincides with either second-person singular or third-person singular Class 1 object agreement. In a PFM1 analysis, a default clause in the definition of the Fula paradigm function specifies one ordering of the subject- and object-agreement rule blocks, but in the realization of the exceptional property sets, this default ordering is overridden by the opposite ordering of the subject- and object-agreement rule blocks (see Stump 2001: 149–56).

A position class is **ambifixal** if its inventory of paradigmatically opposed affixes includes both prefixes and suffixes. In some cases, the prefixes and suffixes constituting an ambifixal class simply contrast, but in other cases, they exist as matched pairs. For example, Swahili has an ambifixal class of relative affixes (verbal affixes expressing the number and noun class of a relativized subject or object): the default use of these affixes is as prefixes, but in tenseless affirmative verb forms, they are instead used suffixally. In one possible PFM1 analysis (Stump 1993b: 145–53), default rules of exponence introduce the relative affixes as prefixes, and there is a metarule M such that for each rule introducing a relative prefix Y , M induces a competing rule that suffixes Y if the property set being realized is both tenseless and affirmative. In another, perhaps preferable sort of analysis, each relative affix Y is introduced by a single rule of exponence whose formulation involves a conditional suffixation operator (Stump 2012), which prefixes Y by default but suffixes Y if the relevant condition (“tenseless and affirmative”) is met by the property set being realized.

An affix belonging to a **portmanteau** position class $[m, n]$ is paradigmatically opposed to combinations of an affix from position class m with an affix from position class n . In Sanskrit, for example, the default expression of membership in the ninth conjugation is a suffix $-nī$ (sandhi form $-ṇī$), as in

the imperative form *krī-ñī-ta* ‘you (pl) buy!’, and the default expression of second-person singular subject agreement in active imperatives is *-hi*, as in *krī-ñī-hi* ‘you (sg) buy!’ But if a ninth-conjugation verb root ends in a consonant, the expected sequence of *-ñī-hi* in the second-person singular imperative active is supplanted by a special suffix *-āna*, as in *aś-āna* ‘you (sg) eat!’ (Table 17.5). The rule of exponence introducing *-āna* is special: its application excludes that of both the rule of exponence introducing *-ñī* (which belongs to rule Block I and is formulated in (20a)) and the rule of exponence introducing the subject marker *-hi* (which belongs to rule Block II and is formulated in (20b)). Stump (2001: 139ff.) therefore proposes that in instances of this kind, the rule of exponence introducing *-āna* is the sole member of a rule Block [II,I] that is in paradigmatic opposition to both Block I and Block II; this rule is formulated in (20c). The relevant clause in the definition of the Sanskrit paradigm function invokes rule Block [II,I] as in (21), allowing the *-āna* rule to override both the *-ñī* rule and the *-hi* rule in the realization of the cell in (22). In the realization of the cell in (23), however, (20c) cannot apply (since *Stem*($\langle \text{KRĪ}, \sigma: \{2\text{sg imp active}\} \rangle$) = $\langle \text{krī}, \sigma \rangle$ and *krī* doesn’t end in a consonant); instead, Block [II,I] defaults to the composition of Blocks II and I, in accordance with the Function Composition Default (24).

(20) Three rules of exponence in Sanskrit

- a. I, $X_{V[9\text{th conjugation}]}, \{\} \rightarrow X\text{ñī}$
- b. ii, $X_V, \{2\text{sg imp active}\} \rightarrow X\text{hi}$
- c. [II,I], $XC_{V[9\text{th conjugation}]}, \{2\text{sg imp active}\} \rightarrow XC\text{āna}$, where C is a consonant.

(21) $\text{PF}(\langle L, \sigma \rangle) = [[\text{II}, \text{I}] : \text{Stem}(\langle L, \sigma \rangle)]$

(22) $\langle \text{AŚ}, \{2\text{sg imp active}\} \rangle$

(23) $\langle \text{KRĪ}, \{2\text{sg imp active}\} \rangle$

(24) Function Composition Default:

By default, $[[m, n] : \langle X, \sigma \rangle] = [m : [n : \langle X, \sigma \rangle]]$.

Some templatic phenomena have been claimed to require an approach to inflectional morphology that is at odds with the assumptions in (19). Luís and Spencer (2005) observe that in situations where two series of

Table 17.5. *Second-person imperative active forms of two ninth-conjugation verbs in Sanskrit*

	KRĪ ‘buy’	AŚ ‘eat’
2sg	<i>krī-ñī-hi</i>	<i>aś-āna</i>
2du	<i>krī-ñī-tam</i>	<i>aś-ñī-tam</i>
2pl	<i>krī-ñī-ta</i>	<i>aś-ñī-ta</i>

affixes can be realized either prefixally or suffixally, it sometimes happens that the affixes occur in the same relative order on either side of the stem. This is illustrated in (25) with Italian pronominal affixes. Luís and Spencer interpret this phenomenon as evidence that a language's morphology defines affix sequences as autonomous morphological constituents which are positioned as wholes with respect to the stem with which they join: [*me-lo*]-*spedisce*, *spedisci*-[*me-lo*]. This interpretation is not necessary, however. For example, one need only assume (i) that the pronominal affixes in (25) are introduced by rule blocks that are both reversible and ambifixal and (ii) that the same morphosyntactic property sets that condition the override of the default prefixal status of the pronominal affixes also cause the default ordering of rule blocks to be overridden in (25b).

- (25) a. *Me lo spedisce.* b. *Spedisci-me-lo!*
 1SG.DAT 3SG.ACC sends send.IMP-1SG.DAT-3SG.ACC
 ‘He sends it to me’ ‘Send it to me!’ (Monachesi 1999: 44)

4 Extensions and Alternatives

We now discuss various extensions and modifications that have been proposed for implementing the core assumptions of PFM. These proposals do not alter the core assumptions, but constitute new approaches to their execution. They take the formal articulation of PFM in various directions for varied reasons; not all proponents of PFM subscribe to all of them.

4.1 Content versus Form: PFM2

Early work in PFM focused on complex inflectional systems in which the mapping of a paradigm cell $\langle L, \sigma \rangle$ to its realization W is relatively transparent – in which the status of W 's inflectional markings as exponents of σ is comparatively straightforward. Recent work has, however, called attention to diverse phenomena in which the realization of a paradigm's cells fails to exhibit such transparency. These include phenomena such as **deponency**, **syncretism**, **defectiveness**, **heteroclisis**, **suppletion**, and **overabundance**. In a series of papers (Stump 2002, 2006; Stewart and Stump 2007; Spencer and Stump 2013) and most definitively by Stump (2016), an extension of PFM has been proposed to account for such misalignments between content and form; following Spencer and Stump, we refer to this extension as PFM2. The central innovation of PFM2 is a conceptual distinction between **content paradigms** and **form paradigms**.¹² A lexeme L 's content paradigm specifies the full range of morphosyntactic property sets with which L may be

¹² Compare Round (2013), who develops a detailed account of Kayardild morphosyntax based on a similar assumption.

associated in syntax; thus, each cell in L's content paradigm is the pairing of L with a morphosyntactic property set σ such that L and σ may occupy the same node in syntax. By contrast, the form paradigm of a stem S specifies the full range of morphosyntactic property sets for which S may inflect in the morphological component; thus, each cell in the form paradigm of S is the pairing of S with a morphosyntactic property set σ such that σ may be realized morphologically through the inflection of S.

In the simplest case, the content paradigm of a lexeme L aligns perfectly with the form paradigm of its lone stem S: for each cell $\langle L, \sigma \rangle$ in L's content paradigm (i.e., each **content cell**), there is a single and definite corresponding **form cell** $\langle S, \sigma \rangle$ (= *Stem*($\langle L, \sigma \rangle$)). This is the **canonical correspondence** between content paradigms and form paradigms. The observed misalignments between content and form are therefore instances in which this canonical correspondence is disturbed.

Paradigm functions continue to play a central role in PFM2. A language's paradigm function remains a function from paradigm cells to their realizations; but now, there are two sorts of paradigm cells to which a paradigm function may apply: content cells and form cells. Given a form cell $\langle S, \sigma \rangle$, the value of $PF(\langle S, \sigma \rangle)$ is defined (as before) in terms of blocks of realization rules. Realization rules still take the form in (12) (repeated here as (26)), but they are slightly different in their interpretation. In earlier PFM, inflection classes were regarded as classes of lexemes; in this new version of PFM, inflection classes are regarded as sets of stems. Thus, given a pair $\langle W, \sigma \rangle$, where W is a stem and σ is a well-formed and complete set of morphosyntactic properties, a realization rule having the form in (26) applies to $\langle W, \sigma \rangle$ only if (i) W belongs to class C and (ii) τ is a subset of σ . If these requirements are met, then the rule applies to $\langle W, \sigma \rangle$ to yield the value $\langle f(W), \sigma \rangle$, where by convention $f(W)$ then belongs to the same inflection class(es) as W.

(26) $n, X_C, \tau \rightarrow f(X)$

For a content cell $\langle L, \sigma \rangle$, the value of $PF(\langle L, \sigma \rangle)$ is defined indirectly: where *Stem*($\langle L, \sigma \rangle$) is the form cell to which $\langle L, \sigma \rangle$ corresponds (i.e., where *Stem*($\langle L, \sigma \rangle$) is the **form-correspondent** of $\langle L, \sigma \rangle$), the value of $PF(\langle L, \sigma \rangle)$ is equated with that of $PF(\textit{Stem}(\langle L, \sigma \rangle))$.

The relation between content cells and their form correspondents is specified by **rules of paradigm linkage**. The default rule of paradigm linkage may be formulated as in (27); this rule expresses the simple relation in which each morphosyntactic property set σ that is relevant for the syntax of L is likewise relevant for the inflectional morphology of *Stem*($\langle L, \sigma \rangle$), and vice versa. This rule is, however, subject to override by more specific rules of paradigm linkage, in accordance with Pāṇini's principle. The default rule of paradigm linkage should not be equated with the canonical correspondence between content paradigms and form paradigms. In instances of canonical correspondence, there is a single stem S such that $PF(\langle L, \sigma \rangle) = PF(\langle S, \sigma \rangle)$ for every cell $\langle L, \sigma \rangle$ in L's content

Table 17.6. *Present indicative subparadigm of two Latin verbs*

		simple verb		deponent verb	
		AMŌ ‘love’		IMITOR ‘mimic’	
		ACTIVE	PASSIVE	ACTIVE	PASSIVE
sg	1	<i>amō</i>	<i>amor</i>	<i>imitor</i>	
	2	<i>amās</i>	<i>amāris</i>	<i>imitāris</i>	
	3	<i>amat</i>	<i>amātur</i>	<i>imitātur</i>	
pl	1	<i>amāmus</i>	<i>amāmur</i>	<i>imitāmur</i>	
	2	<i>amātis</i>	<i>amāmini</i>	<i>imitāmini</i>	
	3	<i>amant</i>	<i>amantur</i>	<i>imitantur</i>	

paradigm; but (27) allows instances in which $\text{Stem}(\langle L, \sigma \rangle) = \langle X, \sigma \rangle$ and $\text{Stem}(\langle L, \sigma' \rangle) = \langle Y, \sigma' \rangle$ but $X \neq Y$.

(27) Default rule of paradigm linkage

Given a lexeme L , $\text{PF}(\langle L, \sigma \rangle) = \text{PF}(\text{Stem}(\langle L, \sigma \rangle))$.

Deponency is one type of case where the default rule in (27) is overridden by a narrower rule of paradigm linkage. Consider Latin deponent verbs, in whose inflection passive forms are used to realize the active subparadigm (Table 17.6) and the passive subparadigm goes unrealized. This situation can be accounted for by means of the two rules of paradigm linkage in (28).¹³

- (28) a. Where L is a deponent verb lexeme, $\{\text{active}\}$ is a subset of σ and $\sigma' = \sigma/\text{passive}$,
 $\text{PF}(\langle L, \sigma \rangle) = \text{PF}(\text{Stem}(\langle L, \sigma' \rangle))$.
 b. If L is a deponent verb lexeme, $\text{PF}(\langle L, \sigma:\{\text{passive}\} \rangle)$ is undefined.

Pāṇini's principle causes these rules to override the default rule of paradigm linkage in the inflection of deponent verbs. By (28a), active cells in a deponent verb's content paradigm are mapped to passive form cells. By (28b), passive cells in a deponent verb's content paradigm lack form correspondents, and therefore go unrealized.

Directional whole-word syncretism is another phenomenon that may be modeled by means of overrides of the default rule of paradigm linkage; thus, the rule of paradigm linkage in (29) is a simple alternative to including clause (5) in the definition of the Sanskrit paradigm function.

- (29) Where L is a neuter lexeme, $\{\text{nom}\}$ is a subset of σ and $\sigma' = \sigma/\{\text{acc}\}$,
 $\text{PF}(\langle L, \sigma \rangle) = \text{PF}(\text{Stem}(\langle L, \sigma' \rangle))$.

In the directional syncretism defined by (29), nominative realizations are parasitic on accusative realizations. But as Baerman et al. (2005) have

¹³ We leave aside here both semi-deponent verbs and the realization of participles. See Hippisley (2007) for thorough discussion and analysis.

shown, most syncretism is **symmetric** (or nondirectional): neither of two syncretized forms can be said to be parasitic on the other. A case in point is the syncretism of the genitive dual with the locative dual in Sanskrit. Such cases motivated Stump (2010) to propose a second, nondirectional approach to syncretism.¹⁴ Adapting this approach, we allow a form cell to be either the pairing $\langle X, \sigma \rangle$ of a stem X with a morphosyntactic property set σ or the pairing $\langle X, \Sigma \rangle$ of X with a set Σ of morphosyntactic property sets; in the default case, a form cell $\langle X, \Sigma \rangle$ then serves as the form correspondent of any content cell $\langle L, \sigma \rangle$ such that $L\text{-index}(X) = L$ and σ is a member of Σ . For instance, a Sanskrit nominal's form paradigm doesn't contain distinct {gen du} and {loc du} cells, but a single {{gen du}, {loc du}} cell, to which the *Stem* function links both the {gen du} and {loc du} content cells: $\text{Stem}(\langle L, \{\text{gen du}\} \rangle) = \text{Stem}(\langle L, \{\text{loc du}\} \rangle) = \langle X, \{\{\text{gen du}\}, \{\text{loc du}\}\} \rangle$.

The postulation of form cells with second-order property sets such as {{gen du}, {loc du}} makes it necessary to supplement the interpretation of realization rules having the form in (11): given a pair $\langle W, \Sigma \rangle$, where W is a stem and Σ is set of morphosyntactic property sets, a realization rule having the form in (11) applies to $\langle W, \Sigma \rangle$ only if (i) W belongs to class C and (ii) there is some property set σ in Σ such that τ is a subset of σ . If these requirements are met, then the rule applies to $\langle W, \Sigma \rangle$ to yield the value $\langle f(W), \Sigma \rangle$, where $f(W)$ belongs to the same inflection class(es) as W .

Although symmetric syncretisms defined in this way conform to the default rule of paradigm linkage in (27), they do not conform to the canonical correspondence between content paradigms and form paradigms: they involve a many-to-one relation between content cells and forms cells, whereas canonical correspondence is a one-to-one relation.

Like deponency and directional syncretism, morphological defectiveness involves an override of the default rule of paradigm linkage. Defectiveness may coincide with deponency, as in (28), but need not; for instance, the defective French verb *TRAIRE* 'to milk' involves the simple rule of paradigm linkage in (30).

(30) $\text{PF}(\langle \text{TRAIRE}, \sigma: \{\text{pst pfv}\} \rangle)$ is undefined.

PFM2 models heteroclisis and stem suppletion as instances of the same phenomenon. The Russian nouns in Table 17.7 illustrate this. Each nominal lexeme in Table 17.7 is associated with a default stem by the *Stem* function, as in (31). In the default case, a noun's realizations are all based on the form paradigm of its default stem. The nouns *NEBO* and *ČELOVEK*, however, have different stems in the plural, as specified in (32); that is, they get their singular realizations from one form paradigm (that of their default stem) but their plural realizations from a different form paradigm (that of the overriding stem). Thus, although *NEBO* and *ČELOVEK* both conform to the default rule of

¹⁴ See Stump (2001: 222–3) for a different approach to symmetrical syncretisms involving realization metarules.

Table 17.7. *Paradigms of five Russian nouns*

		MESTO 'place'	NEBO 'sky'	SLON 'elephant'	ČELOVEK 'person'	GOST' 'guest'
sg	nom	<i>mesto</i>	<i>nebo</i>	<i>slon</i>	<i>čelovek</i>	<i>gost'</i>
	gen	<i>mesta</i>	<i>neba</i>	<i>slona</i>	<i>čeloveka</i>	<i>gostja</i>
	dat	<i>mestu</i>	<i>nebu</i>	<i>slonu</i>	<i>čeloveku</i>	<i>gostju</i>
	acc	<i>mesto</i>	<i>nebo</i>	<i>slona</i>	<i>čeloveka</i>	<i>gostja</i>
	ins	<i>mestom</i>	<i>nebom</i>	<i>slonom</i>	<i>čelovekom</i>	<i>gostem</i>
	prep	<i>meste</i>	<i>nebe</i>	<i>slone</i>	<i>čeloveke</i>	<i>goste</i>
pl	nom	<i>mesta</i>	<i>nebesa</i>	<i>slony</i>	<i>ljudi</i>	<i>gosti</i>
	gen	<i>mest</i>	<i>nebes</i>	<i>slonov</i>	<i>ljudej</i>	<i>gostej</i>
	dat	<i>mestam</i>	<i>nebesam</i>	<i>slonam</i>	<i>ljudjam</i>	<i>gostjam</i>
	acc	<i>mesta</i>	<i>nebesa</i>	<i>slonov</i>	<i>ljudej</i>	<i>gostej</i>
	ins	<i>mestami</i>	<i>nebesami</i>	<i>slonami</i>	<i>ljudjami</i>	<i>gostjami</i>
	prep	<i>mestax</i>	<i>nebesax</i>	<i>slonax</i>	<i>ljudjax</i>	<i>gostjax</i>

paradigm linkage, they diverge from the canonical correspondence of content paradigms to form paradigms. In the case of the suppletive noun NEBO, this divergence is purely a matter of phonological form; its stems *neb* and *nebes* belong to the same declension class. In the case of the heteroclitite noun ČELOVEK, by contrast, the divergence is a matter of both the phonological form of the stem and its declension-class membership: its singular stem *čelovek* belongs to the *slon*-class and its plural stem *ljud* to the *gost'* class. (In this case, heteroclitis coincides with suppletion, but there are convincing cases of heteroclitite lexemes with phonologically identical stems; an example is the Czech noun PRAMEN 'source,' whose singular stem follows the soft-inanimate declension and whose plural stem follows the hard-inanimate declension but both of whose stems have the phonological form *pramen*.)

(31) Default rules of basic stem choice

- $\text{Stem}(\langle \text{MESTO}, \sigma:\{\} \rangle) = \langle \text{mest}, \sigma \rangle$ (where $\text{mest} \in [\text{DECLENSION: mesto}]$)
- $\text{Stem}(\langle \text{NEBO}, \sigma:\{\} \rangle) = \langle \text{neb}, \sigma \rangle$ (where $\text{neb} \in [\text{DECLENSION: mesto}]$)
- $\text{Stem}(\langle \text{SLON}, \sigma:\{\} \rangle) = \langle \text{slon}, \sigma \rangle$ (where $\text{slon} \in [\text{DECLENSION: slon}]$)
- $\text{Stem}(\langle \text{ČELOVEK}, \sigma:\{\} \rangle) = \langle \text{čelovek}, \sigma \rangle$ (where $\text{čelovek} \in [\text{DECLENSION: slon}]$)
- $\text{Stem}(\langle \text{GOST'}, \sigma:\{\} \rangle) = \langle \text{gost'}, \sigma \rangle$ (where $\text{gost'} \in [\text{DECLENSION: gost'}]$)

(32) Overriding rules of basic stem choice

- $\text{Stem}(\langle \text{NEBO}, \sigma:\{\text{plural}\} \rangle) = \langle \text{nebes}, \sigma \rangle$ (where $\text{nebes} \in [\text{DECLENSION: mesto}]$)
- $\text{Stem}(\langle \text{ČELOVEK}, \sigma:\{\text{plural}\} \rangle) = \langle \text{ljud'}, \sigma \rangle$ (where $\text{ljud'} \in [\text{DECLENSION: gost'}]$)

Whole-word suppletion also involves overrides of the default rule of paradigm linkage. In suppletion of this sort, the suppletive word fails to exhibit either the expected stem or the expected inflectional marking; for

example, the comparative adjective *worse* exhibits neither the stem *bad* nor the affix *-er*. In PFM2, instances of whole-word suppletion involve such local overrides of the default rule of paradigm linkage as that of (33).

$$(33) \quad \text{PF}(\langle \text{BAD}, \{\text{comparative}\} \rangle) = \langle \text{worse}, \{\text{comparative}\} \rangle$$

Paradigm Function Morphology is built on the premise that inflection is a *function* from the cells in a lexeme's paradigm (lexeme/property set pairings) to their realizations. It is natural to assume that each cell in a lexeme's paradigm has at most one realization. Although this expectation is satisfied in the vast majority of cases, there are cases which do not conform to it. For instance, the past-tense cells in the paradigms of the English verbs DREAM, LEAP, and BURN may be realized either as *dreamt*, *leapt*, and *burnt* or as *dreamed*, *leaped*, and *burned*. Thornton (2012) terms the phenomenon **overabundance**, and documents the fact that overabundance can affect either individual cells, slabs of cells, or even the full paradigm of a lexeme. In the cases she discusses, overabundance is an exceptional property of individual lexemes, but there are also cases of **systematic overabundance** such that all lexemes in some syntactic category have more than one way of expressing some morphosyntactic property sets. In Spanish, each verb has two sets of forms expressing the past subjunctive (Alcoba 1999), with one set exhibiting the stem-forming suffix *-ra*, the other exhibiting the suffix *-se*; the pair of verbs in Table 17.8 illustrates this.

One way of accommodating overabundance within the framework of PFM2 is to assume that, in some languages, the *Stem* function isn't strictly a function at all, but a relation, potentially mapping the same content cell onto the same cell in more than one form paradigm, as in (34) and (35).

$$(34) \quad \begin{array}{ll} \text{a. } \text{Stem}(\langle \text{DREAM}, \sigma:\{\text{pst}\} \rangle) = \langle /d\text{.}\dot{\text{r}}\text{im}/_1, \sigma \rangle \\ \quad \quad \quad (\text{where } /d\text{.}\dot{\text{r}}\text{im}/_1 \text{ belongs to the } \textit{mean} \text{ conjugation}) \\ \text{b. } \text{Stem}(\langle \text{DREAM}, \sigma:\{\text{pst}\} \rangle) = \langle /d\text{.}\dot{\text{r}}\text{im}/_2, \sigma \rangle \\ \quad \quad \quad (\text{where } /d\text{.}\dot{\text{r}}\text{im}/_2 \text{ belongs to the } \textit{seem} \text{ conjugation}) \end{array}$$

$$(35) \quad \begin{array}{ll} \text{a. } \text{Stem}(\langle \text{CORTAR}, \sigma:\{\text{sbjv pst}\} \rangle) = \langle \textit{cortara}, \sigma \rangle \\ \text{b. } \text{Stem}(\langle \text{CORTAR}, \sigma:\{\text{sbjv pst}\} \rangle) = \langle \textit{cortase}, \sigma \rangle \end{array}$$

Such instances suggest that a language's paradigm function should be reconceived as a function mapping each content cell onto a **set** of realizations; in most cases this is a unit set, but not invariably so.¹⁵ That is, given the rules in (36), the English paradigm function might be partially defined as in (37); accordingly, $\text{PF}(\langle \text{DREAM}, \{\text{pst}\} \rangle)$ would have the pair of realizations in (38).

¹⁵ Bonami and Boyé (2007) draw upon similar evidence to argue that paradigm functions should be seen as relations rather than as functions. The solution suggested here, that of regarding paradigm functions as set-valued functions, is equivalent and allows for the name "Paradigm Function Morphology" to keep its transparent meaning.

Table 17.8. *Past subjunctive paradigms of two Spanish verbs*

	CORTAR ‘to cut’		VIVIR ‘to live’	
	Form 1	Form 2	Form 1	Form 2
1sg	<i>cortara</i>	<i>cortase</i>	<i>viviera</i>	<i>viviese</i>
2sg	<i>cortaras</i>	<i>cortases</i>	<i>vivieras</i>	<i>vivieses</i>
3sg	<i>cortara</i>	<i>cortase</i>	<i>viviera</i>	<i>viviese</i>
1pl	<i>cortáramos</i>	<i>cortásemos</i>	<i>viviéramos</i>	<i>viviésemos</i>
2pl	<i>cortarais</i>	<i>cortaseis</i>	<i>vivierais</i>	<i>vivieseis</i>
3pl	<i>cortaran</i>	<i>cortasen</i>	<i>vivieran</i>	<i>viviesen</i>

(36) a. Rules of exponence

$I, X_{V[\text{Conjugation: mean}], \{\text{pst}\}} \rightarrow /X't/$ (subject to (36b))

$I, X_{V[\text{Conjugation: seem}], \{\text{pst}\}} \rightarrow /Xd/$

b. Morphological metageneralization

Where X has a high, tense vowel Y, X' is like X except in that Y is replaced by its mid, lax counterpart.

(37) For each value $\langle X, \sigma' \rangle$ of *Stem*($\langle L, \sigma \rangle$), $[I : \langle X, \sigma' \rangle]$ is a member of $PF(\langle L, \sigma \rangle)$.

(38) $PF(\langle \text{DREAM}, \{\text{pst}\} \rangle) = \{[I : \langle d\text{rim}/_1, \{\text{pst}\} \rangle], [I : \langle d\text{rim}/_2, \{\text{pst}\} \rangle]\}$
 $= \{ \langle d\text{r}\text{ɛ}mt/, \{\text{pst}\} \rangle, \langle d\text{r}\text{im}d/, \{\text{pst}\} \rangle \}$

PFM2 is attractive because it allows the diverse phenomena of deponency, heteroclisis, suppletion, syncretism, and defectiveness to be given similar diagnoses: each disturbs the canonical correspondence between content paradigms and form paradigms. (See Spencer and Stump (2013) for discussion of another phenomenon that is subject to the same diagnosis, that of **functor-argument reversal** in the inflection of Hungarian pronouns.) Moreover, PFM2 affords a simple account of the interface of inflectional morphology with syntax and semantics: this interface is the set of content paradigms. Information present in content paradigms (the association of lexemes with morphosyntactic property sets) is accessible to rules of syntax and semantics; information which is instead situated in form paradigms (the phonology and inflection-class membership of stems, noncanonical form correspondents) is inaccessible.

4.2 Wackernagel Affixes

Nevis and Joseph (1992) draw attention to the existence of “Wackernagel affixes” — affixes that appear in second position within a word. Such affixes are unusual among affixes in that their placement is determined by their position relative to the edge of a word rather than by their position relative to a word’s stem. A case in point is that of endoclititic person markers in Sorani Kurdish (MacKenzie 1961–2; Samvelian 2007).

In the past tense of transitive verbs, subject-agreement markers are normally realized enclitically on the first major constituent of VP, as in (39).¹⁶ If, however, that first constituent happens to be the verb itself, then the clitic is not realized at the periphery of the verb, but has to be enclitic to the verb's first morph, irrespective of whether this first morph is the verb stem (as in (40a)), the negative prefix (as in (40b,c)), or an aspect prefix (as in (40d)).

- (39) *bâzîrgân-akân* [VP *Sirwan=jân nard*]
 merchant-DEF.PL Sirwan=3PL send.PST
 'The merchants sent Sirwan'
- (40) a. *bâzîrgân-akân* [VP *nard=jân=im*]
 merchant-DEF.PL send.PST=3PL=1SG
 'The merchants sent me'
- b. *bâzîrgân-akân* [VP *na=jân=nard-im*]
 merchant-DEF.PL NEG=3PL=send.PST-1SG
 'The merchants did not send me'
- c. *bâzîrgân-akân* [VP *na=jân=da-nard-im*]
 merchant-DEF.PL NEG=3PL=IPFV-send.PST-1SG
 'The merchants were not sending me'
- d. *bâzîrgân-akân* [VP *da=jân=nard-im*]
 merchant-DEF.PL IPFV=3PL=send.PST-1SG
 'The merchants were sending me'

This evidence casts doubt on the a-morphousness hypothesis (19b): according to that hypothesis, rules of exponence apply to phonological representations, yet the positioning of the Sorani Kurdish endoclititic seemingly requires reference to a representation in which individual morphs are delimited.

Two general approaches to this phenomenon have been proposed. One approach involves an enrichment of the representations on which realization rules operate; the other instead involves an enrichment of the rules themselves. Pursuing the former approach, Crysmann (2002), Bonami and Samvelian (2008) and Walther (2012) have developed the idea that rules of exponence create unordered sets of morphs whose ordering is specified by independent rules of linearization. This idea requires a relaxation of assumptions (19b–d)—that is, it entails that the representations on which realization rules operate are not strictly “a-morphous,” but consist of discrete morphs; that the rule introducing an affixal exponent does not determine its order with respect to the stem with which it joins; and that although a language's paradigm function determines the

¹⁶ These same agreement markers serve as object pronouns in the present, exhibiting an instance of morphological reversal (Baerman 2007). This has no consequences for the analysis of the data at hand.

rule blocks relevant for a word's inflection, it does not determine the relative order of the affixes introduced by those rule blocks, and indeed imposes no ordering whatever on the rule blocks themselves. This approach makes it possible for a linearization rule to position an endoclititic after a word's first morph, in that way accounting for the special distribution of Wackernagel affixes in a straightforward way. Moreover, this approach opens the way to an account of ambifixal and reversible position classes that is very different from that of Section 3.2 – an account in which both the ordering of an affix with respect to the stem with which it joins and the relative ordering of a word's affixes are regulated purely by linearization rules.

An alternative approach builds on the hypothesis that Wackernagel affixes are akin to infixes. Infixes are positioned relative to a particular phonological substring of the host word-form *W*. This “pivot” (Yu 2007: 67ff.) may be characterized in segmental terms (e.g., “*W*’s first consonant”) or in terms of syllabification (“*W*’s first syllable”) or prosody (“*W*’s first foot”). There are also inflectional systems in which some infixation pivots are determined morpholexically. In Dakota, for example, subject agreement markers are sometimes prefixed and sometimes infixed (Riggs 1893: 55–6). Monomorphemic verb stems having initial vowels exhibit infixation (*opa* ‘follow’: *o-wa-pa* ‘I follow’). Consonant-initial verb stems vary in their behavior. Some monomorphemic stems exhibit prefixation (*daka* ‘have an opinion of’: *wa-daka* ‘I have an opinion of’) while others exhibit infixation (*pahta* ‘bind’: *pa-wa-hta* ‘I bind’). Verb stems with instrumental prefixes likewise vary: stems with the instrumental prefix *ba-* (which implies a cutting instrument, such as a knife) exhibit infixation, but those formed with the instrumental prefix *ka-* (which implies a striking instrument, such as an axe) exhibit prefixation; thus, from the root *ksa* ‘separate’ come the derived verbs *ba-ksa* ‘cut off (as with a knife)’ and *ka-ksa* ‘chop off (as with an axe),’ whose first-person singular present-tense forms are *ba-wa-ksa* ‘I cut off’ and *wa-ka-ksa* ‘I chop off.’ Vocalic prepositional prefixes do not alter the location of a stem’s subject marker: *wa-kaštaŋ* ‘I pour out,’ *o-wa-kaštaŋ* ‘I pour out in’; *pa-wa-hta* ‘I bind,’ *a-pa-wa-hta* ‘I bind on.’ As these examples show, infixation pivots in Dakota verbs are identified by a mix of phonological, morphological, and lexical principles including those in (41). (The formulation of these principles presumes that subject markers are infixed after a verb stem’s pivot but prefixed in the absence of a pivot.) The important point here is that although the principles defining the Dakota infixation pivots make reference to morphological and lexical information, the stems over which they are defined are merely phonological representations, of which the infixation pivots are phonological substrings; that is, the principles in (41) do not necessitate a weakening of the a-morphousness hypothesis (19b).

- (41) a. By default, a verb stem's pivot is its first syllable: e.g., *opa* 'follow,' *pahta* 'bind,' *baksa* 'cut off,' *okaštan* 'pour out in.'
- b. A verb stem formed by means of the instrumental prefix *ka-* lacks a pivot: e.g., *kaksa* 'chop off.'
- c. By lexical stipulation, *daka* 'have an opinion of' lacks a pivot.
- d. Where Y is a vocalic prepositional prefix and X is a stem with pivot Z, the pivot of YX is Z: e.g., *apahta* 'bind on.'

A similar account may be given for the Sorani Kurdish pronominal endoclititics. In particular, one might postulate a morphological metageneralization to the effect that if a rule of exponence concatenates the phonological expressions X and Y as XY, then the pivot of XY is X. This suffices to determine the endoclititic placement in (38) in a manner compatible with the a-morphousness hypothesis.

At the time of writing it seems that the two competing strategies for modeling Wackernagel affixes (that of enriching the representations of a language's stems and words and that of enriching a language's system of morphological rules) can both account for the observed facts, but both come at a conceptual cost. More work on varied inflection systems is needed to ascertain whether one strategy is definitely preferable over the other.

4.3 Periphrasis and the Morphology-syntax Interface

Since the seminal studies of Börjars et al. (1997) and Ackerman and Webelhuth (1998), there is a growing consensus that some syntactic constructions express the pairing of a lexeme with a morphosyntactic property set, and should thus be incorporated into inflectional paradigms as **inflectional periphrases**. Although the exact limits of periphrasis are hard to pin down, examples such as that of the Persian perfect (Bonami and Samvelian 2009) are reasonably clearcut. Table 17.9 illustrates the relevant properties. In the past indicative and the subjunctive, the perfect is expressed by a combination of the perfect participle of the main verb with a form of the copula. In the present indicative, the periphrase has been morphologized into a synthetic form.¹⁷

The Persian past perfect possesses two diagnostic properties of periphrases identified by Ackerman and Stump (2004). It is **featurally intersective**: the combination of the feature values *past* and *perfect* is expressed

¹⁷ This difference is most immediately seen by looking at topicalization data: the participle in a past perfect can be topicalized (i), but not in the present perfect (ii). Note that for simplicity we ignore here forms expressing indirect eventuality. See Bonami and Samvelian (2009) for a fuller discussion of Persian conjugation in the context of PFM.

(i)	<i>Foruxte</i> in <i>tâblo=râ</i> <i>Maryam</i> <i>bud</i> sold DEM picture=ddo <i>Maryam</i> be.PST.3SG 'Maryam had sold this picture'
(ii)	<i>*Foruxte</i> in <i>tâblo=râ</i> <i>Maryam=ast</i> sold DEM picture=ddo <i>Maryam=be.PRS.3SG</i> (intended) 'Maryam has sold this picture'

Table 17.9. *Third-person singular forms of Persian FORUXTAN ‘sell’*

		Indicative		Subjunctive
		Present	Past	
Affirmative	Perfective		<i>foruxt</i>	<i>beforušad</i>
	Imperfective	<i>miforušad</i>	<i>miforuxt</i>	
	Perfect	<i>foruxte=ast</i>	<i>foruxte bud</i>	<i>foruxte bašad</i>
Negative	Perfective		<i>naforuxt</i>	<i>naforušad</i>
	Imperfective	<i>nemiforušad</i>	<i>nemiforuxt</i>	
	Perfect	<i>naforuxte=ast</i>	<i>naforuxte bud</i>	<i>naforuxte bašad</i>

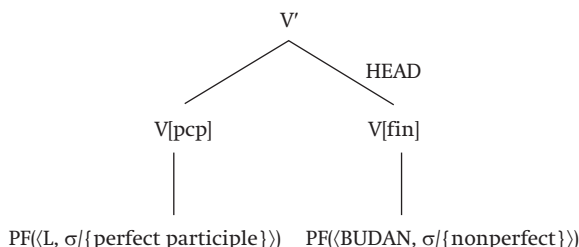
periphrastically, but both values can also be expressed synthetically in other cells of the paradigm. It also exhibits **distributed exponence**: polarity is realized on the main verb while TAM and agreement are realized on the auxiliary.

Such data motivate introducing **rules of periphrastic exponence** which enter into Pāṇinian competition with ordinary rules of exponence. An informal statement of the relevant rule for the Persian perfect is given in (42), which will apply to realize the property “perfect” unless it is overridden by more specific rules applying to realize the property set {present perfect}.

- (42) The word form realizing $\langle L, \sigma:\{\text{perfect finite}\} \rangle$ is the combination of the word form realizing $\langle L, \sigma/\{\text{perfect participle}\} \rangle$ and the word form realizing $\langle \text{BUDAN}, \sigma/\{\text{nonperfect}\} \rangle$.

How is the word “combination” in (42) to be understood? Existing proposals can be grouped in two families. **Phrase-structure-based accounts** follow Ackerman and Webelhuth (1998) in assuming that the right-hand side of rules of periphrastic exponence is a specification of a schematic phrase structure (Sadler and Spencer 2001; Stump 2001; Ackerman and Stump 2004). A possible formulation of that kind is given in (43a). **Functional accounts** (Bonami and Samvelian 2009; Stump and Hippisley 2011; Bonami and Webelhuth 2013) assume that rules of periphrastic exponence define a word-form carrying a requirement that this word-form enter a specified grammatical relation to another word-form. The rule in (43b) is a simplification of Bonami and Samvelian’s proposal for Persian.

- (43) a. $\text{PF}(\langle L, \sigma:\{\text{perfect finite}\} \rangle) = \langle W, \sigma \rangle$,
where $W =$



- b. Where {perfect finite} is a subset of σ ,
 $\tau = \sigma / \{\text{nonperfect}\}$,
 $\text{PF}(\langle \text{BUDAN}, \tau \rangle) = \langle W, \tau \rangle$, and
 W' is like W except that it subcategorizes for L 's perfect
 participle:
 $\text{PF}(\langle L, \sigma \rangle) = \langle W', \sigma \rangle$.

As Bonami and Webelhuth (2013) emphasize, functional accounts are preferable because they are more clearly compatible with the phrase-structural diversity of periphrases. Normally, a periphrase in a given language presumes a functional relation between its auxiliary and main elements and is compatible with the various phrase-structural instantiations of that relation that are independently licensed by that language's syntax. In addition, the diversity of phrase-structural configurations that can be involved in periphrasis entails that a phrase-structure based account would need to endow rules of periphrastic exponence with the full power of syntactic description, including nested syntactic structure and arbitrary embedding.

The difficult issue is to find a way of expressing (43b) that is compatible with the core assumptions of PFM discussed in Section 2. Bonami and Samvelian's (2009) proposal has a definite **incremental** flavor, since rules of exponence may modify a word's subcategorization requirements. Stump and Hippius (2011) propose to avoid this problem by relying on a combination of feature co-occurrence restrictions and rules of referral; Bonami and Webelhuth (2013) choose to model rules of periphrastic exponence as an alternative to PFM-based synthetic exponence, rather than as part of the PFM system. Bonami (2015) improves on these proposals by allowing a word-form's inflectional exponents to include a collocational requirement on the syntactic context in which it is placed; periphrastic conjugation thus arises as the effect of a collocational exponent requiring a main verb to occur in the syntactic dependency of an auxiliary.

4.4 Exponence-based and Implicative Generalizations in Inflectional Morphology

Implicative rules such as (5) deduce the realization of one cell in a lexeme's paradigm from that of another cell; in this way, they make it possible to describe instances of directional whole-word syncretism in a precise way. But one can imagine generalizing the role of implicative rules in the definition of a language's inflectional system. In particular, implicative rules might be formulated to deduce the realization of one cell from that of a distinct cell even in cases in which the two realizations are phonologically distinct; for instance, one might postulate the implicative rule in (44) for Latin verbs; according to this rule (which, in formal terms, is a clause in

the definition of the Latin paradigm function), a verbal lexeme whose present active infinitive realization is of the form *Xe* has a first-person plural imperfect active subjunctive realization of the form *Xēm̄us*. This rule correctly deduces the subjunctive forms *laudārēm̄us* ‘we praised,’ *monērēm̄us* ‘we advised,’ *dūcerēm̄us* ‘we led,’ *audīrēm̄us* ‘we heard,’ and *caperēm̄us* ‘we took’ from the corresponding infinitive forms *laudāre*, *monēre*, *dūcere*, *audīre* and *capēre*.

- (44) Where $\sigma_1 = \{\text{prs active inf}\}$ and $\sigma_2 = \{\text{1pl impf active subjv}\}$,
If $\text{PF}(\langle L, \sigma_1 \rangle) = \langle Xe, \sigma_1 \rangle$, then $\text{PF}(\langle L, \sigma_2 \rangle) = \langle Xēm̄us, \sigma_2 \rangle$.

Implicative rules such as (44) make it possible to dispense with inflection-class diacritics because they allow all of a lexeme’s realizations to be deduced from certain key forms, traditionally referred to as **principal parts**. (Latin verbs are traditionally assumed to have four principal parts: the first-person singular present active indicative, the present active infinitive, the first-person singular perfect indicative active, and the perfect passive participle.)

We can therefore distinguish between exponence-based and implicative generalizations in the definition of a language’s inflectional morphology: exponence-based generalizations include rules of exponence (e.g., those in Table 17.3), while implicative generalizations include rules of referral (e.g. (17)) as well as implicative clauses in the definition of a language’s paradigm (e.g. (5), (44)). It is wrong, in our view (and *pace* Blevins (2006)), to regard these as competing alternatives: the most perspicuous description of a language’s inflectional morphology may involve generalizations of both sorts. Indeed, some implicative generalizations specifically apply to rules of exponence.

Consider, for example, the partial declensional paradigms in Table 17.10. Given a locative singular form *Xau*, one cannot deduce any other form in the paradigm, since the stems for the remaining case forms could either be *Xi* and its alternants or *Xu* and its alternants; nevertheless, a locative singular form *Xau* does allow one to deduce the rules of exponence through whose application the remaining case forms arise from their stems (whatever their form may be). By the same token, given a genitive singular form *Xasya*, one cannot deduce the rule of exponence by which the corresponding nominative singular is formed: this could be a rule suffixing *-s* or a rule suffixing *-m*. Even so, a genitive singular form *Xasya* does allow one to deduce that the corresponding nominative singular form is based on the stem *Xa*.

These examples show that it is not simply words, but also rules of stem choice and rules of exponence that participate in implicative relations. The modeling of these relations has important consequences for lexical representations: for example, for the choice between marking lexemes with inflection-class diacritics such as “first declension” and specifying lexemes’ principal parts. This is a complex issue whose resolution remains to be

Table 17.10. *Partial declensional paradigms of four Sanskrit nouns*

		AŚVA 'horse'	ĀSYA 'mouth'	AGNI 'fire'	ŚATRU 'enemy'
Singular	NOM	<i>aśva-s</i>	<i>āsya-m</i>	<i>agni-s</i>	<i>śatru-s</i>
	VOC	<i>aśva</i>	<i>āsya</i>	<i>agne</i>	<i>śatro</i>
	ACC	<i>aśva-m</i>	<i>āsya-m</i>	<i>agni-m</i>	<i>śatru-m</i>
	GEN	<i>aśva-sya</i>	<i>āsya-sya</i>	<i>agne-s</i>	<i>śatro-s</i>
	LOC	<i>aśve</i>	<i>āsye</i>	<i>agnau</i>	<i>śatrau</i>
Dual	NOM/VOC/ACC	<i>aśvau</i>	<i>āsye</i>	<i>agnī</i>	<i>śatrū</i>
	GEN/LOC	<i>aśvay-os</i>	<i>āsya-os</i>	<i>agny-os</i>	<i>śatrv-os</i>
Plural	NOM/VOC	<i>aśvā-s</i>	<i>āsya-ni</i>	<i>agnay-as</i>	<i>śatrav-as</i>
	ACC	<i>aśvā-n</i>	<i>āsya-ni</i>	<i>agnī-n</i>	<i>śatrū-n</i>
	GEN	<i>aśvā-nām</i>	<i>āsya-nām</i>	<i>agnī-nām</i>	<i>śatrū-ñām</i>
	LOC	<i>aśve-ṣu</i>	<i>āsye-ṣu</i>	<i>agni-ṣu</i>	<i>śatru-ṣu</i>

worked out; for details, see Finkel and Stump (2007, 2009) and Stump and Finkel (2013: Chapter 7).

5 Conclusion

The core assumptions of PFM presented in Section 2 are very robust. Although they impose important constraints on the formal definition of a language's inflectional morphology, they are also flexible; various instantiations of PFM are imaginable within the compass of these core assumptions. This, in our view, is one of the theory's virtues; progress in morphological theory (and in linguistics generally) depends on the comparison of alternative analyses that are precise in their formulation. As we have seen in Section 4, various morphological issues (e.g., deponency, defectiveness, syncretism, heteroclisis, suppletion, variable affix order, endocclisis, periphrasis, implicative relations among a paradigm's cells) suggest a range of new directions for the formal elaboration of PFM; our conviction is that the investigation of these new directions will ultimately afford a more fully articulated set of core assumptions.

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Network Morphology

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1 Introduction

Network Morphology uses the notion of defaults and overrides to capture the systematicity and exceptionality of morphology in a formal way, making its theories computable and therefore easy to test. Morphological knowledge is represented as a network, and this allows for an elegant account of inflectional classes and various other dissociations between syntax and morphology, such as syncretism and deponency. Paradigms play a central role in the framework, with the minimal sign assumed to be the lexeme, and the relation between meaning and form to be inferential-realization (see Chapter 3). In this overview of the framework we outline the key notions in Network Morphology: **default inheritance**, **default inference** and **default orthogonal multiple inheritance**. Treating each of these in turn we show how these notions can lead to valuable insights into the workings of morphology. To make the point, we will sometimes use Network Morphology's formalism, DATR (Evans and Gazdar 1996). The reader is encouraged to read Chapter 11 of this book as important background on how defaults are used in morphological description.

Inflectional classes share many properties with each other; they are far from redundant free. In Section 2 we show much of this redundancy can be wrung out by recasting classes as a network of nodes that shares with each other. The sharing is through default inheritance, which we show also renders irregularity as a scalar concept. We illustrate with Latin nouns. Staying with Latin, in Section 3 we show how Pāṇini-style default inference captures certain kinds of syncretism, provides naturally for an indexed stem approach to allomorphy (see Chapter 5), and treats the seemingly exceptional phenomenon of deponency as a relatively small step misalignment of function and form. Illustrating with a number of Iranian languages, we introduce the concept of **paradigm signature**, a way of profiling a language's inflectional system through default inference that

provides an interesting point of typological comparison between languages. Section 4 deals with the final key notion, default orthogonal multiple inheritance, which is used to account for lexical relatedness in word formation, illustrated with Russian, and morphology's place in the overall architecture of the grammar.

For a monograph treatment of the framework, we refer the reader to Brown and Hippisley (2012) and the references therein. Corbett and Fraser (1993) is a seminal and classic Network Morphology treatment of Russian inflectional classes, syncretism, and gender assignment. A Network Morphology bibliography can be found at

<http://www.smg.surrey.ac.uk/approaches/network-morphology/bibliography> (accessed April 30, 2016).

2 Default Inheritance

The paradigms of five Latin nouns are given in (1).¹ Together they stake out much of the space of noun inflectional variation found in the language. As such, these five paradigms, representing five inflectional classes, together generalize over thousands of lexemes. But the generalization is itself subject to generalization.

(1)	1	2	3	4	5
	AQUA	SERVUS	IŪDECS	FRŪCTUS	RĒS
	'water'	'slave'	'judge'	'fruit'	'thing'
	SINGULAR				
nominative	aqua	servus	iūdecus	fructus	rēs
genitive	aquae	servī	iūdicis	fructūs	reī
dative	aquae	servō	iūdici	fructui	reī
accusative	aquam	servum	iūdicem	fructum	rem
ablative	aquā	servō	iūdice	fructū	rē
	PLURAL				
nominative	aquae	servī	iūdicēs	fructūs	rēs
genitive	aquārum	servōrum	iūdicum	fructuum	rērum
dative	aquīs	servīs	iūdicibus	fructibus	rēbus
accusative	aquās	servōs	iūdicēs	fructūs	rēs
ablative	aquīs	servīs	iūdicibus	fructibus	rēbus

An inflectional class consisting solely of unique cells is hard to find in the world's languages. Corbett (2009: 8) cites Burmeso verb classes as coming close (see also discussion in Chapter 11, §5). Rather classes share properties with one another. Here the dative and ablative plural *-īs* exponent is shared by the AQUA and SERVUS classes (1 and 2). Classes 2 and 4

¹ See Chapter 11 for a default inheritance account of noun classes in Polish.

share accusative singular *-um*, classes 2 and 5 share genitive singular *-i*, and classes 3 and 4 share plural dative and ablative *-ibus*, for example. As well as *horizontal* sharing there may be *vertical* sharing. Within a single class, cells may share an exponent: the genitive and dative singular *-ae* in class 1, the nominative and accusative plural *-ūs* in class 4, for example. All classes share the ablative and dative plural: *-īs* in classes 1 and 2, *-ibus* in classes 3 and 4, and *-bus* in class 5. For these cells there is a combination of horizontal and vertical sharing.

Network Morphology captures horizontal sharing and vertical sharing by distributing morphological facts across a network of nodes that share with each other through inheritance. A partial Network Morphology account of the facts in (1) is given in (2). (The complete theory based on the full chapter discussion is provided in the appendix.)

(2) a. Noun:

```
<syn cat> == noun
<mor pl dat> == "<stem>" is
<mor pl abl> == "<mor pl dat>" .
```

b. Class_1:

```
<> == Noun
<mor sg nom> == "<stem>" a
<mor sg gen> == "<stem>" ae
<mor sg dat> == <mor sg gen>
<mor sg acc> == "<stem>" am
...
```

Class_2:

```
<> == Noun
<mor sg nom> == "<stem>" us
<mor sg gen> == "<stem>" i
<mor sg dat> == "<stem>" ō
<mor sg acc> == "<stem>" um
<mor sg abl> == <mor sg dat>
...
```

Class_3:

```
<> == Noun
<mor sg nom> == "<stem 2>" s
<mor sg gen> == "<stem 1>" is
<mor sg dat> == "<stem 1>" i
<mor sg acc> == "<stem 1>" em
<mor pl dat> == "<stem 1>" ibus
...
```

c. Aqua:

```
<> == Class_1
<sem lex> == water
<stem> == aqu.
```



```

Servus:
    <> == Class_2
    <sem lex> == slave
    <stem> == serv.

Iūdecis:
    <> == Class_3
    <sem lex> == judge
    <stem 2> == iūdec
    <stem 1> == iūdic.

```

In (2) we have a DATR representation of a hierarchy of nodes related by default inheritance. (2a) is the root node, (2b) a set of nodes that inherit from the root, and (2c) a set of leaf nodes representing lexeme-style lexical entries that inherit from the (2b) set. To best understand the notation we can begin by looking at the lexical entry nodes (2c). These represent lexemes that belong to classes 1, 2, and 3. The first line is the node label, here the lexeme label. The second line represents inheritance from a (2b) node representing the lexeme's inflectional class. The third line pairs the stem attribute with a value—in other words, a form. In the case of IŪDECS 'judge,' there are two attribute-value pairings for stem. Node sets (2a) and (2b) contain *inheritable* facts. The facts in (2a) are more generalizable: the first line says that, for nouns in Latin, the syntactic category attribute (part of speech) is noun. Since the (2b) class nodes all inherit from this node, and the lexical entry nodes inherit from the class nodes, the lexical entry nodes will share this attribute; in other words, they are all nouns. (2c) nodes therefore express that lexical entries in Network Morphology are lexemes: they gather together syntactic <syn>, (lexical) semantic <sem lex>, phonological <stem>, and morphological <mor> types of information.

The highest-level inheritable facts are located at (2a), the node that generalizes over Latin nouns. We have already seen that this node holds the syntactic category generalization. The next line expresses that the plural dative is realized as a stem suffixed with *-is*. The quotes simply mean that the stem is specifically the one belonging to the lexical entry that is of interest at the time. This fact about dative plural realization is inherited by classes 1 and 2 by virtue of these nodes not offering an alternative realization. However, the same fact is overridden at class 3 where an alternative realization is stated: the suffix is *-ibus*. So we are capturing a horizontal paradigm relation between classes 1 and 2 through inheritance; but we are preserving the integrity of class 3 by making the inheritance *by default*—in other words, an inheritable fact can be overridden if necessary. (2a) also shows how a vertical paradigm relation is captured. The third line says that realizing the plural ablative is the same as realizing the plural dative—that is, these cells are shared within a class by default. This is how Network Morphology captures directional syncretism. Because this particular

within-class cell sharing happens for all five classes, the nature of the cell sharing is placed at the highest level in the inheritance hierarchy. It should be carefully noted that it is the cell sharing that is being generalized rather than the specific exponents. Though class 3 has a different exponent for the dative plural, once you know what it is, you know what the ablative plural is. The quotes around the plural dative path ensure what is needed is the dative plural of the lexical entry you happened to be querying, and if that is a class 3 lexeme it will be stem plus *-ibus*.

The (2b) nodes collect facts about the individual classes that are *not* inherited—in other words, that make them distinct. Only some of these facts have been inserted for the purpose of illustration, hence the ellipsis.² The second to last line of the class 1 node and the last line of the class 2 nodes capture cell sharing—that is, directional syncretisms that are class specific. Class 3 distinguishes cells that use the first stem from the (one and only) cell that uses the second stem. (For a discussion of indexed stems, see Chapter 5.)

2.1 Semi-regularity

The Latin for ‘coin’ NUMMUS behaves like a typical class 1 noun except that its genitive plural is *nummum* instead of expected *nummōrum*. Rather than thinking of the noun as irregular, Network Morphology treats it as *semi-regular* by situating it in the inheritance path of the class 1 node, and simply overriding the realization of the genitive plural.

```
(3) Nummus :
      <> == Class_1
      <sem lex> == coin
      <stem> == numm
      <mor pl gen> == <stem> um.
```

Latin has a number of defective nouns: in their paradigm, certain cells lack a word-form for lexical insertion into phrasal nodes. For example, the word for ‘change’ has the stem *vic-* and patterns like a class 3 noun but lacks word-forms for nominative and dative singular. The singular sub-paradigm is given in (4).

```
(4) Vic- ‘prayer’
    singular
    nominative —
    genitive   vicis
    dative     —
    accusative vicem
    ablative   vice
```

² Appendix 18.1 gives the complete theory.

For the offending cells, the lexical entry for this noun would simply override the inheritance of how the cells are normally realized with the alternative ‘no realization’ or ‘undefined’: `<mor sg nom> == .`

Another type of irregularity that is better seen as semi-regularity is suppletion. Moving from the world of nouns to verbs, the Latin for ‘carry’ is highly irregular. (5) compares regular class 3 verb REGŌ ‘rule’ to irregular FERŌ ‘carry.’

(5)	<i>Present</i>	<i>Perfect</i>	<i>Perfect passive (masc)</i>
1sg	regō ferō	reksī tulī	rēctus sum lātus sum
2 sg	regis fers	reksistī tulistī	rēctus es lātus es
3 sg	regit fert	reksit tulit	rēctus est lātus est

The irregularity lies not in the pattern of exponence but in drastic variation of the stem. So FERŌ has phonologically distinct stems for present, perfect, and perfect passive forms. Otherwise, the verb is (more or less) regular. The lexical entry in (6) represents the semi-regularity: inherit whatever class 3 verbs do, but use special stems in the realization. It can be compared to the lexical entry of the regular verb in (7) (based on Brown and Hippisley 2012: 199–200).

(6) Ferō:
`<> == VERB`
`<sem lex> == carry`
`<root> == fer`
`<stem> == CLASS_3`
`<stem 2> == tul`
`<stem 3> == lāt.`

(7) Regō:
`<> == VERB`
`<sem lex> == rule`
`<root> == reg`
`<stem> == CLASS_3.`

3 Default Inference

A lexeme may have more than one stem in its paradigm of word-forms, for example FERŌ above and the class 3 noun IŪDECS ‘judge’ in (2c). Such items are given two stem definitions at the lexical entry level that correspond to facts about realization at the inflection class level. In (2b) at the class 3 node the nominative singular is defined with reference to stem 2, and the other morphosyntactic feature combinations with reference to stem 1. If we look back at IŪDECS’ paradigm in (1) we see that all cells except nominative

singular use stem 1. We can think of stem 1 as the basic stem, the stem that applies in all cases unless otherwise stated. Network Morphology provides for this by exploiting “narrower statement beats broader statement” or “broader statement unless otherwise stated.” This is the elsewhere statement in lexical phonology, or Pāṇinian default inference, and is used to resolve competition among rules. In other words Network Morphology subscribes to the Pāṇini Determinism Hypothesis (Stump 2001; Chapter 17). The lexical entry for IŪDECS can be rewritten as (8).

- (8) Iūdec̄s:
- ```

<> == Class_3
<sem lex> == judge
<stem 2> == iūdec̄
<stem> == iūdic̄.

```

In DATR a path implies, by default, any extension of itself (see Chapter 11, §5.2). So <stem> implies both <stem 1> and <stem 2>. Here explicit mention of the longer path <stem 2> is mentioned and a different value given. This then is the value that will be used in the evaluation of the nominative singular in the class 3 node (2b). There is no special mention of the longer path <stem 1> so the default inference is that the value of <stem> will be used to evaluate every cell requiring stem 1. The lexical entry of a different class 3 noun RADICS ‘root’ is given in (9).

- (9) Rādīcs:
- ```

<> == Class_3
<sem lex> == root
<stem> == rādīc̄.

```

In this case <stem> will imply both <stem 1> and <stem 2> since no mention of these longer paths is made. That is because for this noun the basic stem is used for all cells, and conflates the notions of stem 1 and stem 2. The singular sub-paradigm of RĀDĪCS where a single stem is used is given in (10).

- (10) RĀDĪCS ‘root’
- | | |
|-----------------|---------|
| <i>singular</i> | |
| nominative | rādīcs |
| genitive | rādīcis |
| dative | rādīci |
| accusative | rādīcem |
| ablative | rādīce |

3.1 Syncretism and Default Inference

Representing morphological operations as fact sharing in a network provides for a natural treatment of syncretism, as we showed for the Latin dative and ablative plural syncretism in (2a), and other class specific

syncretisms in (2b). These are all cases of directional syncretism where there is a source (e.g., the dative) and a target (e.g., the ablative). A non-directional analysis is also possible where the syncretism can be thought of as a neutralization of features (see Baerman et al. 2005: 30; Brown and Hippisley 2012: 155–6). Consider the paradigm for the Latin adjective *BONUS* ‘good’ in (11).

(11)	Masculine	Feminine	Neuter
	<i>Singular</i>		
Nominative	bonus	bona	bonum
Genitive	bonī	bonae	bonī
Dative	bonō	bonae	bonō
Accusative	bonum	bonam	bonum
Ablative	bonō	bonā	bonō
	<i>Plural</i>		
Nominative	bonī	bonae	bona
Genitive	bonōrum	bonārum	bonōrum
Dative	bonīs	bonīs	bonīs
Accusative	bonōs	bonās	bonā
Ablative	bonīs	bonīs	bonīs

Cells in (11) are an intersection of case, number, and gender features. In the dative singular (and ablative), the same exponent is used for both masculine and neuter agreement. One way to handle this is through a directional syncretism as in (12).

- (12) Adjective:
- ```

<syn> == adjective
<mor sg dat neut> == <mor sg dat masc>
<mor sg dat masc> == "<stem>" ō
...
```

But in the plural dative (and ablative) the same exponent is used for all three genders. That multiplies out the number of targets: if the neuter is a target then its source (say, feminine) is also a target, whose source is the masculine. A more intuitive way of thinking about it is that the *expression* of gender in certain morphosyntactic contexts is partially or wholly neutralized. To capture syncretism as neutralization Network Morphology uses default inference, where a path is extended by the gender attribute just in case the expression of gender is needed. This is shown in (13).

- (13) Adjective:
- ```

<syn> == adjective
<mor sg nom masc> == "<stem>" us
<mor sg nom fem> == "<stem>" a
<mor sg nom neut> == "<stem>" um
<mor sg dat> == "<stem>" ō
```


Network Morphology's use of default inference helps get at the exact nature of HORTOR's exceptionality. There are a number of features at play in a single cell of a Latin verb's paradigm: {person, number, tense, aspect, voice}. But if the passive paradigm of regular AMŌ is compared to HORTOR then it is clear that what is exceptional is not the realization of values for person, number, tense, or aspect but only voice. So the second-person imperfective past is *-bāris* for both AMŌ and HORTOR. It is really only the voice feature that is mixed up. This can be expressed as in (16).

(16) DEPONENT:

```
<> == VERB
<mor active> == "<mor passive>".
```

By default inference, `<mor active>` implies `<mor active ipfv pres sg 2>`. The facts of Latin require the longer path, narrower rule, to override the shorter path—in other words, there is a unique cell for this feature combination. With (16) we are getting at a different kind of inference: for a class of verbs, the deponent verbs, any time you want to evaluate an active path containing any other feature value you are switched to an evaluation of a passive path with the identical feature value. An extension of the active path is referenced to the *same* extension of the passive path. So (16) is equivalent to (17).

(17) DEPONENT:

```
<> == VERB
<mor active ipfv pres sg 2> == "<mor passive ipfv
pres sg 2>"
...
```

The left-hand side of (16) implies the equivalent right-hand side, unless otherwise stated. There are contexts where the inference here has to be overridden. The way of forming a future infinitive active is the same for AMŌ as it is for HORTOR. Compare *amātūrus esse* with *hortātūrus esse*. The narrower context therefore has to be specified (18). Here it is referred to a node generalizing about realization for (regular) verbs.

(18) DEPONENT:

```
<> == VERB
<mor active> == "<mor passive>"
<mor active ipfv fut inf> == VERB.
```

3.3 Paradigm Signatures and Default Inference

From the Latin deponency example we can see the importance of deciding how features should be ordered: voice must come first, at the very least to capture the fact that the distinction is one of voice morphosyntax. Ordering

aspect next, which is either imperfective or perfect, suggests that Latin verbs could be split not only along voice lines but also aspect lines. In fact this is true for a subclass of deponent verbs termed “semi-deponent” because only a proportion of their paradigm displays deponent behavior. This proportion can be defined aspectually: perfect forms are deponent; imperfective forms are regular. In fact there is a semi-deponent verb lurking in the Plautus extract in (14): the verb *SOLEŌ* ‘be wont’ at the end of the first line. Here it is being used in the imperfective aspect, so it behaves like any other verb. However, its perfect paradigm is deponent: for example, its active present perfect first-person singular is *solitus sum*, which we can compare to *amatus sum*, the *passive* present perfect first-person singular of regular *amō*. Given (17), for semi-deponents we can simply override the statement about deponent behaviour with a narrower, more specific statement about imperfective realizations. The longer path pinpoints exactly where deponency does not apply: `<mor active ipfv> == VERB`.

The order of attributes therefore expresses how a paradigm is partitioned: voice, followed by aspect. This gives the verb what Network Morphology terms its **paradigm signature**. The facts about deponency are used to inform the Latin verb’s paradigm signature. The facts about adjective syncretism, where the gender feature is neutralized in certain contexts (§3.1), help determine the paradigm signature of adjectives in as much as the gender feature is placed last in the sequence of feature attributes. Case and number (higher-order attributes) define the contexts for the syncretism of gender (lower-order attribute). What about the ordering of case and number? Looking back at (11) neither feature is fully neutralized: a word-form in a given cell tells you something about case and something about number. So the paradigm signature of a Latin adjective is either (19a) or (19b). There is therefore some flexibility in the signature.

- (19) a. NUMBER → CASE → GENDER
 b. CASE → NUMBER → GENDER

Paradigm signatures may be inflexible, and we illustrate with the verb paradigms of Iranian languages (Hippisley and Stump 2014). These languages hold vestiges of split-ergativity which are manifested in object agreement and gender agreement in past tense contexts. (20) illustrates absolutive (object) argument agreement in Pashto, where the verb is controlled by an argument in the first-person singular (example from Babrakzai 1999: 61).

- (20) *minee* *ze* *pe* *baagh* *kee* *we* *lid-em*
 Meena.OBL 1SG.DIR at garden in PRF saw-1SG
 ‘Meena saw me in the garden’

As a vestige of split-ergativity we can think of the verb as a target for agreement with the absolutive argument in past tense contexts and with the nominative argument in non-past tenses. The present and past imperfective forms of the Pashto transitive verb *TAR* ‘tie’ is given in (21).

(21)	present		Past		
	nominative agr		absolutive agr		
	Sg	Pl	Sg	Pl	
1	taɾ-əm	taɾ-ú	taɾəl-əm	taɾəl-u	
2	taɾ-é	taɾ-əy	taɾəl-e	taɾəl-əy	
3	taɾ-í	taɾ-í	taɾ-ə	taɾəl(-ə)	M
			taɾəl-a	taɾəl-e	F

Source: Tegey and Robson (1996)

Cells in the paradigm make reference to three features: number, person and gender. Some of the cells display syncretism of the neutralization kind: for example, in third-person present the same form is used for both singular and plural such that number is neutralized. Using default inference, we capture this situation with the path $\langle \text{mor } 3 \rangle$ which implies both $\langle \text{mor } 3 \text{ sg} \rangle$ and $\langle \text{mor } 3 \text{ pl} \rangle$. The first person behaves differently: $\langle \text{mor } 1 \rangle$ implies $\langle \text{mor } 1 \text{ sg} \rangle$ but not $\langle \text{mor } 1 \text{ pl} \rangle$, which has its own values. This suggests a paradigm signature that strictly orders person before number, expressing person as a context for number syncretism; or the dependency of the expression of number on person.

(22) PERSON $\rightarrow$ NUMBER

In the past, which is the context for object agreement, or absolutive agreement, it is only in the third person that the distinction between a nominative argument (present context) and an absolutive argument (past context) is overtly made. So $\langle \text{mor } 1 \text{ sg} \rangle$ implies both $\langle \text{mor } 1 \text{ sg nom} \rangle$ and $\langle \text{mor } 1 \text{ sg abs} \rangle$, /əm/. And $\langle \text{mor } 2 \text{ sg} \rangle$ implies both $\langle \text{mor } 2 \text{ sg nom} \rangle$ and $\langle \text{mor } 2 \text{ sg abs} \rangle$, /e/. But $\langle \text{mor } 3 \rangle$ must be extended by $\langle \text{mor } 3 \text{ sg abs} \rangle$ to provide for distinct absolutive agreement in the third person. The signature now incorporates a feature for case-based agreement, and this is ordered after number. So case is dependent on number, which is dependent on person.

(23) PERSON $\rightarrow$ NUMBER $\rightarrow$ CASE

Finally we bring in gender, but in a very restricted way. It “appears” in the third person when the argument is absolutive. So we need $\langle \text{mor } 3 \text{ sg abs f} \rangle$ just in case the absolutive argument is feminine, /a/.

(24) PERSON $\rightarrow$ NUMBER $\rightarrow$ CASE $\rightarrow$ GENDER

These dependencies—gender on case, case on number, and number on person—inform the paradigm signature. The paradigm signature of Pashto emerges from the most parsimonious set of paths. (25) shows through shading which attributes are necessary to include in the paths expressing the cells in a transitive verb’s paradigm. The longest path, narrowest rule, is needed for agreement with a third-person singular (or plural) absolutive argument if it is feminine.

- (25) { 1 sg nom masc } { 2 sg nom masc } { 3 sg nom masc }
 { 1 sg nom fem } { 2 sg nom fem } { 3 sg nom fem }
 { 1 pl nom masc } { 2 pl nom masc } { 3 pl nom masc }
 { 1 pl nom fem } { 2 pl nom fem } { 3 pl nom fem }
 { 1 sg abs masc } { 2 sg abs masc } { 3 sg abs masc }
 { 1 sg abs fem } { 2 sg abs fem } { 3 sg abs fem }
 { 1 pl abs masc } { 2 pl abs masc } { 3 pl abs masc }
 { 1 pl abs fem } { 2 pl abs fem } { 3 pl abs fem }

We can compare Pashto with the West Iranian language Kurmanji Kurdish, whose transitive indicative paradigm is given in (26). Unlike Pashto there is no gender feature. Also unlike Pashto the contexts for neutralization syncretism are different.

- (26) present imperfect
 nominative agr absolutive agr
 Sg Pl Sg Pl
 1 dibîn-im dibîn-in didît-im didît-in
 2 dibîn-î dibîn-in didît-î didît-in
 3 dibîn-e dibîn-in didît didît-in

Source: Khan and Lescot (1991)

Given the context of plural number, person distinctions are neutralized. And no distinction is made between an absolutive or nominative argument unless the argument is third person: *dibîn-e*, if the argument is nominative; *didît*, if it is absolutive. Classic vestigial split-ergativity. The paradigm signature is therefore as in (27), which is diagrammed in (28).

- (27) NUMBER → PERSON → CASE

- (28) { sg 1 nom } { sg 2 nom } { sg 3 nom }
 { sg 1 nom } { sg 2 nom } { sg 3 nom }
 { sg 1 abs } { sg 2 abs } { sg 3 abs }
 { sg 1 abs } { sg 2 abs } { sg 3 abs }
 { pl 1 nom } { pl 2 nom } { pl 3 nom }
 { pl 1 nom } { pl 2 nom } { pl 3 nom }
 { pl 1 abs } { pl 2 abs } { pl 3 abs }
 { pl 1 abs } { pl 2 abs } { pl 3 abs }

Paradigm signatures can be a valuable component in a cross-linguistic comparison. For example, Pashto and Kurmanji Kurdish differ not only in the presence/absence of the gender feature but also in the ordering of number with respect to person. The fact that in both languages the case and gender features extend shorter paths captures that these are the vestigial split-ergative features that are subject to loss, where Pashto is “more” split-ergative than Kurmanji Kurdish. The east Iranian language Ishkashimi has lost both gender and case, and its paradigm signature is given in (29),

which can be viewed as being on a trajectory defined by Kurmanji Kurdish's paradigm signature in (27).

(29) NUMBER $\rightarrow$ PERSON

4 Default Orthogonal Multiple Inheritance

In our discussion of Latin nouns in (1) we captured fact sharing of cells across paradigms (horizontal relations) in a purely hierarchical way: the dative plural in *-is* is shared by classes 1 and 2, so is located as a fact at the root node, and overridden by classes 3, 4, and 5. To better capture *limited* cross-class sharing, where a minority of classes is involved, it would be more elegant to have one class inherit directly from another in some instances while maintaining its main line of inheritance for most instances. Network Morphology uses multiple inheritance to allow inheritance from two sources. To ensure that inheritance from more than one source does not bring about any conflict, the secondary inheritance is specifically orthogonal. We will see below that linked orthogonal hierarchies are used in Network Morphology to express modularity in the grammatical system. The root node along with class 1 and 2 nodes from (2a) and (2b) are revised in (30) and (31). In (31) the fact about dative plural is a reference to a sister node, expressing that the sharing of the dative plural is strictly a class 1 and 2 affair.

(30) Noun:

```
<syn cat> == noun
<mor pl dat> == "<stem>" is
<mor pl abl> == "<mor pl dat>".
```

(31) Class_1:

```
<> == Noun
<mor sg nom> == "<stem>" a
<mor sg gen> == "<stem>" ae
<mor pl dat> == Class_2:<mor pl dat>
...
```

Class_2:

```
<> == Noun
<mor sg nom> == "<stem>" us
<mor sg gen> == "<stem>" i
<mor sg dat> == "<stem>" o
<mor sg abl> == <mor sg dat>
<mor pl dat> == "<stem>" is
...
```

4.1 Multiple Inheritance and Irregularity

A common type of irregularity is characterized by an item appearing to belong to more than one inflectional class. In Latin the word

for ‘old man’ SENECS chiefly patterns as a class 3 noun and in one instance as a class 5 noun, namely the dative singular. Its paradigm is given in (32).

(32) SENECS ‘old man’

	<i>singular</i>	<i>plural</i>
nominative	senecs	senēs
genitive	senis	senum
dative	senī	senibus
accusative	senem	senēs
ablative	sene	senibus

There are two ways of treating such irregularity: lexically specifying the dative singular *senī* or “computing” it by specifying a part of the network where the value is already available. The latter approach is possible through multiple inheritance.

(33) Senecs:

```
<> == Class_3
<sem lex> == judge
<stem 2> == senec
<stem> == sen
<mor sg dat> == Class_5:<mor sg dat>.
```

In our analysis of NUMMUS ‘coin’ in (3) above, we expressed the exception as an override where an alternative value is provided within the lexical entry. But through multiple inheritance we can think of the irregular genitive plural as “already” available in the network, at a different node.

(34) Nummus:

```
<> == Class_1
<sem lex> == coin
<stem> == numm
<mor pl gen> == Class_3:<mor pl gen>.
```

The mixing of inflectional classes can be much more prevalent than one cell. So-called cases of heterocclisis are where a lexical item is truly divided between inflectional classes. In Sanskrit the word for ‘heart’ HRDAYA patterns after the neuter *-a* stem nouns in direct cases, and after neuter consonant stem nouns in oblique. In (35) the singular paradigms of a neuter *-a* stem and a neuter consonant stem flank the paradigm *hrdaya*, based on Stump (2006: 283) who cites Whitney (1889: 397). Stump mentions the widespread occurrence of heterocclisis, extending beyond Indo-European to Afro-Asiatic, Altaic, Australian, Chukotko-Kamchatkan, Niger-Congo, Nilo-Saharan, North Caucasian, Oto-Manguean, Penutian, Siouamun, and Uralic (2006: 280).

(35)	ĀSYA	HRDAYA	TRIVṚT
	‘mouth’	‘heart’	‘threefold’
	neuter <i>a</i> -stem		neuter <i>C</i> -stem
Nominative	āsyam	hṛdayam	trivṛt
Vocative	āsyā	hṛdaya	trivṛt
Accusative	āsyam	hṛdayam	trivṛt
Instrumental	āsyena		hṛdā trivṛtā
Dative	āsyaya		hṛde trivṛte
Ablative	āsyāt		hṛdas trivṛtas
Genitive	āsyasya		hṛdas trivṛtas
Locative	āsyē		hṛdi trivṛti

4.2 Multiple Inheritance and Derivational Morphology

In the lexeme-based world of morphology, derivation is viewed as adjustments at different levels of lexemic description. To see this we can think of the deriving and derived item as a particular kind of relationship (see Chapter 2; and see Spencer 2013 for derivation as a type of “lexical relatedness”). Consider the Russian derivationally related pair ČITAT’ ‘read’ and ČITATEL’ ‘reader.’ Their relation is given in (36) (from Brown and Hippisley 2012: 252–3).

(36)	ČITAT’	ČITATEL’
	<i>syntactic level</i>	<i>syntactic level</i>
	syn cat = V	syn cat = N
	args = 2 (NP_NP)	
	<i>semantic level</i>	> <i>semantic level</i>
	‘read’	‘person who reads’
		sem sex = male
	<i>phonological level</i>	<i>phonological level</i>
	stem 1 = /čit-/	—
	stem 2 = /čita-/	/čita-tel’/
	<i>morphological level</i>	<i>morphological level</i>
	mor class = V_I	mor class = N_I

At the syntactic level, there is a change in syntactic category (and argument structure). The semantic level records that features of agenthood and semantic sex have been added. At the phonological, suffixation is expressed as an adjustment to the second stem of deriving item. And finally the morphological level records inflectional class information, which is a change from a verb morphological class to a noun morphological class. The description of the derived lexeme ČITATEL’ is therefore a mix of what is present in the deriving lexeme and what has been added in the derivation. In Network Morphology this is captured by multiple inheritance: one source is a lexical entry and another source is a node expressing a word-formation rule that takes a lexeme as its input and output. The relevant word-formation rule for (37) is shown in (38).

- (37) WFR
syntactic level
 syn cat = N
semantic level
 ‘person who [base sem]’
 (implied: {+animate,+male})
phonological level
 [base stem 2] –tel’

The network containing the deriving lexical entry, the derivative and the word formation rule is given in (38).

- (38) a. Čitat’ :
 <> == VERB
 <sem> == read
 <conjugation_class> == V_I:<mor>
 <root all> == čit
 <stem 2> == <root all> a
 <valence> == 2.
 b. Čitatel’ :
 <> == WFR
 <base> == "Čitat’ :<>".
 c. WFR:
 <> == NOUN
 <sem> == λx [<sem feature> (x) & "<base sem>" (x)]
 <sem feature> == person
 <stem> == "<base stem 2>" tel’.

In (38b) the derivative item’s main source of inheritance is the word formation node (38c) from where it inherits the fact that it is a noun (first line), as well as some semantic and phonological information, expressed as instructions on how to form its meaning and stem. These instructions make reference to the inheriting lexical entry’s *base* expressed by the path <base> and its extensions: <base sem>, <base stem 2>. How does base information come about? In (38b) the second line represents inheritance from a second source: that source is the deriving lexical entry (i.e., multiple inheritance is going on). Specifically, this line represents that all facts are inherited from the deriving node, and recorded as “base” facts. This expresses the relation between a deriving item and its derivative as an *inheritance* relation. Such information is used to shape the semantics and form of the derivative lexical item as specified at the word-formation rule. A similar analysis of a word-formation rule as a node of inheritable facts in a network is given in Construction Morphology (Chapter 16; Booij 2010).

Different word-formation rules makes different uses of base information – in other words, what gets inherited from the deriving lexeme is more or less

relevant in a derivation. So in examples of conversion where the phonological level (stem) is preserved the WFR node will not provide phonological-level information. Examples abound in English, such as the verb *text* from the noun *text*. In transpositions, the semantics is (more or less) preserved, while the syntactic class and stem undergo changes. An example from Russian is the noun PERIPISKA ‘copying’ derived from the verb PERIPISAT’ ‘copy.’ Here there is no semantic inheritance from the WFR taking place, making the semantics coming from the deriving item fully relevant. Finally, an extreme case of maximal relevance of what comes from the deriving lexeme is a category that preserves derivation. In such cases morphosyntactic features such as gender, syntactic class, or defining variables of a new lexeme are those of the deriving lexeme. Even semantics is barely altered, being mainly restricted to semantics of a subsecutive kind: a bit bigger than X, a bit smaller than Y, where X and Y belong to the deriving lexical item. Such behaviour characterizes evaluative morphology. Russian DOM ‘house’ derives evaluative (augmentative) DOMIŠČE ‘big house,’ for example. Despite the fact that its morphological class changes to one associated with neuters, its gender is that of the lexeme that derives it.

4.3 Multiple Inheritance and Autonomous Morphology

Multiple sources of inheritance for a derivative lexeme are suggestive of multiple hierarchies: the hierarchy of lexemes and the hierarchy of word-formation rules. The network in Network Morphology is in fact really a domain of orthogonal hierarchies that interconnect, where each hierarchy represents a subsystem of the grammar. So there is a subsystem of lexemes, which inherit from nodes that generalize over lexeme classes, for example nouns and verbs, and from each other in cases of a derivational relationship. And there is a subsystem of morphological rules. In fact, inflectional and derivational rules (the word formation nodes) occupy a separate area of the network, expressing the division and interconnect-edness of inflectional and derivation morphology (see Chapter 2). Moreover, Network Morphology treats inflection as a separate subsystem of the grammar, interfacing with but autonomous from syntax (see Chapter 8). Phenomena such as syncretism and deponency, where there is a dissociation between what syntax demands and what morphology supplies, point to treating morphology in this way. In syncretism several morphosyntactic words are demanded for corresponding particular phrase structure nodes, but only one item (morphological word) is delivered: for example for AQUA ‘water’ both genitive and dative singular get the same word-form *aquae* (1). In deponency a morphosyntactic word of a particular feature value (active) is provided by the morphology with a word-form of a different value (passive). We illustrate with Latin how multiple inheritance from orthogonal hierarchies, the lexemic and inflectional hierarchies, captures morphology/syntax dissociations.

4.3.1 Latin Dissociations and Default Paradigm Linkage

Syncretism dissociation, as we explained, is where multiple syntactic units, morphosyntactic words, map onto a single word-form created by the morphology, a morphological word. To capture this kind of dissociation Network Morphology assumes two separate but related hierarchies: a lexemic hierarchy and an inflectional hierarchy. Lexical entries are defined by their connection to both hierarchies through multiple inheritance. To illustrate, consider the singular genitive and dative syncretism of Latin Class 1 nouns discussed in Section 2 with reference to (1) and (2b). So *aquae* is the word-form used for both genitive and dative singular morphosyntactic words. One hierarchy is referenced for building the morphological words and another for the morphosyntactic words. By default, the morphosyntactic words are whatever the morphological words are—that is, by default there is no dissociation. We adjust the Latin noun network as follows.

(39) a. NOUN:

```
<syn cat> == noun
<sem> == thing
<syn> == "<mor>"
```

b. MOR_NOUN:

```
<mor pl abl> == "<mor pl dat>".
```

(40) Aqua:

```
<> == NOUN
<mor> == Class_1
<sem lex> == water
<stem> == aqu.
```

In (40) the lexical entry's main source of inheritance is NOUN, a node in a lexemic hierarchy (39a), and its secondary source is Class_1, a node in a distinct inflectional hierarchy. The important point is that the syncretism is captured by a referral located in the inflectional hierarchy, shown again in (41). The first line expresses that the node inherits not from the NOUN node in the lexemic hierarchy which generalizes over noun lexemes including semantic and syntactic properties, but from a node that generalizes over distinctly morphological facts about nouns. The syncretism, in bold, is captured as a purely morphological affair because it is a generalization made in the morphological hierarchy.

(41) Class_1:

```
<> == MOR_NOUN
<mor sg nom> == "<stem>" a
<mor sg gen> == "<stem>" ae
<mor sg dat> == <mor sg gen>
<mor sg acc> == "<stem>" am
...
```


In (39a) a lexeme's morphosyntactic words are inherited from the lexemic hierarchy, along with syntactic category and the broad-level semantics associated with being a noun (following Jackendoff 1990). How are morphosyntactic words inherited? By the bold-faced equation $\langle \text{syn} \rangle == \langle \text{mor} \rangle$. Recall in Section 3.2 how we captured the special irregular nature of deponent verbs by using default inference. In (16) $\langle \text{mor active} \rangle == \langle \text{mor passive} \rangle$ was interpreted as: any extension of an active path implies the same extension of a passive path. Here any extension of a $\langle \text{syn} \rangle$ path implies the corresponding extension of a $\langle \text{mor} \rangle$ path which is available at a lexical entry as a fact inherited from a distinct morphological hierarchy. So for *aqua* $\langle \text{syn sg dat} \rangle$ implies $\langle \text{mor sg dat} \rangle$, and in the morphological hierarchy from which the item inherits that fact is evaluated as a directional syncretism. In this way we keep separate the morphological world, along with its referrals, from objects of the syntactic world, including morphosyntactic words. So morphosyntactic words are encapsulated in the spirit of morphology-free syntax, or lexicalism (see Chapter 10).

Deponency is a kind of dissociation which is characterized by a mismatch. An active morphosyntactic word is mismatched with a passive morphological word. To capture what is really going on, a mismatch between two worlds, we revise our account of deponency given in (16) and repeated here in (42) with a version that uses $\langle \text{syn} \rangle$ and $\langle \text{mor} \rangle$ paths (43).

(42) DEPONENT:

$\langle \rangle == \text{VERB}$
 $\langle \text{mor active} \rangle == \langle \text{mor passive} \rangle$

(43) DEPONENT:

$\langle \rangle == \text{VERB}$
 $\langle \text{syn active} \rangle == \langle \text{mor passive} \rangle$
 $\langle \text{syn passive} \rangle == \text{undefined.}$

Assuming the default fact $\langle \text{syn} \rangle == \langle \text{mor} \rangle$ at the node VERB, the default is that there is no mismatch. The node in (43) overrides this default for deponent verbs. A comparison between theorems of regular verbs and those of a deponent verb show the mismatch as a mismatch of $\langle \text{syn} \rangle$ and $\langle \text{mor} \rangle$ values.

- (44) a. $\text{Am}\bar{o} : \langle \text{syn act ipfv pst ind sg1} \rangle = \text{am } \bar{a} \text{ bam.}$
 $\text{Am}\bar{o} : \langle \text{syn act ipfv pst ind sg3} \rangle = \text{am } \bar{a} \text{ bat.}$
 $\text{Am}\bar{o} : \langle \text{syn pass ipfv past ind sg1} \rangle = \text{am } \bar{a} \text{ b}\bar{a}r.$
 $\text{Am}\bar{o} : \langle \text{syn pass ipfv past ind sg3} \rangle = \text{am } \bar{a} \text{ b}\bar{a}t\bar{u}r$
 ...
 b. $\text{Am}\bar{o} : \langle \text{gloss} \rangle = \text{love}$
 $\text{Am}\bar{o} : \langle \text{mor act ipfv past ind sg1} \rangle = \text{am } \bar{a} \text{ bam.}$

- $\text{Am}\bar{o} : \langle \text{mor act ipfv past ind sg3} \rangle = \text{am } \bar{a} \text{ bat.}$
 $\text{Am}\bar{o} : \langle \text{mor pass ipfv past ind sg1} \rangle = \text{am } \bar{a} \text{ b}\bar{a}r.$
 $\text{Am}\bar{o} : \langle \text{mor pass ipfv past ind sg3} \rangle = \text{am } \bar{a} \text{ b}\bar{a}t\bar{u}r.$
 ...
- (45) a. $\text{Hortor} : \langle \text{syn act ipfv pst ind sg1} \rangle = \text{hort } \bar{a} \text{ b}\bar{a}r.$
 $\text{Hortor} : \langle \text{syn act ipfv pst ind sg3} \rangle = \text{hort } \bar{a} \text{ b}\bar{a}t\bar{u}r.$
 $\text{Hortor} : \langle \text{syn pass ipfv pst ind sg1} \rangle = \text{undefined.}$
 $\text{Hortor} : \langle \text{syn pass ipfv pst ind sg3} \rangle = \text{undefined}$
 ...
- b. $\text{Hortor} : \langle \text{mor act ipfv pst ind sg1} \rangle = \text{hort } \bar{a} \text{ bam.}$
 $\text{Hortor} : \langle \text{mor act ipfv pst ind sg3} \rangle = \text{hort } \bar{a} \text{ bat.}$
 $\text{Hortor} : \langle \text{mor pass ipfv pst ind sg2} \rangle = \text{hort } \bar{a} \text{ b}\bar{a}r$
 $\text{Hortor} : \langle \text{mor pass ipfv pst ind sg3} \rangle = \text{hort } \bar{a} \text{ b}\bar{a}t\bar{u}r$
 ...

Example cells of the active subparadigm of the regular verb *amō* are expressed as the $\langle \text{syn} \rangle$ theorems in (44a) (theorems are notated with a single "=" and theories with a double "=="). The passive paths in (44a) tally with the active paths of a deponent verb's paradigm in (45a). This is the result of a mismatch at a different level. As well as $\langle \text{syn} \rangle$ theorems, every verb will have $\langle \text{mor} \rangle$ theorems via the morphological hierarchy, representing the products of morphology, the morphological words of a lexeme. The difference between *AMŌ* and *HORTOR* boils down to a difference in how their $\langle \text{syn} \rangle$ and $\langle \text{mor} \rangle$ paths match up. Comparing (44a) with (44b) we see an exact match. But (45a) and (45b) show a mismatch: *HORTOR*'s morphosyntactic $\langle \text{syn} \rangle$ word for first-person *active* imperfective is matched with *HORTOR*'s morphological $\langle \text{mor} \rangle$ word for first-person *passive* imperfective.

The notion that the mismatch is between two different sets of words, morphosyntactic and morphological, which are usually aligned, is captured by Stump's universal default paradigm linkage theory (Stump 2006). Every lexeme has a content paradigm of morphosyntactic words and a form paradigm of morphological words which are aligned by default. Dissociations such as syncretism and deponency are instances where the two don't quite line up. In such cases the default is overridden. (43) expresses the case where this default is being overridden; the paradigm linkage default is expressed by the equation $\langle \text{syn} \rangle == \langle \text{mor} \rangle$, which is situated at the root node of the lexemic hierarchy as the highest level generalization about a lexeme's morphosyntactic words.

4.3.2 Morphological Change and Virtual Paradigms

In a rather dramatic restructuring of the Latin verbal paradigm, deponent verbs started to regularize, first by "growing" a passive sub-paradigm (where deponents are passive defective) and second by using active morphology for active syntax. This is beautifully documented in Flobert (1975), whose examples we fill out here (for a fuller discussion see Brown and

Hippisley 2012, Chapter 6). Such a morphological change can be seen as evidence for a separate form/morphological paradigm: those forms were always “there” in the morphological paradigm; at a certain point in a lexeme’s history they were switched on – that is, made available to syntax. We can illustrate with a fragment from Jonas’ *Vita Columbani* (Life of Columbanus) from the seventh century AD.

- (46) *sic enim a Domin-o sub apostol-orum numer-o*
 thus for by Lord-ABL.SG under apostle-GEN.PL order-ABL.SG
hort-āmur
 encourage-1PL.PRS.PASS
 (=PASS)
 ‘for thus are we encouraged by the Lord under the order of the
 apostles’

Here the word-form *hortāmur* looks passive and is passive. As a deponent verb classical *hortor* was defective for passives – that is, it lacked a passive paradigm. In Jonas’ *Vita Austrigislii Episcopi Biturgi* (Life of Austrigisl, Bishop of Bourges), the same verb is used, this time where active morphology corresponds to a active syntax.

- (47) *ut, si esset Domin-i voluntas, face-ret*
 COMP if be.3SG.PRS.SBJV Lord-GEN.SG desire.NOM.SG do-3SG.SBJV.ACT
quod horta-bant
 wh.ACC.SG encourage-3PL.IPFV.PST.ACT
 ‘[He promised to act in such a way] that, if it was the Lord’s will, he would be
 doing what they exhorted him to do’

A Network Morphology account makes sense of this morphological change as a realignment of <syn> paths with <mor> paths where they were once misaligned. So for the deponent verb *hortor* <syn active> == “<mor passive>” is replaced by <syn active> == “<mor active>”. This is represented in (48) with a node representing the “new” HORTOR.

- (48) *Hortor_new*:
 <> == *Hortor*
 <syn> == VERB.

On the one hand the lexical item inherits all its properties from classical *hortor*. On the other hand, it inherits the default that <syn> == “<mor>”, a fact generalizable over all verbs hence inherited from the VERB node. This has the effect of undoing the mismatch that characterizes HORTOR as a deponent verb, while inheriting all that verb’s <mor> paths, some of which we listed in in (45b) as representing its morphological paradigm. So the morphological paradigm of classical HORTOR is a virtual morphosyntactic paradigm, ready and available to become a reality just in case regularization takes place (see Stump 2002: 174).

5 Concluding Remarks

In the short space provided we have attempted to show that Network Morphology is a lexicalist theory (see Chapter 10) that assumes a separation of syntax from morphology and a division between inflection and derivation, takes the lexeme to be the minimal sign, and views paradigm structures as part of the organization of the morphological system. Its primary mechanism for capturing morphological phenomena and how they interface with syntax is through networks of orthogonally linked nodes, allowing separation to be connected. The network supports inheritance by default, default inference, and orthogonal multiple inheritance. As such Network Morphology represents a platform for exploring the irregularity that characterizes morphology as semi-regularity, really curiosities susceptible to systematic treatment albeit at a lower level of observation. Through the DATR language Network Morphology is wholeheartedly committed to rigorous analysis that is machine testable. Theories such as the one presented in Appendix 18.1 can be tested online using Raphael Finkel's CAT'S CLAW DATR evaluator, at www.cs.uky.edu/~raphael/linguistics/datr.cgi (accessed April 11, 2016).

Appendix 18.1

A Network Morphology theory of a fragment of Latin nouns

NOUN:

```
<syn cat> == noun
<sem> == thing
<syn> == "<mor>".
```

MOR_NOUN:

```
<mor pl abl> == "<mor pl dat>".
```

Class_1:

```
<> == MOR_NOUN
<mor sg nom> == "<stem>" a
<mor sg gen> == "<stem>" ae
<mor sg dat> == <mor sg gen>
<mor sg acc> == "<stem>" am
<mor sg abl> == "<stem>" ā
<mor pl nom> == "<stem>" ae
<mor pl gen> == "<stem>" ārum
<mor pl acc> == "<stem>" ās
<mor pl dat> == Class_2:<mor pl dat>.
```

Class_2:

```
<> == MOR_NOUN
<mor sg nom> == "<stem>" us
<mor sg gen> == "<stem>" ī
<mor sg dat> == "<stem>" ō
<mor sg acc> == "<stem>" um
<mor sg abl> == <mor sg dat>
<mor pl nom> == "<stem>" ī
<mor pl gen> == "<stem>" ōrum
<mor pl dat> == "<stem>" is
<mor pl acc> == "<stem>" ōs.
```

```

Class_3:
    <> == MOR_NOUN
    <mor sg nom> == "<stem 2>" s
    <mor sg gen> == "<stem 1>" is
    <mor sg dat> == "<stem 1>" i
    <mor sg acc> == "<stem 1>" em
    <mor sg abl> == "<stem 1>" e
    <mor pl nom> == "<stem 1>" ěs
    <mor pl gen> == "<stem 1>" um
    <mor pl dat> == "<stem 1>" ibus
    <mor pl acc> == <mor pl nom>.

Class_4:
    <> == MOR_NOUN
    <mor sg nom> == Class_2:<mor sg nom>
    <mor sg gen> == "<stem>" ūs
    <mor sg dat> == "<stem>" ui
    <mor sg acc> == Class_2:<mor sg acc>
    <mor sg abl> == "<stem>" ū
    <mor pl nom> == "<stem>" ūs
    <mor pl gen> == "<stem>" uum
    <mor pl dat> == Class_3:<mor pl dat>
    <mor pl acc> == <mor pl nom>.

Class_5:
    <> == MOR_NOUN
    <mor sg nom> == Class_3:<mor sg nom>
    <mor sg gen> == "<stem 1>" i
    <mor sg dat> == <mor sg gen>
    <mor sg acc> == "<stem 1>" m
    <mor sg abl> == "<stem 2>"
    <mor pl nom> == <mor sg nom>
    <mor pl acc> == <mor pl nom>
    <mor pl gen> == "<stem 2>" rum
    <mor pl dat> == "<stem 2>" bus.

Aqua:
    <> == NOUN
    <mor> == Class_1
    <sem lex> == water
    <stem> == aqu.

Servus:
    <> == NOUN
    <mor> == Class_2
    <sem lex> == slave
    <stem> == serv.

```

Iudecs:

```
<> == NOUN
<mor> == Class_3
<sem lex> == judge
<stem 2> == iūdec
<stem> == iūdic.
```

Radics:

```
<> == NOUN
<mor> == Class_3
<sem lex> == root
<stem> == rādīc.
```

Fructus:

```
<> == NOUN
<mor> == Class_4
<sem lex> == fruit
<stem> == frūct.
```

Res:

```
<> == NOUN
<mor> == Class_5
<sem lex> == thing
<stem> == re
<stem 2> == rē.
```

Nummus:

```
<> == NOUN
<mor> == Class_2
<sem lex> == coin
<stem> == numm
<mor pl gen> == Class_3:<mor pl gen>.
```

Vic:<> == NOUN

```
<mor> == Class_3
<sem lex> == change
<stem> == vic
<mor sg nom> ==
<mor sg dat> == .
```

Senecs:

```
<> == NOUN
<mor> == Class_3
<sem lex> == judge
<stem 2> == senec
<stem> == sen
<mor sg dat> == Class_5:<mor sg dat>.
```

#show

<syn cat>

<sem>

<sem lex>

```

<stem>
<syn sg nom>
<syn sg gen>
<syn sg dat>
<syn sg acc>
<syn sg abl>
<syn pl nom>
<syn pl gen>
<syn pl dat>
<syn pl acc>
<syn pl abl>.
#hide
NOUN MOR_NOUN Class_1 Class_2 Class_3 Class_4 Class_5.

```

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Part V

The Role of Morphology in Theories of Phonology and Syntax

19

The Role of Morphology in Generative Phonology, Autosegmental Phonology, and Prosodic Morphology

Sharon Inkelas

1 Introduction

The role of morphology in the rule-based phonology of the 1970s and 1980s, from classic Generative Phonology (Chomsky and Halle 1968) through Autosegmental Phonology (e.g., Goldsmith 1976) and Prosodic Morphology (e.g., Steriade 1988; McCarthy and Prince 1999), is that it produces the inputs on which phonology operates. Classic Generative, Autosegmental, and Prosodic Morphology approaches to phonology differ in the nature of the phonological rules and representations they posit, but converge in one key assumption: all implicitly or explicitly assume an item-based morphological approach to word formation, in which root and affix morphemes exist as lexical entries with underlying phonological representations. The morphological component of grammar selects the morphemes whose underlying phonological representations constitute the inputs on which phonological rules operate. On this view of morphology, the phonologist is assigned the task of identifying a set of general rules for a given language that operate correctly on the inputs provided by the morphology of that language to produce grammatical outputs.

This assignment is challenging for a variety of reasons, sketched below; as a group, these reasons helped prompt the evolution from classic Generative Phonology to its autosegmental and prosodic descendants, and have since led to even more dramatic modifications in the way that morphology and phonology interact (see Chapter 5).

First, not all phonological rules apply uniformly across all morphological contexts. For example, Turkish palatal vowel harmony requires suffix vowels to agree with the preceding stem vowel (*paşa* ‘pasha,’ *paşa-lar* ‘pasha-PL’; *meze* ‘appetizer,’ *meze-ler* ‘appetizer-PL’) but does not apply within roots (*elma* ‘apple,’ *anne* ‘mother’). The response to this lack of uniformity is either to morphologically condition the rules in question, or to alter the phonological representations of morphemes in a way that accounts for the (non)application of the phonological rules in question. The former approach reached full flower during the period covered in this article in the form of the theory of Lexical Morphology and Phonology (Kiparsky 1982a). The latter approach is seen in the evolution of autosegmental and prosodic representations, as well as in the increased use of underspecification during this era.

Second, not all morphemes are phonologically canonical, in the sense of consisting of a contiguous segmental string. Item-based theories of morphology operate transparently when morphemes adhere to what Bye and Svenonius (2012) describe as a “concatenative ideal,” as described by the following characteristics (among others):

- (1) a. Proper precedence: morphemes are linearly ordered (i.e., no overlapping)
- b. Additivity: morphemes are additive (i.e., no subtraction)
- c. Segmental autonomy: the segmental content of a morpheme is context-free (i.e., morphemes should not have segmental content determined by the lexical entry of another morpheme)
- d. Morpheme preservation: morphemes are preserved when additional morphemes are added to them (i.e., no overwriting).

To this list one might add another ideal:

- (2) e. Generality: namely, that the phonological component be able to apply to the output of morphology in a fully general manner (i.e., no exception statements for individual morphological environments).

As with the canons of Corbett’s (2005) Canonical Typology, actual morphological systems depart from these morphophonological ideals in almost every way. For example, the only phonological substance shared across the entries in a derivational Arabic verb paradigm is their consonants (McCarthy 1979, 1981); this unpronounceable collection of consonants (e.g., {k,t,b} for the verb meaning ‘write’) is identified as the root of the verb (see Section 4.1). The only phonological substance associated with third-person masculine singular object agreement in Chaha is labialization of the rightmost (nonpalatalized) noncoronal consonant in the verb (*nækəs* ‘bite,’ *nækʷəs* ‘bite him’; *mækʷər* ‘burn,’ *mʷækʷər* ‘burn him’ (McCarthy 1983: 179) (see §3.2). These phenomena violate proper precedence, autonomy – and if not those, then generality. Yet they are not singularities. As the areal focus of morphology and phonology expanded in the 1970s and 1980s beyond European languages to the rest of the globe, the documented instances of phenomena like this multiplied correspondingly.

Retrospectively, one can see the 1970s and 1980s as a time in which phonological theory was driven by the impetus to solve these apparent problems for item-based morphology. This is the perspective that shapes the current chapter, which is structured as follows. Section 2 summarizes the key developments from classic Generative Phonology to its autosegmental and prosodic rule-based successors. Sections 3–5 discuss the role of morphology in inspiring an array of representational innovations in rule-based phonological theory. Section 6 addresses a residue of morphological processes that resist straightforward representational phonological solutions. Section 7 discusses phonological patterns that appear not to be fully general (i.e., which appear to have some morphological conditioning) and their implications for the structure of the phonological component of grammar. Section 8 concludes.

2 The Trajectory from Generative Phonology

As outlined in *The Sound Pattern of English* (Chomsky and Halle 1968) and taught for decades in introductory classes in phonology and phonological theory, classic Generative Phonology makes three key assumptions that are relevant to our discussion. First is the **generative** assumption that morphemes are stored as underlying representations and that the job of the phonological grammar is to map these underlying representations to surface representations. Second is the **rules** assumption, namely that underlying representations are transformed into surface representation by means of the applications of phonological rules which actively alter representations. Third is the assumption that phonological **representations**, both underlying and surface, consist of (strings) of segments, which are themselves fully or partially specified matrices of distinctive features.

The generative assumption underlies the term “Generative Phonology” and persists through the representational evolutions from the eponymous Generative Phonology of Chomsky and Halle (1968) into Autosegmental Phonology and Prosodic Morphology. (It even persists into Optimality Theory (see Chapter 20), though competes there with the assumption that all representations are surface-only.) The rules assumption persists as well throughout most of this era, though the evolution toward a more constraint-based model of grammar does begin to emerge in the era covered in this chapter, as in the Obligatory Contour Principle, discussed in Sections 3.1.1 and 4.1. The wholesale rejection of rules, however, reaches full flower only with the ascent of Optimality Theory in the 1990s.

The representations assumption is the main change that this chapter will focus on. Autosegmental theory and Prosodic Morphology are almost entirely representational innovations. Autosegmental theory, discussed in Section 3, explodes the segment by introducing “floating features” and featurally underspecified timing units; morphemes may consist of, and rules may operate on, either or both. Prosodic Morphology, discussed in Sections 4

(on templatic morphology) and 5 (on reduplication), takes the representation of timing units to a new level, enabling a more insightful characterization of templatic morphological form. This new representational flexibility enables phonologists to posit underlying representations for morphemes which depart from the classical canon.

We turn next to more in-depth examination of these representational developments and their empirical motivations.

3 Morphemes as Subsegmental Units

Phonological theory was transformed by the development of autosegmental representations, which broke distinctive features out of segmental matrices and treated them, and the timing units they associate with, as independent entities in the grammar. Many excellent surveys of Autosegmental Phonology exist, including but not limited to Goldsmith (1976, 1979, 1990), Clements (1980), Halle and Vergnaud (1983), and Akinlabi (2011).

3.1 Tone

Phonologists working on African tone languages presented some of the most convincing arguments for decoupling features from the segments containing them.

3.1.1 Tone Melodies

One of the strongest early motivations for extracting tone out of segments was the need to characterize tonal melodies independently of the vowels bearing the tones. In the 1970s, discussion focused on languages like Mende (Leben 1973, 1978; though cf. Dwyer 1978; Conteh et al. 1983) in which the only tonal melodies available to morphological roots in the system are claimed to be H, L, HL, LH, HLH. The component tones of these melodies are distributed in highly predictable ways over the vowels (or, more precisely, “tone-bearing units” of the words). A similar pattern applies in Kukuya stem (Hyman 1987). The Mende examples in (3) are drawn from Leben (1978).

(3) Tone patterns on monosyllabic words

H	H	kó	‘war’	pélé	‘house’	háwámá	‘waist’
L	L	kpà	‘debt’	bèlè	‘pants’	kpàkàlì	‘three-legged chair’
Fall	HL	mbû	‘owl’	ngílà	‘dog’	félàmà	‘junction’
Rise	LH	mbǎ	‘rice’	fândé	‘cotton’	ndāvúlá	‘sling’
Rise-fall	LHL	mbǎ́	‘companion’	nyàhà	‘woman’	nikíllì	‘peanut’

If 5 atomic tones existed, we might expect 25 possible tone patterns on disyllabic words and 125 patterns on trisyllabic words. Moreover, we would lack an explanation for why HHL contours do not contrast with HLL, why

stretches of level tone are restricted to the ends of words, and why contour tones (rise, fall) are found only on the final syllable. These problems were solved with three major additions to phonological theory: an autosegmental tier for tone, the Obligatory Contour Principle, and a set of Universal Association Conventions. All three proposals (extended to other features and known collectively as “Autosegmental Phonology”) turned out to have much broader applicability within phonological theory.

Researchers such as Leben, Hyman, Williams (1976), Goldsmith (1976), and Pulleyblank (1986) posited an independent tonal “tier” on which tones could exist autonomously with segments. Tone melodies thus take on an existence independent of the segmental makeup and syllable count of the stems they are lexically affiliated with; the association of these tones to tone-bearing units is predictable.

In order to explain why the melody inventory is so limited, and specifically why contrasts like HL versus HLL versus HHL were thought not to occur in systems like Mende, Leben (1973, 1978) invoked what Goldsmith (1976: 36) later termed the Obligatory Contour Principle (OCP):

- (4) Obligatory Contour Principle: Adjacent identical autosegments are prohibited.

A striking early result of autosegmental work on tone was the emergence of seemingly universal conventions of autosegmental association which map tonal autosegments to potential tone-bearing units (Goldsmith 1976; the statement below is from Pulleyblank 1986):

- (5) Association conventions for tone:
- a. Map a sequence of tones onto a sequence of tone-bearing units,
 - i. from left to right
 - ii. in a one-to-one relation.
 - b. A linked tone spreads rightward to any remaining unspecified tone-bearing units.
 - c. Leftover tones are assigned to the rightmost tone-bearing unit.
 - d. Association lines may not cross.

Example (6) illustrates the conventions, which are shown applying to two of the Mende words from (3):

- (6)
- | | | |
|--|--|--|
| $\left[\begin{array}{c} \text{felama} \\ \text{H L} \end{array} \right]$ | $\left[\begin{array}{c} \text{felama} \\ \text{H L} \end{array} \right]$ | $\left[\begin{array}{c} \text{felama} \\ \text{H L} \end{array} \right]$ |
| $\left[\begin{array}{c} \text{nyaha} \\ \text{L H L} \end{array} \right]$ | $\left[\begin{array}{c} \text{nyaha} \\ \text{L H L} \end{array} \right]$ | $\left[\begin{array}{c} \text{nyaha} \\ \text{L H L} \end{array} \right]$ |
| UR | Mapping (a) | Spreading (b) Docking (c) |

This analysis captures a phonological generalization holding over root morphemes in Mende. But it also extends to generalizations holding over

certain complex words. In Mende, toneless suffixes such as *-ma* ‘on’ join into the domain of tone association, such that a disyllabic root with a LHL melody, in combination with *-ma*, surfaces with the same tones as a trisyllabic root with a LHL melody (7).¹

- (7) *nyàhá-mà* ‘woman-on’ (cf. *nyàhâ* ‘woman’)

This “duplication” problem, in which root structure conditions are mirrored by conditions holding over words (see, e.g., Kenstowicz and Kisseberth 1979: 427), had a major influence on phonological theory, principally in the development of Optimality Theory (see Chapter 20). Even during the era covered by the present chapter, however, the duplication problem was significant; it prompted cyclic analysis in which the same set of phonological rules could potentially apply to roots and (again) to affixed stems (Section 7.3).

3.1.2 Tonal Affixes

An even stronger argument from morphology for the postulation of floating autosegments is provided by featural affixes, whose only phonological content is manifested as the addition of or change to a feature. Morphological processes without clear segmental morphs to mark them are potentially problematic for item-based approaches to morphology (e.g., Chomsky 1957; Lees 1960; Halle 1973; Lieber 1980, and many others). Autosegmental Phonology addressed this problem by permitting individual phonological features to be treated as autonomous objects.

Consider, for example, the genitive construction in Igbo. This construction juxtaposes two nouns and imposes a tonal change which is straightforwardly described by analyzing the genitive morpheme as a floating tone which associates to a nearby vowel (Williamson 1968, via Hyman 2011):

- (8) a. Central Igbo àgbà + + èṅwè → àgbá èṅwè ‘jaw of monkey’
 L L H L L L H L L
- b. Aboh Igbo ègbà + + èṅwè → ègbá èṅwè ‘jaw of monkey’
 L L H L L L H L L

A similar phenomenon occurs in Bamileke-Dschang, where the associative morpheme is analyzed by Hyman (1985) as a floating L tone whose presence causes phonetic downstep, transcribed as a raised exclamation point:

¹ Leben (1978) observes that LH melodies, in particular, do not always display predicted linking behavior; in some roots, the H of the LH melody links to the last available vowel, leaving L to spread to the preceding vowels. This latter pattern is actually the norm in Kukuaya (Hyman 1987). The behavior of these LH melodies was an early crack in the universality of the linking conditions. For discussion of this and other exceptions to tone mapping in Mende, see Dwyer (1978), Conteh et al. (1983).

- (9) Bamileke-Dschang genitive marker: floating L (Hyman 1985)²
- a. séŋ 'bird'
- H
- séŋ 'séŋ 'séŋ 'séŋ 'bird of bird of bird of bird'
- H L H L H L H
- b. kàŋ 'squirrel'
- L
- kàŋ 'kàŋ 'kàŋ 'kàŋ 'squirrel of . . . of squirrel'
- L L L L L L L

In Hausa, a suffixed floating L tone produces a falling contour on a final H-toned syllable, as illustrated below by the verbal noun-forming *-(L)wá:* and the definite *(L)-r* (feminine) and *(L)-n* (masculine) suffixes (Newman 2000):

- (10) a.

verb	verbal noun	
ká:wó:	ká:wô:-wá:	'buy/buying'
káràntá:	káràntâ:-wá:	'read/reading'
lí:kè:	lí:kè:-wá:	'patch/patching'
- b.

noun	definite noun	
gídá:	gídâ:-n	'house/the house'
rì:gá:	rì:gâ:-r	'gown/the gown'
dǎ:kì:	dǎ:kì:-n	'hut/the hut'

Hyman (1987) and Pulleyblank (1986) made the influential argument that the assignment of floating affixal tone follows from the association conventions. One piece of evidence offered by Hyman are the tonal melodies in Kukuya verbs. Kukuya verbs exhibit the same five tone melodies as Mende nouns – but with the twist that the LHL melody occurs only with complex verbs, in which the L portion is supplied by the root and the HL portion by a suffix (the aorist, in the following examples).

- (11) Realizations of L root melody + HL suffix melody in Kukuya (Hyman 1987: 314)
- a. (ndé)-bvĩ ' (he) falls'
- b. (ndé)-kàây ' (he) loses weight'
- c. (ndé)-pàlǎ^ 'he goes out'
- d. (ndé)-bàámǎ 'he wakes up'
- e. (ndé)-kàlógǎ 'he turns around'

Pulleyblank's (1986) analysis of Tiv provided further support. As seen below, the recent past and general past tenses in Tiv are encoded only by means of tone melody affixation. Recent past suffixes a HL melody, while general past prefixes a L:

² The floating L genitive marker alternates with an allomorph that has a fixed vowel.

(12)	Underlying stem tone	Recent past	General past
'come'	H	vé	^l vá
'hear'	H	óngó	^l úngwà
'flee'	H	yévèsè	^l yévèsè
'go'	L	dzé	dzà
'refuse'	L	vèndé	vèndè
'accept'	L	ngòhórò	ngòhòrò

Pulleyblank argues that the linking of the floating affixal tones follows from the universal rules of tone association. As seen below, floating tones associate in a left-to-right, one-to-one manner on each morphological cycle.

- (13) Derivation of *ngòhórò* 'accepted, recent past' and ^l*yévèsè* 'fled, general past'
UR

	$\left[\begin{array}{c} \left[\begin{array}{c} \text{ngohoro} \\ \vdots \\ \text{L} \end{array} \right] \text{H} \end{array} \right]$	$\left[\begin{array}{c} \left[\begin{array}{c} \text{yevese} \\ \vdots \\ \text{L} \end{array} \right] \text{H} \end{array} \right]$
	'accept, recent past'	'come, general past'
Root cycle: association of underlying tone	$\left[\begin{array}{c} \text{ngohoro} \\ \vdots \\ \text{L} \end{array} \right]$	$\left[\begin{array}{c} \text{yevese} \\ \vdots \\ \text{H} \end{array} \right]$
Stem cycle: association of affix tone	$\left[\begin{array}{c} \text{ngohoro} \\ \vdots \\ \text{L} \quad \text{H} \end{array} \right]$	$\left[\begin{array}{c} \text{yevese} \\ \\ \text{L} \text{H} \end{array} \right]$
Word level: association of default L tone	ngòhórò	^l yévèsè

The generalization that lexical stem tone is always realized on the first stem syllable, and that suffix tone is realized on the second stem syllable, follows from the first universal association convention in (5). Note, however, that Tiv does not exhibit automatic left-to-right spreading. Instead, default Low is assigned to toneless tone-bearing units.

3.1.3 Universality of Tone Rules

The 1980s were a period during which phonologists tended to complicate representations in order to simplify rules, as characterized in this well-known quote from McCarthy (1988: 84):

During the last 10 years or so, phonological theory has made great progress ... by adhering to two fundamental methodological premises. The first is that primary emphasis should be placed on studying phonological representations rather than rules. Simply put, if the representations are right, the rules will follow.

Note, however, that even the meager set of morphologically sensitive tonal alternations seen so far is problematic for the universality of the association conventions. In Bamileke Dschang associatives and in the Tiv general past,

floating L tones do not dock to form contours, thus violating association convention (5c). Convention (5b) is flouted in Tiv, in which tone does not automatically spread rightwards to toneless tone-bearing units. And even association convention (5a) turned out to be language-specific. To take one example, Newman (1986) observed that Hausa tone patterns appear to associate from right to left. Example (14) shows that in Hausa, the imperative form of verbs replaces lexical tone with a uniform LH melody:

(14)	Declarative		Imperative (LH)	Gloss
	HL	rúfè:	rùfé:	'close'
	HLH	bínciké:	bìnciké:	'investigate'
	H	nánnè:mó:	nànnè:mó:	'seek repeatedly'
	LH	sò:yú	sò:yú	'be fried'

The fact that the LH imperative melody associates to trisyllabic words as L*H, rather than as H*L, suggests either right-to-left or what Yip (1988) terms 'edge-in' tone association, in which peripheral melodic elements associate to peripheral skeletal positions. Either way, the example shows the language particularity of tone association rules. The role of morphology in the development of the autosegmental approach to tone is thus twofold: providing evidence *for* autosegmental representations, and providing evidence *against* universal tone association principles.

3.2 Segmental Features

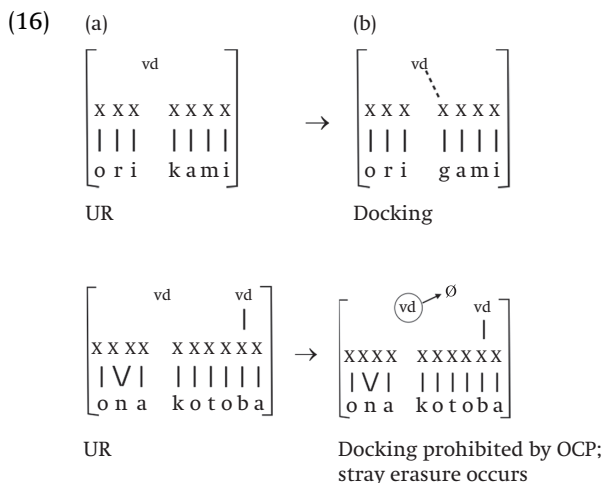
Beyond tone, the 1980s saw a wave of support for autosegmentalization in a variety of areas. In this section we touch on evidence coming from morphology.

One of the most influential morphological arguments for autosegmental features other than tone is presented by Itô and Mester (1986) in their analysis of Japanese Rendaku voicing, which famously targets the initial obstruent of native Japanese lexical items serving as the second member of endocentric noun-noun compounds. Rendaku voicing is shown applying in (15a,b). In (15c), however, it is blocked by "Lyman's Law," the prohibition against Rendaku voicing if the undergoer contains a voiced plosive in another position (data from Itô and Mester 1986):

(15)	a.	ori	kami	→	origami	
		'fold'	'paper'		'paper folding'	
	b.	kokoru	tsutai	→	kokorudzutai	
		'heart'	'usage'		'consideration'	
	c.	onna	kotoba	→	onnakotoba	*onnagotoba
		'woman'	'speech'		'feminine speech'	

Itô and Mester's influential analysis of Rendaku voicing posits a floating voicing ([vd]) feature which is introduced by the morphological compounding construction, much like the floating tones of the

genitive and associative constructions in Igbo and Bamileke-Dschang, seen above. The [vd] feature docks to the first consonant of the second member (16a). Linking is blocked, however, if another [vd] feature exists on the same tier (16b):



The constraint responsible for Lyman's Law is the Obligatory Contour Principle (4), the same constraint that prohibits two adjacent floating H tones in the melodies of Mende roots and Kukuya stems.

Rendaku voicing provided evidence for a further refinement to phonological theory, namely what Mester and Itô (1989) subsequently termed "contrastive underspecification." Autosegmental representations already necessarily assume some degree of underspecification; Mende vowels, for example, are not underlyingly linked to tones. In Japanese, underspecification is crucially context-sensitive. Vowels and nasal consonants, though phonetically voiced, do not interfere with the application of Rendaku, as seen in (15a,b). Itô and Mester argue that sonorant segments lack a phonological [voice] feature in the lexical phonology; only obstruents may be lexically specified for voicing. The contextual underspecification of voicing on sonorants accounts for their invisibility to the OCP constraint enforcing Lyman's Law.

Our next example, Chaha, played an important role in phonological theory in showing that inflectional morphology could be manifested solely by phonological featural changes – and that the association of those features is not only to edges. Example (17a) shows that second-person feminine singular is encoded on imperative verbs by end palatalization, which targets the final consonant. Third-person masculine singular object marking is accomplished by rightmost labialization, targeting the rightmost noncoronal consonant (17b). Impersonal forms of the verb are marked by both end palatalization *and* rightmost labialization (17c) (McCarthy 1983: 179):

- (17) a.
- Second-person feminine singular realized by final palatalization:*

Imperative 2 m sg	Imperative 2 f sg	gloss
nəqət	nəqətʲ	‘kick’
gʲækʲət	gʲækʲətʲ	‘accompany’
nəmæd	nəmædʲ	‘love’
nəkəs	nəkəsʲ	‘bite’
wətæq	wətæqʲ	‘fall’
fəɾæx	fəɾæxʲ	‘be patient’

- b.
- Third-person masculine singular object realized by labialization of rightmost noncoronal:*

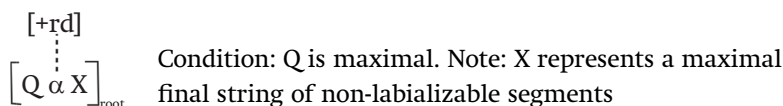
	Perfective (no object)	Perfective (3 m sg object)	gloss
i.	dænæg	dænægʷ	‘hit’
	nækæb	nækæbʷ	‘find’
ii.	nækæs	nækʷæs	‘bite’
	kæfæt	kæfʷæt	‘open’
	qætær	qʷætær	‘kill’
iii.	mækʲær	mʷækʲær	‘burn’
iv.	sædæd	sædæd	‘chase’

- c.
- Impersonal realized by both labialization and palatalization:*

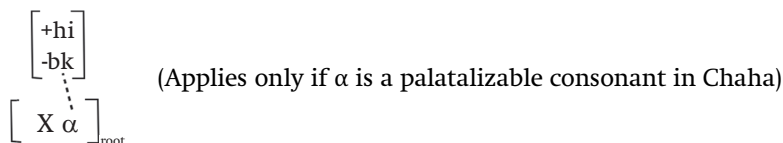
	Personal	Impersonal	gloss
i.	kæfæt	kæfʷætʲ	‘open’
ii.	bænær	bʷænær	‘demolish’
iii.	nækæb	nækæbʷ	‘find’

McCarthy’s (1983: 178) analysis, carrying forward an earlier observation by Hetzron (1971), is that: “the feature complexes [+high, -back] and [+round] are morphemes marking various properties of the verb.” These featural morphemes associate to root consonants by the autosegmental rules of rightmost labialization (18a) and end palatalization (18b), which must be crucially ordered to account for impersonal forms like (17c.i,ii), in which labialization applies first and potentially blocks palatalization. No single consonant can be both labialized and palatalized.

- (18) a) Rightmost labialization:



- b) End palatalization:



McCarthy's analysis of Chaha dramatically converted an apparent case of process morphology to a clear case of regular affixation – albeit of abstract morphemic representations. Here again, autosegmental representations allow otherwise exiled nonconcatenative morphological processes to enter the large tent of item-based morphology.

A question at this juncture is whether the rules required to associate subsegments to skeletal positions are actually all that general – in other words, whether the representations do indeed do all the work. For example, the Chaha rules above target the rightmost skeletal position, not the leftmost, as the Universal Association Rules in (5) would predict.

This 'residue' of phonological rules which are not fully general but have to access specialized morphological information is addressed in Section 7.

4 Prosodic Templates: Morphemes as Prosodic Skeletons

Prosodic morphology is diagnosed when any morphological construction imposes a fixed phonological shape on the stem it creates, regardless of the varying shapes of the morphemes composing the stem. Prosodic templaticity (this section) and reduplication (Section 5), in particular, played a major role in the development of phonological representations and the nature of phonological rules during the 1970s and 1980s.³

The most influential prosodic morphological templates in the literature are those of the Arabic verbal paradigm, as famously analyzed by McCarthy (1979, 1981); this work inspired many other analyses of templaticity in other languages. Initially templates were characterized in CV terms. The realization in the late 1980s and early 1990s that templates can be insightfully analyzed in terms of the prosodic hierarchy – namely mora, syllable, foot, prosodic word (McCarthy and Prince 1999) – inspired a tidal change in phonological analysis, with more and more phenomena attributed to prosodic considerations. Whether templates are atomic lexical objects or compositionally constructed by grammatical rules or constraints is a question that also began to arise during this time; it has been taken much further in the era of Optimality Theory (Chapter 20).

We begin our coverage of prosodic templates with Arabic, moving next to influential developments in Yowlumne and Japanese.

4.1 Paradigmatic Templaticity: Semitic Morphology

Most discussions of prosodic templates include a description of the verbal system of Arabic, in which each derivational category (*binyan*) is

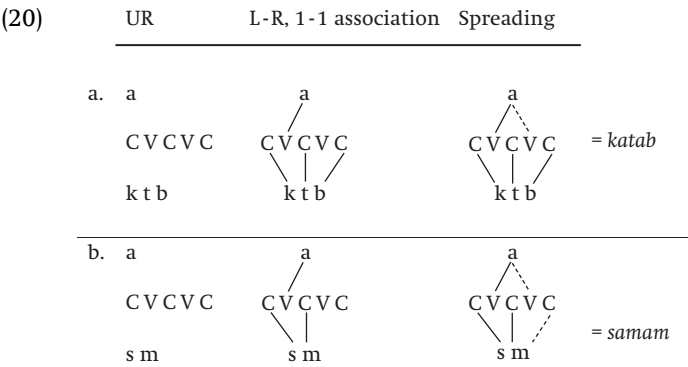
³ Prosodic morphological templates are not to be confused with morphological templates whose purpose is to describe or control the order of affixes; on the latter, see for example Chapter 5.

associated with a fixed skeletal shape (McCarthy 1979, 1981; see also McCarthy and Prince 1990 on templatic patterns in Arabic plural nouns). The root morpheme of each Arabic verb is purely consonantal, and the vocalic melody comes from a third morphological source. The partial examples below illustrates how skeletal shape varies across *binyanim* for the same consonantal root, and how vowel melodies vary by aspect/voice within a *binyan*:

(19)

		Perfective		Imperfective	
<i>Binyan</i>	# root consonants	Active	Passive	Active	Passive
I	3	katab	kutib	aktub	uktab
	3	kaðab			
	2	samam			
II	3	kattab	kuttib	ukattib	ukattab
	3	kaððab			
	4	daḥraj	duḥrij	udaḥrij	udaḥraj
III	3	kaatab	kuutib	ukaatib	ukaatab
	3	raasal			
IV	3	ʔaktab	ʔuktib	uʔaktib	uʔaktab
XI	3	ktaabab		aktaabib	
	4	dḥarjaj	dḥurjij	adḥarjij	udḥarjaj

McCarthy’s foundational insight was that each *binyan* could be represented as a skeletal morpheme, a template defined in terms of C and V units. The association between these templatic positions and the consonants of the root and the vowels of the aspect/voice morpheme are determined by the Universal Association Conventions seen earlier in (5):



A striking prediction of this model is that, assuming the OCP is in force, the consonants of a bilateral root such as $\sqrt{sm}$ ‘poison’ will associate to a three-consonant template in left-to-right, one-to-one fashion, with the right-most consonant spreading from the second to the third consonantal skeletal position (20b). This derives Greenberg’s famous (1978) generalization to the effect that given a verb with three surface consonants of which two are

identical, it is never the case that the first and second are identical (thus *samam*, but never **sasam*).

Cast in these prosodic and autosegmental representation terms, the templatic morphology of Arabic is brought more in line with canonical concatenative affixation. Templates, vocalic melodies, and consonantal roots are all morphemes with fixed phonological substance. The fact that they combine “vertically” instead of “horizontally” is an effect of their representations: none of these morphemes can syllabify and be pronounced on its own.

A question for this wildly successful analysis of Arabic is this: how fully general within the language (or universal grammar) are the association rules for Arabic? Clearly, capturing Greenberg’s Generalization is a huge coup for the Universal Association rules. However, we have seen that in other languages those rules are not so exceptionless. And indeed, even in Arabic, McCarthy (1981) remarks that a number of special statements have to be made in order to fully account for the details of the system. For example, Binyan II and Binyan VII both contain four consonant slots. When roots with fewer than four consonants map to these templates, a consonant must double. The Universal Association conventions predict the last consonant to spread, as seen above for the root $\sqrt{\text{sm}}$ → *samam* (Binyan I). But this is not the pattern seen in (21). Root $\sqrt{\text{ktb}}$ ‘write,’ in combination with template CVCCVC, is realized as *kattab*, not **katbab* as predicted by the Universal Association Conventions (UAC).

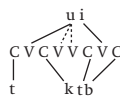
(21)	Root	Predicted by UAC	Actual
Binyan II: CVCCVC	$\sqrt{\text{ktb}}$	* <i>katbab</i>	<i>kattab</i>

It is not the case that templatic association is prohibited from forming consonant clusters; compare Binyan XI with quadriliteral root $\sqrt{\text{dhrj}}$, which is realized as *dharraj*, not **dharraj*. It appears that Binyan II invokes a different spreading convention than Binyan XI. McCarthy (1981) and McCarthy and Prince (1999) invoke a Binyan-specific internal gemination rule for this purpose; alternatively, it may be that Binyan II exhibits “edge-in” association (e.g., Yip 1988).

(22)	Binyan II	cf. Binyan XI
	‘Edge-in’ association or special internal gemination: <i>kattab</i>	Left to right association: <i>dharraj</i>

The vowel /i/ also requires special association. In defiance of the Universal Association Conventions, a melody-final /i/ gravitates directly to the last vowel position:

- cf. Binyan VI, Passive Participle



Phonetic tree diagram for the word 'tuck' [tʌk]. The root node is 'tuck', which branches into 't' and 'ʌk'. 'ʌk' branches into 'ʌ' and 'k'. 'ʌ' branches into 'u' and 'a'. 'k' branches into 'C' and 'V'. 'C' branches into 't'. 'V' branches into 'k' and 'tʰ'.

Left to right association:
tukaatah

4.2 Pervasive Templaticity: Japanese Minimality

Detailed discussions of Japanese bimoraicity can be found in Itô (1990) and Poser (1984, 1990), as well as in the many sources cited therein. In Japanese, a short vowel is one mora, a long vowel is two moras, and a coda consonant contributes one mora. The bimoraic foot can therefore take three forms: a foot composed of two monomoraic syllables ([CV]_μ[CV]_μ), a bimoraic open syllable ([CVV]_μ), and a bimoraic closed syllable ([CVC]_μ).

As shown in a detailed study by Itô (1990), a bimoraic template is imposed on a variety of morphologically derived stems. Example (24) illustrates loanword clipping, which produces derived words of either one (24a) or two (24b,c) bimoraic feet:

- (24) a. amachua → ama 'amateur'
herikoputaa → heri 'helicopter'
b. furasutoreeshoN → furasuto 'frustration'
asuparagasu → asupara 'asparagus'
c. hebii metaru → hebi meta 'heavy metal'
paasonaru konpyuutaa → paso kon 'personal computer'

Example (25) illustrates the imposition of a bimoraic stem template in tandem with the suffixation of /-tyan/, which forms nicknames from proper girls' names. Names which are trimoraic or longer shorten (25a–c), and names which are monomoraic will lengthen to conform to the bimoraic template (25d) (Poser 1984):

- (25) a. megumi → megu-tyan
 wa-sabu-roo → wasa-tyan
 b. syuusuke → syuu-tyan
 kinsuke → kin-tyan
 c. midori → mii-tyan, mit-tyan, mido-tyan
 d. ti → tii-tyan

An interesting wrinkle in the Japanese case is that bimoraic minimality is not imposed on monomorphemic words in Japanese, including verbs like *mi* 'look' and *ne* 'sleep' as well as nouns like *ki* 'tree,' *e* 'picture,' *no* 'field,' *na* 'name,' and *su* 'vinegar' (Ito 1990: 218).

Monomoraic CV roots do, however, undergo vowel lengthening when reduplicated or compounded: for example, *mi* → *mii-mii* 'while looking,' *ne* → *nee-nee* 'while sleeping'; cf. *tabe* 'eat' → *tabe-tabe* 'while eating' (Itô 1990: 226; Poser 1990).

The immunity of monomoraic roots to the demands of the bimoraic template can be understood, as observed by Itô (1990), as a species of derived environment restriction, the topic of Section 7.3.3.

4.3 Morpheme-specific Templaticity: Yowlumne

While the Arabic and Japanese examples might give the impression that templaticity is a systemic trait of a language, other cases discussed in the 1980s revealed that templaticity can be highly morphologically particular. The prosodic templates specific to individual roots and affixes in Yowlumne (Yokuts, Penutian; known in the literature as Yawelmani (Newman 1944)) energized phonological theory when they were introduced into the generative literature by Archangeli (1983, 1984, 1991); see also Noske (1985).

Verb roots in Yowlumne consist of one distinctive vowel and two or three consonants. Each root is lexically associated with one of the three templates in (26).

- (26) σ_μ (=CVC)
 $\sigma_{\mu\mu}$ (=CVVC)
 $\sigma_\mu\sigma_{\mu\mu}$ (=CVCVVC)

The root vowel and consonants map to the template in a predictable, left-to-right manner, modeled in autosegmental and prosodic phonology by Archangeli (1983, 1984, 1991: 125). For example, the root $\sqrt{\text{yawl}}$ 'follow' is

lexically associated with the $\sigma_{\mu\mu}$ template, to which its vowel /a/ and consonants /y,w,l/ map to produce the string *yawaal*.⁴

A root's lexical template characterizes the shape of the root when it combines with the non-templatic suffix: for example, aorist *-hin* (~ *-hun*) Archangeli 1991: 247):

(27)		Root	Template	Root + aorist /-hin/
a.	'shout'	$\sqrt{\text{caw}}$	σ_{μ}	caw-hin
	'float'	$\sqrt{\text{hogn}}$	σ_{μ}	hogn-hin (< hogn-hin)
b.	'devour'	$\sqrt{\text{cum}}$	$\sigma_{\mu\mu}$	c'om-hun (< c'oom-hin)
	'consent'	$\sqrt{\text{cupn}}$	$\sigma_{\mu\mu}$	coopun-hun (< cuupun-hun)
c.	'become quiet'	$\sqrt{\text{ni}}$	$\sigma_{\mu}\sigma_{\mu\mu}$	ninee-hin (< ninii-hin)
	'follow'	$\sqrt{\text{yawl}}$	$\sigma_{\mu}\sigma_{\mu\mu}$	yawal-hin (< yawaal-hin)

A number of Yowlumne suffixes are templatic, lexically associated with one or another of the three templates in (26). When a root combines with a template-selecting suffix, the root conforms to the template associated with the suffix, rather than to the template associated lexically with the root. In (28), we see three different roots combining with the consequent adjunctive suffix, which imposes the iambic template. Each of the three roots illustrated here is itself lexically associated with a distinct template. These root templates are irrelevant in the consequent adjunctive: each root conforms perfectly to the demands of the iambic template associated with the affix. Forms in (28) are based on Newman (1944: 163):

- (28) a. $\sqrt{\text{t'ul}}$ **t'uloo-ʔuy** lit. 'burn-CONS.ADJ' (<|t'uluu-ʔuy|)
(cf. lexical monomoraic root template, *t'ul*-)
- b. $\sqrt{\text{tan}}$ **tanaa-ʔeey** lit. 'go-CONS.ADJ' = 'footprint'
(cf. lexical bimoraic root template, *taan*-)
- c. $\sqrt{\text{c'uy}}$ **c'uyoo-ʔoy-nu** lit. 'urinate-CONS.ADJ-IND.OBJ' (<|c'uyuu-ʔoy-nu|)
(cf. lexical iambic root template, *c'uyuu*-)

In (29), roots associated with three different lexical templates combine with the desiderative affix *-hain*, which imposes a moraic template. The roots all conform to the affix-associated template, surfacing as monomoraic with a single short vowel. Data from Newman (1944: 114):

- (29) a. $\sqrt{\text{linc'}}$ **linc'-hain** 'speak-DESID'
(cf. lexical monomoraic root template, *linc'*-)
- b. $\sqrt{\text{wuʔy}}$ **wuʔy-hain** 'go to sleep-DESID'
(cf. lexical bimoraic root template, *wuuʔy*-)
- c. $\sqrt{\text{liʔ}}$ **liʔ-hain** 'sink-DESID'
(cf. lexical iambic root template, *liʔee*-)

⁴ Cited Yowlumne forms follow the transcription convention of Archangeli (1983, 1991), who in turn follows Newman (1944) except for using vowel doubling rather than a raised dot to indicate vowel length.

Yowlumne is also a significant language in the development of phonological theory because of the high degree of phonological opacity it exhibits, for which the templatic morphology is partly responsible. Long high vowels shorten to mid in Yowlumne. Vowel length is provided by morphological templates. An underlying (short) high vowel may lengthen templatically, lower by rule, and then shorten again if, in the course of subsequent affixation, it ends up being syllabified into a closed syllable. The result is an opaque short mid vowel, as in *c'omhun* in (27b).

Yowlumne opacity is mentioned in virtually every textbook and discussion of phonological opacity in the 1970s and 1980s (e.g., Kenstowicz and Kisseberth 1979), and also features in later theoretical developments seeking to eliminate rule ordering or to sharply delimit the range of opacity effects. See, for example, Lakoff (1993), who argues that rule ordering can be replaced in this instance by reference to three levels of representation, as well as Cole and Kisseberth (1995) and McCarthy (1999, 2007), among many others.

5 Reduplication

Reduplication, whether total or partial, poses a challenge to Bye and Svenonius's (2012) "concatenative ideal" (1). The response to this challenge resulted in a number of developments in phonological theory during the 1970s and 1980s.

The greatest novelty of reduplication is the mysterious instruction of "phonological copy." While feature assimilation is a standard element of any phonological theory, the nature of reduplicative copying strained the ability of phonological theories of this era. Copying was not in the toolbox of standard generative phonology. How can reduplicative morphology be rationalized in an item-based approach to morphology?

The solution to this problem lay, first, with the realization that the same abstract structures used to characterize templates could also represent partial reduplicative morphemes (Marantz 1982; Broselow and McCarthy 1983). In a clarion call, Marantz (1982: 445) proposed to rationalize reduplication as "simply the affixation of a skeleton to a stem." Example (30) illustrates CVC prefixing reduplication in Agta. Affixation of a CVC skeleton triggers full copy of all the segments in the base; these associate, by universal conventions, to the prefixal skeleton. Unassociated segments are deleted:

- (30)
- | | | | | |
|---|---|---|---|---|
| $\begin{array}{c} \text{CVC} + \text{CVCV} \\ \begin{array}{c} \quad \quad \\ \text{b a r i} \end{array} \end{array}$ | — | $\begin{array}{c} \text{CVC} + \text{CVCV} \\ \begin{array}{c} \quad \quad \\ \text{b a r i} \end{array} \end{array}$ | — | $\begin{array}{c} \text{CVC} + \text{CVCV} \\ \begin{array}{c} \quad \quad \quad \quad \\ \text{b a r i} \end{array} \end{array}$ |
| Affixation | | Melodic copy | | Association |

After some debate about whether the reduplicative skeleton should consist of C and V elements, as Marantz proposed, or instead simply of X timing units (Levin 1985), contemporaneous studies of reduplication by Steriade (1988) and McCarthy and Prince (1999) persuaded phonologists to convert to the same types of prosodic units that we saw above in the analysis of prosodic templates: moras, syllables, feet. This conversion was inspired by cases like Mokilese (Harrison and Albert 1976), in which the only way to give a consistent characterization of the shape of the reduplicative prefix is to say that reduplication adds a bimoraic syllable (McCarthy and Prince 1999). The nature of the segments in the added syllable, as well as the existence of extra copied segments outside that syllable to supply an onset to the following syllable, cannot be captured as succinctly or insightfully in a CV or X skeletal approach.

(31)	Skeletal shape	Prosodic shape	Stem	Progressive	Gloss
	CVC	$\sigma_{\mu\mu}$	pɔdɔk	pɔd-pɔdɔk	‘plant’
	VCC	$\sigma_{\mu\mu}$	andip	and-andip	‘spit’
	CVV	$\sigma_{\mu\mu}$	pa	paa-pa	‘weave’

The power and elegance of this approach was tempered by two general concerns: more identity than expected (Section 5.1), and less identity than expected (Section 5.2), between base and reduplicant.

5.1 Identity Effects

Wilbur noted in an early, seminal (1973) study that the application of phonological segmental rules to the output of reduplication is sometimes inhibited—or, conversely, catalyzed—in reduplication, in service of the maintenance of identity between the two copies.

In Tagalog, a famous and influential example of reduplicative “overapplication,” involves internal CV root reduplication which interacts with a rule of nasal substitution operative at the prefix-root boundary (Bloomfield 1933: 122). Clements (1985) discusses the example of the Tagalog stem *sayaw* ‘dance,’ which undergoes both the morphological processes of *maŋ-* prefixation and root-initial CV reduplication. The result is *ma-na-nayaw*. This form is derived by applying nasal substitution (*ŋ-s* → *n*) across the internal boundary; nasal substitution precedes and feeds reduplication. Assuming a morphological structure of *maŋ-CV_{Red}-sayaw*, this is an instance of “overapplication” of fusion; “normal application” would produce the incorrect *maŋ-sa-sayaw* → **manasayaw*.

In Javanese, certain vowel-initial suffixes trigger the deletion of stem-final /h/ (32a), versus (32b) (Horne 1961; Sumukti 1971; Dudas 1976; see McCarthy and Prince 1995 for discussion). A suffixed reduplicated stem undergoes normal /h/ deletion—but exactly when it does, the first copy loses its /h/ as well, even though no vowel follows (32c). Note, as in (32d), that reduplication itself does not cause /h/ deletion when no triggering suffix is present. (Data in (32a) are from Dudas (1976: 164) and Sumukti

(1971: 92); data in (32b) are from Dudas (1976: 133); data in (32c–d) are from Dudas (1976: 207).)

(32)	a.	aneh	‘strange’	ane-e	Demonstrative suffixation: h-deletion
		kokoh	‘rice in soup’	kɔkɔ-e	
		sareh	‘patient’	sare-ɔ	Hortatory suffixation: h-deletion
	b.	adɔh	‘far’	ng-adɔh-ake	Causative suffixation: no h-deletion
		akeh	‘much, many’	ng-akeh-ake	
	c.	bəḍah	‘broken’	bəḍa-bəḍa-e	Root reduplication + suffixation:
		ḍajɔh	‘guest’	ḍajɔ-ḍajɔ-e	double deletion
	d.	bəḍah	‘broken’	bəḍah-bəḍah	Root reduplication
		ḍajɔh	‘guest’	ḍajɔh-ḍajɔh	

Wilbur (1973) generalized over-effects like these with a global Identity Principle stating that base and reduplicant tend to be identical even when phonological rules might change one but not the other. However, phonological theory of the time was not suited to the incorporation of such a principle, and it hung uncomfortably on the outskirts of the theory until its reification as a correspondence constraint in McCarthy and Prince’s (1995) Base-reduplicant Correspondence Theory.

Lacking a constraint-based theory in which to comfortably embed the Identity Principle, researchers in the 1970s and (especially) the 1980s sought representational solutions to the reduplicative identity problem. For example, both Clements (1985) and Mester (1986) developed analyses in which reduplicative association precedes the linearization of reduplicant and base. To account for the overapplication of nasal substitution in Tagalog, Mester (1986) proposed to do away with melodic copy and associate the reduplicative template directly with the segments of the base, on a separate skeletal tier (33a). On this account, nasal substitution applies once, to the shared segmental string (33b). A subsequent process of linearization, or what Mester termed “Tier conflation,” produces the copy effect (33c):

(33) Reduplication of /paN-takot/ ($\rightarrow$ *pa-na-nakot*) in Tagalog (Mester 1986: 183)

a. Morphemic representation:	C V
	p a N t a k o t
	C V C V C
b. Nasal substitution:	C V
	p a n a k o t
	C V C V C
c. Tier conflation (linearization):	p a n a n a k o t
	C V C V C V C V C

Reduplicative overcopying of segmental alternations is a form of opacity. In the rule-ordering theory of the 1970s and 1980s, opacity was invariably handled by the ordering of operations, such that the later operations obscured the environments of the earlier operations. This is seen in the derivation (33), in Mester's (1986) analysis. Many instances of opacity arise through morphological combination, as in the case of reduplication or, in Yowlumne, templatic morphology. It is interesting to observe in hindsight that opacity was easy to handle and not viewed as particularly problematic in the 1970s and 1980s, but became much more of an issue for phonological theory in the surface-oriented, constraint-based theories of the 1990s and beyond.

5.2 Reduplicative Reduction

Reduction is a striking characteristic of many cases of partial reduplication. It produces a *lack* of identity between base and reduplicant. Reduplicative reduction played an important role in the development of phonological theories of underspecification (Pulleyblank 1988) and, later, unmarkedness (Steriade 1995). In an important early paper in the study of partial reduplication, Steriade (1988) noted that partial reduplicants were often reduced or unmarked versions of the bases that they copied. For example, prefixing partial intensive reduplication in Sanskrit does not preserve onset clusters, reducing them to their initial (less sonorant) element (Marantz 1982: footnote 9; Steriade 1988: 108):

- (34) kan-i-krand 'cry out'
 ban-i-bhranr- 'fall'
 dhan-i-dhvans- 'sound'

This phenomenon is puzzling for phonological theory. Clearly Sanskrit tolerates onset clusters; only prefixed reduplicants lack them. How can this morphologically conditioned phonological generalization be insightfully captured?

As Marantz notes, preposing a CVC (rather than CCVC) template could account for the reduction from two to one consonants, but would not predict *which* consonants associate, versus delete. A major contribution of Steriade (1988) was to observe that reduplicants, when they differ in such ways from their bases, are relatively *unmarked*. Singleton onsets are less marked than complex ones; obstruents are less marked (in onsets) than sonorants. Steriade's observations about unmarkedness shared with Wilbur's (1973) Identity Principle the property of being ahead of their time. Later, however, Steriade's insights were incorporated very straightforwardly into the ground-breaking Base-Reduplicant Correspondence Theory of McCarthy and Prince (1995).

Looking back on the phonological analysis of reduplication in the 1970s and 1980s, we can see two themes. The first is, as throughout this chapter,

the attempt to rationalize apparently processual reduplication as straightforward affixation to which phonology applies in a regular manner. Despite the best attempts, however, it was still the case that the essential copying process is specific to reduplication. Unlike autosegments, CV skeleta or prosodic units, the copying devices above were not of broader, more general utility in phonological theory. In the current era, this problem has been mitigated by the introduction of Agreement by Correspondence theory, which uses the same formal apparatus to handle reduplication and phonological assimilation (see, e.g., Hansson 2001; Rose and Walker 2004; Yu 2005; Inkelas 2008).

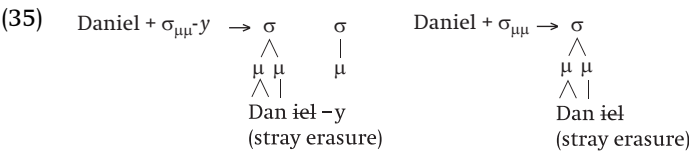
A second theme is the emerging need for phonological well-formedness constraints, in addition to phonological rules. Wilbur's (1973) Identity constraint, though clearly on the outer edges of the realm of phonology, nonetheless belongs to the same family of constraints that includes the Obligatory Contour Principle (Goldsmith 1976), itself motivated in part by the analysis of Arabic root morphemes (McCarthy 1979, 1981) and the tonal melodies characterizing morphemes in Mende, Kukuya, and other languages (Leben 1978; Pulleyblank 1986; Hyman 1987). And the markedness parameters that Steriade elucidated in her 1988 analysis of Sanskrit reduplication paved the way for the theory of markedness in Optimality Theory (Prince and Smolensky 2004).

6 Truncation and Subtraction

Some morphology cannot be analyzed as the addition of an affix because the outcome of the morphological operation is a subset of the phonological material present in the input. There are two subcases of this phenomenon, both of which grabbed the attention of researchers in the 1970s and 1980s. One is truncation, in which the input is mapped to an invariant prosodic template which happens to be smaller than the input. (Many cases of truncation actually flip and become augmentation in case the input happens to be smaller than the template; see Japanese, discussed in Section 4.2.) The other is true subtraction, arguably the most problematic type of morphology for strongly item-based approaches.

Much of what there is to say about truncation was already covered above in the discussion of templates: studies of truncation flourished in the 1980s, inspired by McCarthy and Prince's (1999) observation that the prosodic units to which stems can be truncated as part of particular morphological constructions are the same units found in prosodic templates and in the metrical systems of the languages in question: mora, syllable, foot, and prosodic word. Morphological truncation can operate alone or in tandem with affixation, as in the Japanese hypocoristics in (25).

Truncation, like reduplication, can be handled as additive morphology as long as one accepts that the phonological component will “stray erase” segments that can’t be mapped to the template for lack of space. English nickname formation illustrates this process in (35). In one case, templatic truncation (to a heavy syllable) is accompanied by suffixation of -y; in the other case, it is unaccompanied:



Not all process morphology is readily amenable to analyses of template association and stray erasure. Subtractive morphology is particularly resistant to an additive analysis. Two cases that were frequently discussed during this period are Koasati and Tohono O’odham (known in the literature of this era as Papago). In Tohono O’odham, perfectives are formed by deleting the final segment of the imperfective root (36a) (Zepeda 1983: 60–2). In Koasati, plurals are formed by deleting the final rime of the singular root (36b) (Martin 1988; see also Broadwell 1993).

(36)	a. Imperfective	Perfective	Gloss
	ñeok	ñeo	‘speak’
	‘apt	‘ap	‘walk’
	he:lwuin	he:lwui	‘slide’
	b. Singular	Plural	Gloss
	pitáf-fi-n	pít-li-n	‘to slice up the middle’
	albití-li-n	albít-li-n	‘to place on top of’
	iyyakohóp-ka-n	iyyakóf-ka-n	‘to trip’
	kawał-li-n	káw-wi-n	‘to snap something’

Some languages delete word-final consonants; perhaps Tohono O’odham could be rationalized as a case of (morphologically specific) final consonant deletion. However, Koasati rime deletion is not a process we would expect to occur word-finally as a general phonological rule in any language.

In the 1970s and 1980s, process morphology was discussed by morphologists because of the challenges it poses to item-based theories of morphology (see, e.g., Anderson 1992). Interestingly, process morphology did not typically feature in discussions of morphologically conditioned phonology. Thus its significant ramifications for the degree of morphological conditioning of phonological operations were not taken into account, making the level ordering picture (discussed in the next section) seem cleaner than it otherwise would have been.

7 Morphologically Conditioned Phonology

A theme of this chapter is that the aim of many of the modifications to phonological representations occasioned by subsegmental morphemes, templates, and reduplication during the 1970s and 1980s was to allow the rules of the phonological grammar to be as fully general as possible. Instead of a rule specific to causative verbs that geminated a medial consonant in Arabic, for example, the template itself carried the geminate representation; the phonology could simply apply universal rules of left-to-right, one-to-one association. If the morphology could just get its representations right, the job of the phonology should be simple.

Despite the advances of autosegmental and prosodic representations, the need still remained for some phonological rules to be morphologically conditioned—in other words, to require reference to specific morpheme boundaries, parts of speech, or even individual morpheme identities. These conditions motivated the positive and negative rule exception features of Lakoff (1965), Chomsky and Halle (1968), Lightner (1968, 1972), and Zonneveld (1978), among others. An oft-discussed example is trisyllabic laxing, in English, triggered by suffixes like *-ity*, *-ic*, *-ify*, *-itive* but not by suffixes like *-ious*, *-al*, or *-ing*:

(37)	Suffixed form exhibiting laxing	Suffixed form not exhibiting laxing
	divin-ity	divin-ing
	ton-ic	ton-al
	capac-ity	capac-ious
	defin-itive	defin-ing

We observed earlier in this chapter a split in Javanese between morphological environments which trigger intervocalic stem-final /h/ deletion (32) and those which do not. In the 1960s and 1970s, such differences would have been handled either by associating the triggering suffixes with a minor rule feature [+ /h/ deletion], or by associating the suffixes *not* triggering the rule with an exception feature [-/h/ deletion], depending on whether the rule in question was perceived to be the exception or the general pattern.

In the 1980s, attention focused on the question of whether any principles could be brought to bear on the amount and nature of such conditioning. The theory of Lexical Morphology and Phonology (LMP: Kiparsky 1982a; Mohanan 1986; Pulleyblank 1986; see also Pesetsky 1979) arose in response.

The unique innovation of LMP was its modular analysis of grammar: the morphology consists of ordered modules (“levels,” “strata”), each associated with a unique set of affixes and a characteristic set of phonological rules. These modules differ from one another; as a set, they differ from postlexical phonology. In an early statement of the model, Kiparsky (1984: 142) even ventured the ambitious aspiration that “lexical and postlexical phonology really are a single rule system operating in two modules of the

grammar.” While idiosyncratic differences among levels (as in Malayalam) subsequently made this strong vision difficult to support, the hypothesis of a small number of ordered lexical levels persists to this day in the form of Stratal Optimality Theory (Kiparsky 2008).

7.1 Level Ordering

The best-known example of Level Ordering in the 1970s and 1980s is the analysis by Kiparsky (1982b) and Halle and Mohanan (1985) of the distinction between Class 1 and Class 2 suffixes in English (e.g., Chomsky and Halle 1968; Siegel 1974; Allen 1978; Selkirk 1982). Class 1 suffixes are those which are stress-shifting and trigger spirantization and laxing; Class 2 suffixes are phonologically inert. The LMP analysis of this differences is that cyclic stress assignment, spirantization, laxing (and other rules) apply in Level 1, where (largely Latinate) Class 1 suffixes reside; neither rule applies in Level 2, the home of (largely Germanic) Class 2 suffixes.

- (38) Level 1 Class 1 (“+boundary”) derivation and inflection
- Class 1: -al, -ity, -ic, -ive, -ion, -ate, -ous, in-, con-, pre-, en-, de-, . . .
- Level 2 Compounding, Class 2 (“#-boundary”) derivation and inflection
- Class 2: -ness, -hood, -less, -ful, un-, non-, under-, . . .

Some of the morphophonological differences between these classes are illustrated in (39).

(39)

Class 1 suffix		Class 2 suffix		Isolation	
a. TRISYLLABIC LAXING					
seren-ity	[ɛ]	serene#est	[ij]	serene	[ij]
divín-ity	[ɪ]	divíne#ing	[aj]	divíne	[aj]
tón-ic	[a]	tóne#less	[ow]	tóne	[ow]
b. STRESS					
parént+al		párent#hood		párent	
órigin-al, origin-ál-ity		óorigin#less		óorigin	
prósper, prospér-ity		prósper#ing		prósper	
c. SPIRANTIZATION					
opác-ity	[s]	frólick-ing	[k]	opáque, frólic	[k]
d. CLUSTER SIMPLIFICATION					
iamb+ic	[mb]	iamb#s	[m]	iamb	[m]
prolong+ation	[ŋg]	prolong#er	[ŋ]	prolong	[ŋ]
sign+al	[gn]	sign#er	[n]	sign	[n]
malign+ant	[gn]	malign#ing	[n]	malign	[n]
hymn+al	[mn]	hymn#s	[m]	hymn	[m]
damn-ation	[mn]	damn#er	[m]	damn	[m]

e. NASAL PLACE ASSIMILATION

ir-resolute	[rr]	un-wrap	[nr]
il-legal	[ll]	un-lawful	[nl]
im-mobile	[mm]	un-moved	[nm]

Despite the generalizations captured by level ordering, however, problematic areas remain (see, e.g., Aronoff and Sridhar 1983; Giegerich 1999). One is rules which are exceptional even within the level. For example, the stress-shifting level 1 suffix *-al* fails to trigger Level 1 laxing (*tone*, *ton-al*; cf. Level 1 *-ic*, in *ton-ic*). Conversely, the stress-neutral level 2 suffix *-ist* exceptionally triggers Level 1 spirantization (*classic-ist*).

If level ordering is applied at a level of granularity sufficient to capture all morphological and lexical conditioning, then suffixes like *-al* and *-ist* would require their own levels. The number of lexical levels might begin to approach the number of affixes, rather than being fixed at, say, two. This more expansive approach is taken later in cophology theory (Orgun 1996; Anttila 2002; Inkelas and Zoll 2007). But for the theories of the 1970s and 1980s, which aim to reduce morphological conditioning of phonology to the bare minimum, the residue not covered by a small number of phonologically internally uniform levels was a serious problem.

7.2 Level Nonordering: The Loop

Languages with recursive morphology pose special challenges for the basic architectural assumption of level ordering theory that levels are always strictly ordered. The best-known case of interleaving in a grammar with recursive morphology—Malayalam—was uncovered early in the development of LMP. As analyzed by Mohanan (1982, 1986, 1995) and Mohanan and Mohanan (1984), Malayalam has four levels or strata of morphology (Mohanani and Mohanan 1984: 581):

- (40) Stratum 1: Derivation (negative, unproductive causative, among others)
 Stratum 2: Subcompounding, productive causative suffixation
 Stratum 3: Co-compounding
 Stratum 4: Inflection (case and tense)

Mohanani assigned subcompounding and co-compounding to different lexical strata because of their different phonological patterning. Subcompounds undergo internal junctural consonant gemination, while co-compounds do not; Subcompounds are assigned tone and stress as a single unit, while members of co-compounds undergo tone and stress assignment independently.

Subcompounding and co-compounding are not extrinsically ordered in the way that level ordering theory predicts. Instead, either type of compound can be embedded within the other. (41a) illustrates subcompounds embedded within a co-compound (Mohanani 1986: 111; transcriptions

modified to match those of Mohanan 1995). (41b) illustrates a co-compound embedded within a subcompound (Mohanani 1995: 52):

- (41) a. moohanapaṇiīṭaārakaṇṭanmaārə
 [[moohanani + paṇi]_{Sub} + [ṭaārā + kaṇṭan]_{Sub}]_{Co}
 Mohanan wife Tara husband
 ‘Mohanan’s wife and Tara’s husband’
- b. Co-compound within subcompound
 [[mēēṣa + pēṭṭi]_{Co} + kaśāala]_{Sub} -kaḷ
 table box chair -PL
 ‘chairs made from tables and boxes’

To account for this free relative embedding of subcompounding and co-compounding, Mohanan proposed a “loop” between Strata 2 and 3. While effective in accounting for the free ordering possibilities in Malayalam, the proposal clearly invalidates the claim that levels are strictly ordered. This worrying observation prompted several attempts to locate subcompounding and co-compounding in a single level and recast their tone and stress differences in terms of prosodic structure (Sproat 1986; Inkelas 1989): on this view, a co-compound consists of two prosodic words, while a subcompound consists of one. Mohanan (1995) later argued against this analysis on the grounds that it fails to capture the gemination facts. In any case, prosodic differentiation of the two compounding types still undermines the essential claim that levels are internally phonologically uniform.

A question of interest in the early 1980s was the degree of difference a grammar can tolerate among different levels. The Strong Domain Hypothesis (Kiparsky 1984), the Stratum Domain Hypothesis (Mohanani 1986), and the Uniform Domain Hypothesis (Halle and Mohanan 1985) held that phonological rules had to apply in a contiguous set of levels; for example, a rule could not apply in Level 1 and postlexically, but not in Level 2. However, exceptions were found to these restrictions (see, e.g., Hargus (1988), on Sekani, and Hualde (1988), on Basque). The possibility that levels are not strictly ordered undermined the validity of these hypotheses even further, and they ceased to be a major focus of discussion in the literature.

7.3 Interleaving

Work in LMP pointed clearly to the fact that phonology and morphology are interleaved. This interleaving sometimes goes by the term “cyclicity”; analysts differ in their usage according to whether that term refers specifically to the situation in which exactly the same phonological rule applies every time a morphological operation takes place, or whether it refers simply to the situation in which some phonological rules apply to a word as it is being built. (Noninterleaving is the situation in which no phonological rules apply until a word is completely formed.) Compounding the terminological confusion is the possibility of building an entire word and then applying

phonology from the bottom up in a cyclic fashion to successfully larger subconstituents of the word (as in Chomsky and Halle 1968); that is cyclicity, but it is not interleaving.

The significance of interleaving is that its existence requires the modules of morphology and phonology to coexist and interact, rather than existing in a strictly ordered fashion (first do all the morphology, then do phonology). In this respect, the morphology-phonology interface appeared in the 1970s and 1980s to be substantially different from the phonology-syntax interface. The assumption during this era was that all syntax took place before any phonology and could never be influenced by it (e.g., Pullum and Zwicky 1988). (That assumption started to change in the 1990s; see, for example, the papers in Inkelas and Zec (1990).)

Evidence for morphology-phonology interleaving assembled during the 1970s and 1980s is of two kinds: rule interactions (including so-called “aba” rule ordering, which can result in phonological opacity), discussed in Section 7.3.1; and suppletive allomorphy of the kind that is conditioned by the output of applying phonological rules to the base of affixation on an earlier cycle, discussed in Section 7.3.2.

7.3.1 Phonological Rule Interactions

Many cases of cyclic rule application were adduced during the 1970s and 1980s (see, e.g., Chomsky et al. 1956; Chomsky and Halle 1968; Brame 1974; Kean 1974; Mascaró 1976; Kiparsky 1982c; Harris 1983, and many others). The argument was straightforward: without cycles, with only one pass of rule application, the wrong outcome would result. Often-cited examples are pairs like *còndensátion* versus *còmpeñsátion* (see, e.g., Kiparsky 1982c: 156). Unstressed vowel reduction applies to the second syllable in *còmpeñsátion* but not in *còndensátion*. This is surprising since the metrical structure of the two words seems identical; unstressed vowel reduction ought to apply in the same way to both. A solution can be found in the cyclic application of the English stress rule. *Còndensátion* is constructed from *condénse*, whose second syllable receives cyclic stress. *Còmpeñsátion* is constructed from *cómpensàte*, whose second syllable is never stressed. The preservation of cyclically assigned stress across later cycles of affixation protects the syllable *dense* in *condensation* from undergoing unstressed vowel reduction.

Another famous example of cyclicity is Brame’s (1974: 43) analysis of stress and syncope in Palestinian Arabic. As seen in (42), the *fhím* ~ *fihím* stem shape alternation is derived by the application of two rules: stress assignment and syncope. Syncope deletes unstressed /i/ in nonfinal open syllables (42a). Why does syncope not apply equally to the forms in (42b)?

(42)	a.	fhím-na	‘we understood’	b.	fihím-na	‘he understood us’
		fhím-tu	‘you (pl) understood’		fihím-kum	‘he understood you’
		smíf-na	‘we heard’		simíf-na	‘he heard us’
		smíf-nu	‘you (pl) heard’		simíf-kum	‘he heard you (pl)’

Brame's answer is that the suffixes in (42a) are within the first cycle of stress assignment, while the suffixes in (42b) are outside the first cycle. Because forms in (42b) undergo two applications of stress assignment, the vowel in (42b) that corresponds to the syncope vowel in (42a) is protected from undergoing syncope by the stress assigned to it on the first cycle.

7.3.2 Phonologically Conditioned Suppletive Allomorphy

Another argument for interleaving is evidence that suppletive allomorphy can be conditioned by derived phonological properties due to the application of cyclic phonological rules to the base of affixation, prior to suppletive allomorphy selection. A compelling case of this phenomenon is discussed by Hargus (1993), citing Hall (1990) and earlier sources. The nominalizing suffix illustrated in (43) has two allomorphs: *-erei*, found on verb stems with final stress, and *-ei*, found on all other verb stems (data from Hargus 1993: 49–50):

(43)	Infinitive (=base + <i>en</i>)	Nominal (=base + <i>ei/erei</i>)	Base gloss
a.	bäck-en	Back-eréi	'bake'
	spion-ier-en	Spion-ier-eréi	'spy'
	trompét-en	Trompet-eréi	'trumpet'
b.	ségel-n	Segel-éi	'sail'
	pláuder-n	Plauder-éi	'chat'

Verb stress is (largely) predictable in German, and by hypothesis is assigned by rule. *-ei/-erei* suffixation shifts stress to the suffix. Clearly, then, stress rules must apply to the base before the suffix allomorphy is determined (and again after suffixation).

7.3.3 Derived Environment Effects

Derived environment effects show that morpheme boundaries, or at least some encoding of morphological complexity, are properties of words that phonology must be able to access. The most famous case discussed in the 1970s and 1980s is undeniably Finnish assibilation (e.g., Kiparsky 1973a: 60, 1973b: 93; Keyser and Kiparsky 1984; Kiparsky 1993), an alternation by which underlying /t/ neutralizes to /s/ before the vowel /i/. Assibilation applies to sequences that are heteromorphemic (44a,b), but not to those wholly contained within a root (44b, c).

(44)	a.	/halut-i/	→ halusi	'want-3P.SG.PRET'	
		/halut-a/	→ haluta	'want-INF'	
	b.	/tilat + i/	→ tilasi	'order-3P.SG.PRET'	(*silasi)
		/tilat-a/	→ tilata	'order-INF'	(*silata)
	c.	/æiti/	→ æiti	'mother'	(*æisi)

Morphologically derived environment effects of this kind – often termed “strict cyclicity” in the literature – were handled with meta-grammatical

restrictions on rule application, like the Revised Alternation Condition of Kiparsky (1973a): 65; the Strict Cycle Condition of Kean (1974), Mascaró (1976), and Hualde (1989); and the Elsewhere Condition of Kiparsky (1982a), and Iverson and Wheeler (1988). These effects show that phonological grammars are sensitive to word-internal structure, an important point in debates over whether morphology is item-based or, to use Anderson's (1992) term, "a-morphous," such that words lack internal constituent structure. If derived environment effects require reference to morpheme boundaries, they support the former view. However, as with so many aspects of the morphology-phonology interface, derived environment effects have been reassessed in later theories; see, in particular, proposals to attribute derived environment effects to underspecification (e.g., Kiparsky 1993; Poser 1993) as well as the parallelist, transderivational "Comparative Markedness" approach of McCarthy (2003).

8 Conclusion

In retrospect, the role of morphology in the era of Generative Phonology, Autosegmental Phonology, and Prosodic Morphology can be seen as addressing two fundamental questions. Both tacitly pervade the literature of this era. It is only after the fact that they become particularly clear:

1. Is morphology amenable to an item-based analysis, as syntax is?
2. How sensitive to morphological information does phonology need to be—or, conversely, how much light does phonology shed on the internal morphological structure of words?

We have seen in this chapter that the aspiration to answer Question 1 with "yes" inspired and fueled many exciting representational developments in phonological theory. With the increased focus on phonological representations came a growing acknowledgment that static phonological constraints on representations play a major role in capturing phonological generalizations. This realization paved the way for the subsequent constraint-based era of phonology that began in a serious way in the 1990s and continues to this day. Interestingly, the introduction of constraint-based approaches actually reduced the need to rely on highly technical and abstract underlying representations of morphemes. But that development is the topic of another chapter in history and in this volume (see Chapter 20).

Question 2 also inspired major developments in phonological theory, and played a role in reimagining the modularity of grammar. Evidence from cyclicity showed that phonology could interpret morphological structures either from the bottom up or in tandem with their morphological construction. Work in level-ordering theory sought broad crosslinguistic generalizations about the limits of morphological conditioning of phonological

patterns. The need for cyclicity started to be challenged in the 1990s and still fuels a contentious analytical debate. The question of morphological conditioning of phonology remains open, both on an empirical and a theoretical level.

In sum, the role of morphology in phonology is undeniable and was an important factor in the phonological theorizing of the 1970s and 1980s. The interaction must be well understood in order to develop any successful theoretical model of morphology or of phonology.

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The Role of Morphology in Optimality Theory

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1 Introduction

Since the creation of Optimality Theory (OT) in the early 1990s (McCarthy and Prince 2001; Prince and Smolensky 2004), it has been widely applied in various linguistic sub-disciplines. Optimality Theory was initially designed for phonology. Kager (1999: 16) illustrates the fundamental assumptions of conventional OT with an example from Dutch (1). The symbol ‘-’ indicates a morpheme boundary and ‘.’ indicates a syllable boundary.

- (1) a.i /bɛd/ bɛt ‘bed’
 a.ii /bɛd-ən/ bɛ.dən ‘beds’
 b.i /bɛt/ bɛt ‘(I) dab’
 b.ii /bɛt-ən/ bɛ.tən ‘(we) dab’

Assume an underlying form or input for the phonology is /bɛd/ ‘bed,’ which surfaces in the plural form (1a.ii). The input for ‘bed’ cannot be /bɛt/, with intervocalic voicing in its plural form, otherwise the surface form for ‘dab’ in (1b.ii) would be *[bɛ.dən]. The function GEN(ERATOR) generates a list of logically possible output candidates for the input /bɛd/, which are submitted to the Dutch grammar for evaluation. This grammar consists of the *markedness* constraint *VOICED CODA, favoring voiceless obstruent codas, and the *faithfulness* constraint IDENT-I(NPUT)O(UTPUT) (voice), enforcing identity between an input and its output in terms of the voicing feature. The constraint *VOICED CODA dominates or outranks IDENT-IO (voice) in Dutch so that a violation of *VOICED CODA is more serious than any number of violations of IDENT-IO (voice). The surface form or winning output candidate [bɛt] violates IDENT-IO (voice), but satisfies *VOICED CODA. This form is optimal because it incurs the least serious violation of the above set of constraints, taking into account their hierarchical ranking. By contrast, the losing candidate *[bɛd], for example, violates the higher-ranked constraint *VOICED CODA so that it is ruled out by the grammar.

This example of pure phonology reflects several fundamental assumptions of conventional OT such as input and output, basic types of constraints such as markedness constraints and faithfulness constraints, the function GEN, and the way an OT grammar picks out the optimal candidate. I will elaborate on these fundamentals in Section 2.

Conventional OT has been extended to the morphology-phonology interface—morphophonology in particular. McCarthy and Prince (1995: 365), for example, observe that Arabic roots contain pharyngeals, but affixes do not. To account for this observation in OT, they propose the constraint ranking in (2) where the constraint at the left of “>” outranks the one at the right.

- (2) IDENT-ROOT(Place) > * [pharyngeal] > IDENT-AFFIX(Place)

The markedness constraint * [pharyngeal] bans any pharyngeal in the output. The faithfulness constraint IDENT-ROOT(Place) requires an input segment of a root to be identical with its output in terms of the place feature. The faithfulness constraint IDENT-AFFIX(Place) requires an input segment of an affix to be identical with its output in terms of the place feature. The constraint * [pharyngeal] outranks IDENT-AFFIX(Place) so that an output candidate of an affix which does not contain a pharyngeal will be preferred over one that has a pharyngeal. The constraint * [pharyngeal] is outranked by IDENT-ROOT(Place) so that an input pharyngeal of a root will surface. This is a case of morphophonology, in which morphological categories such as root and affix show their effects in the phonological component of the grammar.¹

Conventional OT is not sufficient to account for cases of the morphology-phonology interface such as phonologically conditioned allomorphy or allomorph selection (see Chapter 5). Here *allomorphy* refers to a phenomenon in which a lexical morpheme or morphosyntactic feature set has multiple phonological representations that cannot be derived from a single underlying form (see Kager 1999; Bonet and Harbour 2012). An extra mechanism has been introduced into conventional OT to account for phonologically conditioned allomorphy: an input allomorph set, in which multiple input allomorphs are stipulated (Kager 1996; Lapointe 2001; Bonet 2004; Bonet et al. 2007; Mascaró 2007; Bonet and Harbour 2012).

There are at least three problems for a conventional OT approach with an input allomorph set. First, in conventional OT, either a stem or an affix is

¹ See other works that index constraints on non-phonological information. Ringen and Vago (1998) and Noske (2000), for example, discuss faithfulness constraints encoding morphological categories such as root and affix in Hungarian and Turkana, respectively. Itô and Mester (1999) index faithfulness constraints on etymological information or vocabulary strata in Japanese such as native, Sino-Japanese, foreign vocabularies. Smith (1997) indexes faithfulness constraints on the lexical category noun. Pater (2000, 2007) indexes both faithfulness and markedness constraints on either lexical or morphological information. In contrast to the indexed constraint theory, other OT frameworks have been proposed to account for morphophonology. These frameworks include Stratal Optimality Theory (Kiparsky 2000) and Cophonology Theory (Orgun 1996; Inkelas et al. 1997; Inkelas 1998, to appear; Anttila 2002; Inkelas and Zoll 2007).

placed in an input, which predicts that stem-conditioned affix allomorphy and affix-conditioned stem allomorphy should be equally prevalent. However, based on cross-linguistic surveys, Paster (2006, 2009) found that the direction of conditioning of allomorphy is inside-out: there are many cases of stem-conditioned affix allomorphy while few cases of affix-conditioned stem allomorphy.²

Second, Paster (2009) argues that phonologically conditioned allomorphy is sensitive to phonological properties of underlying or input forms, not surface forms. By contrast, a conventional OT approach with an input allomorph set predicts that phonologically conditioned allomorphy is sensitive to phonological properties of surface forms, not underlying forms.

Third, sometimes one allomorph can occur in a specific phonological context while the other allomorph occurs elsewhere. The precedence of spell-out between the two allomorphs is determined by Pāṇini's Principle. Stipulating this precedence in an input allomorph set misses Pāṇini's Principle given that in OT any general principle should be reflected in a grammar rather than stipulated in an input. I will demonstrate this point in Section 4.

Given the above problems, an improved version of OT phonology is called for to account for phonologically conditioned allomorphy, if it is still assumed to take place in the phonological component of the grammar. Wolf (2008), for example, proposes the framework of Optimal Interleaving (OI) and attempts to account for phonologically conditioned allomorphy. Optimal Interleaving assumes that lexical insertion takes place in the phonological component of the grammar. Another possibility is to assume that phonologically conditioned allomorphy is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar, which is not a target of conventional OT, so that some assumptions of conventional OT do not apply to the morphological component. Either way, morphological realization must be taken into account to explain phonologically conditioned allomorphy. This chapter argues for the second solution. Extending the other assumptions of conventional OT into the domain of pure morphology can not only account for phonologically conditioned allomorphy, but also shed light on some well-known morphological issues such as blocking and extended morphological exponence, and syncretism.

Section 2 presents various fundamental assumptions of conventional OT, some of which are also taken in OT frameworks for morphology. Section 3 discusses some differences among the mechanisms of several OT frameworks for morphology. Section 4 compares three types of OT approaches to phonologically conditioned allomorphy, a case of the morphology-phonology interface: conventional OT, OI, and Realization

² Unless a footnote is provided, the definition of stem in Aronoff (1994: 39) is used throughout this chapter. That is, a stem is a "sound form to which a given affix is attached or upon which a given nonaffixal realization rule operates."

OT. Section 5 discusses the mechanisms, advantages, and problems of several OT frameworks in terms of how they account for cases of morphology proper such as blocking and extended morphological exponence as well as syncretism. Section 6 summarizes the discussions in previous sections.

Each theoretical framework in this chapter is evaluated using criteria such as the accuracy of their predictions, the complexity of their mechanisms, the quantity of linguistic data they can account for, and the extent to which stipulations are referred to so that generalizations based on linguistic principles are either captured or lost.

2 Fundamentals of Conventional Optimality Theory

The central idea of conventional OT (McCarthy and Prince 2001; Prince and Smolensky 2004), whose target is phonology, is that surface forms of language arise from the interaction between competing demands or constraints. There are three major components of a conventional OT grammar (3) (Kager 1999: 19).

- (3) LEXICON: contains lexical representations (or underlying forms) of morphemes, which form the input to:
 GENERATOR: generates output candidates for some input, and submits these to:
 EVALUATOR: the set of ranked constraints, which evaluates output candidates as to their harmonic values, and selects the optimal candidate.

The lexicon provides inputs, which are to be submitted to the function GEN. Conventional OT makes the richness of the base assumption—in other words, no constraints hold at the level of the input, and grammatical generalizations are expressed as interactions of constraints at the level of the output only.

GEN generates all logically possible candidate analyses of a given input.

The only true restriction imposed on all output candidates generated by GEN is that these are made up of licit elements from the universal vocabularies of linguistic representation, such as segmental structure (features and their grouping below the level of the segment), prosodic structure (mora, syllable, foot, prosodic word, etc.), morphology (root, stem, word, affix, etc.), and syntax (X-bar structure, heads/complements/specifiers, etc.). Within these limits, “anything goes.” (Kager 1999: 20)

The crucial role of EVALUATOR (abbreviated as EVAL) is to “assess the ‘harmony’ of [output candidates] with respect to a given ranking of constraints” and “select the most harmonic one of these as optimal—the actual output of the grammar” (Kager 1999: 21).

In conventional OT frameworks such as McCarthy and Prince (2001), no reference is permitted to morphosyntactic information. Notions such as affix, root, and stem are deemed to constitute enough morphological information for the grammar to select the output.

An OT grammar consists of ranked and violable constraints. Constraints are assumed to be universal in conventional OT. Languages differ by constraint rankings. There are two basic types of constraints in conventional OT: markedness and faithfulness. Markedness is a relative notion and usually expresses an implicational relation: the structure A is more marked than the structure B if and only if the presence of A implies the presence of B in a language but not vice versa. Markedness constraints ban marked output forms, which are crosslinguistically dispreferred. For example, if a language has voiced obstruent codas, it will also have voiceless obstruent codas (e.g., English). If a language has voiceless obstruent codas, it will not necessarily have voiced obstruent codas (e.g., Cantonese). Hence, voiced obstruent codas are more marked than voiceless obstruent codas. The markedness constraint *VOICED CODA bans voiced obstruent codas in the output (1).

Faithfulness constraints, which preserve lexical contrasts in conventional OT, enforce identity either between an input and its output or between two outputs. There are three major types of faithfulness constraints in conventional OT: MAX, DEP, and IDENT (McCarthy and Prince 1995). The MAX constraint prevents loss of information, either from an input to its output or from one output to another. The DEP constraint prevents the occurrence of new information, either from an input to its output or from one output to another. The IDENT constraint requires two corresponding forms to be identical with respect to a feature.

Output candidates are evaluated by an OT grammar. The output or optimal candidate incurs the least serious violations of constraints. Consider the tableau in (4), which shows how an OT grammar selects the optimal candidate. There are four constraints in this tableau: C₁, C₂, C₃, and C₄. C₁ is the highest ranked or undominated constraint. It outranks C₂ and C₃, which is indicated by a solid line. C₂ and C₃ are equally ranked, which is indicated by a dotted line. Both C₂ and C₃ outrank C₄, which is the lowest ranked constraint. Due to transitivity of ranking, C₁ outranks C₄. Three output candidates are listed in this tableau. Candidate c makes one violation of C₁, which is indicated by one violation mark '*'. Candidates a and b satisfy C₁. Because C₁ is undominated, a violation of C₁ is more serious than any number of violations of the lower-ranked constraints so that candidate c is ruled out by the grammar. The violation which causes an output candidate to be ruled out is fatal, which is indicated by the exclamation mark '!'. Candidate a violates C₃ and candidate b violates C₂. Because C₂ and C₃ are equally ranked, the violations of C₂ and C₃ are equally serious so that the decision of choosing the output between candidates a and b is left up to the lowest ranked constraint C₄. Candidate a makes one violation of C₄ while candidate b makes two violations. The violation of C₄ incurred

by candidate b is more serious than that incurred by candidate a. Therefore, candidate b is ruled out and candidate a is selected as the optimal candidate, which is marked by the index ‘ $\mathcal{O}$ ’.

(4)

	C ₁	C ₂	C ₃	C ₄
$\mathcal{O}$ candidate a			*	*
candidate b		*		***!
candidate c	*!			

In conventional OT frameworks such as Prince and Smolensky (2004) and McCarthy and Prince (2001), the derivation of the output from its input is usually parallel—in other words, no intermediate stage of derivation or intermediate output is involved.

3 Differences among the Mechanisms of Several OT Frameworks for Morphology

Extending some of the assumptions of conventional OT into the morphological component of the grammar not only accounts for phonologically conditioned allomorphy, but also sheds light on some well-known morphological phenomena such as blocking and extended morphological exponence, and syncretism. Before turning to these issues, I should first mention not only the assumptions of conventional OT that are taken in almost all OT frameworks for morphology, but also the differences among their mechanisms. These differences lead to both advantages and problems in analyzing various morphological phenomena.

In recent years, there have appeared various OT frameworks for analyzing morphological issues. These frameworks all share some basic conceptions of conventional OT such as input and output, the function GEN, and the way an OT grammar picks out the optimal candidate. These frameworks also show various differences in terms of, for example, whether input morphosyntactic features can be changed or not; whether a morph is introduced via an input, an output candidate, or a constraint; whether the function GEN generates a list of output candidates or introduces output candidates from the lexicon; what types of constraints are used; and whether a morphological derivation should be serial or parallel.

First, there is a difference in terms of whether an input morphosyntactic feature can be changed in the output. Unlike conventional OT, an input in an OT framework for morphology usually includes morphosyntactic information. Frameworks such as Realization Optimality Theory (e.g., Xu and Aronoff 2011a, 2011b), Optimal Interleaving (e.g., Wolf 2008), or Optimal Construction Morphology (e.g., Caballero and Inkelas 2013), whose target is morphological realization, do not assume any change of input

morphosyntactic features. By contrast, Distributed Optimality (Trommer 2001), for example, allows the impoverishment of input morphosyntactic features, but does not allow the insertion of morphosyntactic features in the output.

Second, there is a difference in terms of whether a morph is introduced via an input, a constraint, or an output candidate. In conventional OT, morphs, either a root or an affix, are usually placed in an input. In Realization OT, for example, an uninflected stem is usually placed in an input while inflectional affixes are encoded in constraints. In the frameworks of OI and Optimal Construction Morphology, morphs, either a root or an affix, are usually introduced via output candidates.

There is a third difference with regard to the definition of the function GEN. Most OT works simply assume that GEN generates a list of logically possible output candidates. By contrast, in OI and Optimal Construction Morphology, it is assumed that GEN inserts lexical items or constructions into output candidates from the lexicon. In OI, for example, it is assumed that morphological realization takes place in the phonological component of the grammar. An input usually consists of morphosyntactic features, and a grammar consists of phonological constraints and morphosyntactic ones that either require output candidates to mirror syntactic structures or require the morphosyntactic properties of an output candidate to be faithful to those of its input, which are introduced from a syntactic tree structure. On the other hand, the lexicon supplies inputs for the function GEN, which faithfully maps them to output candidates. Hence, in OI there are actually two sets of input and grammar. One set consists of an input from a syntactic tree structure and a grammar consisting of both phonological constraints and morphosyntactic ones. The other set consists of an input from the lexicon and the function GEN. Such an assumption that two sets of input and grammar share the same output is not taken in morphological frameworks such as Realization OT.

Fourth, several types of constraints have been proposed in OT morphology. In addition to markedness and faithfulness constraints, there are realization constraints and morphotactic constraints. Their significance differs among OT frameworks for morphology. Realization constraints require morphosyntactic features to be expressed by phonological information. Rose (2000), for example, proposes the constraint MORPHEXP, which requires every morphological category to be marked by some affix. Trommer (2001) proposes realization constraints such as PARSE [2], which requires the second-person feature value to be realized by an exponent. Russell (1995), Kager (1996), Yip (1998), MacBride (2004), Xu (2007), and others propose realization constraints which require a specific morphosyntactic feature value to be expressed by a specific exponent. For example, the realization constraint {pl}: -z requires the plural feature value to be expressed by the suffix -z.

Morphotactic constraints determine affix positioning. These include alignment constraints (e.g., McCarthy and Prince 1993; Trommer 2001) and templatic constraints (e.g., Hyman 2003; Paster 2005a; Caballero 2010; Ryan 2010).

Last but not least, there is a question of whether parallel or serial approaches should be taken in OT derivations. On a parallel approach there is usually one input and output only. By contrast, on a serial approach there is at least one intermediate output.³ A parallel approach is simpler and more straightforward compared to a serial approach given that the former involves no intermediate stage of derivation. Unless a serial approach is shown to be indispensable, a parallel approach is generally preferred. Rule-based frameworks are usually serial in nature. A strict serial framework predicts neither inward-looking morphosyntactically conditioned nor outward-looking phonologically conditioned realization (see Trommer 1999; Bobaljik 2000). Although not all rule-based frameworks claim the non-existence of inward-looking morphosyntactically conditioned realization, almost all rule-based frameworks assume the non-existence of outward-looking phonologically conditioned realization. That is, complex words are built up from the root outwards so that the choice of an inner morph cannot be influenced by the phonological information of a morph that is added later (see, e.g., Anderson 1982). A rule-based framework therefore predicts no affix-sensitive stem allomorphy.

Optimal Interleaving (Wolf 2008) is a framework based on Optimality Theory with Candidate Chains (OT-CC) (McCarthy 2007), a serial architecture for OT to do phonology. In OT-CC, the function GEN makes one change of an input when it is mapped to an output candidate.⁴ This can bring about an intermediate output, which becomes another input for GEN to manipulate. A candidate chain consists of an input, intermediate outputs, and a final output. An input is considered an initial link of a chain. Every output, either intermediate or final, is considered a non-initial link. A candidate chain is assumed to be harmonically improving – that is, every non-initial link of a chain should be more optimal than its previous link. The grammar evaluates the final links of chains and selects the optimal output.

In one version of OI, it is assumed that spell-out strictly starts from the root and proceeds outwards. I use Wolf's hypothetical language to demonstrate why this assumption alone cannot predict the non-existence of outward-looking phonologically conditioned allomorphy. Assume there are two root allomorphs, /xof/ and /za/, in this hypothetical language. The plural feature value is expressed by the suffix *-u*.⁵ The following are two

³ See McCarthy (2000), for example, for a discussion of the distinction between parallelism and serialism in OT.

⁴ Wolf (2008) assumes that GEN can sometimes make two changes in a previous link of a chain. For example, in Axininca Campa, [t] is inserted in the derivation from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] 'he will paddle' (Payne 1981; McCarthy and Prince 2001). In OI, GEN must insert [t] and syllabify [noŋ.ko.ma.ti] in one step; in other words, GEN must make two changes in a previous link in one step. Otherwise, the mapping from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] wouldn't be harmonically improving, assuming the insertion of [t] takes place before the syllabification of [noŋ.ko.ma.ti]: "we've added a violation of DEP-C without removing the violation of ONSET which supposedly motivates epenthesis. Thus, we must allow epenthesis to occur simultaneously with syllabification, so that a direct mapping from /no-ŋ-koma-i/ to [noŋ.ko.ma.ti] is licit" (Wolf 2008: 205).

⁵ Wolf (2008) assumes the structure $\sqrt{\text{PETO}}\langle\text{xof}, \text{za}\rangle_{\text{f}}\text{-u}_{\text{PL}}$, in which *xof* and *za* are exponents of the feminine feature value. For simplicity of presentation, I assume that *xof* and *za* are root allomorphs. My assumption will not affect Wolf's (2008) conclusion that OI cannot predict the non-existence of outward-looking phonologically conditioned allomorphy without additional stipulations.

legitimate chains, in which each non-initial link contains one more lexical item than a link which immediately precedes it.

- (5) a. $\langle \text{ROOT-}\{\text{pl}\}, \text{xof-}\{\text{pl}\}, \text{xof-u} \rangle$
 b. $\langle \text{ROOT-}\{\text{pl}\}, \text{za-}\{\text{pl}\}, \text{za-u} \rangle$

Consider the tableau in (6) (adapted from Wolf 2008: 166), in which both the output candidates are the final links of the above two chains. The partial grammar consists of the constraints *ONSET*, **x*, and **VOICED OBSTRUENT*. The constraint *ONSET* requires every syllable to have a consonant onset. The constraint **x* forbids the occurrence of the segment [x]. The constraint **VOICED OBSTRUENT* forbids the occurrence of any voiced obstruent.⁶ Candidate b is ruled out by *ONSET*. As we can see, the selection between *xof* and *za* is sensitive to *u*, which is an outer morph. Hence, this is a case of outward-looking phonologically conditioned root allomorphy.

- (6) Affix-conditioned root allomorphy in a hypothetical language

Input: ROOT-{\text{pl}}	ONSET	*x	*VOICED OBSTRUENT
a. xof.u		*	
b. za.u	*!		*

In order to rule out outward-looking phonologically conditioned allomorphy, Wolf (2008: 160) proposes Local Optimality (LO), which is defined as follows:

- (7) Local Optimality
 Let $\langle \dots f_{n-1}, f_n \rangle$ be a valid chain in some language *L*. Let $g_1, \dots g_m$ be all of the forms which can be formed from f_n by applying some operation *O* in GEN. The chain $\langle \dots f_{n-1}, f_n, g_i \rangle$ is then a valid chain in *L* iff:
 a. g_i is more harmonic than f_n .
 b. g_i is the most harmonic member of the set $\{g_1, \dots g_m\}$.

Under LO, a grammar also needs to evaluate intermediate links that are labeled with the same number. Hence, the grammar of the above hypothetical language also needs to evaluate the intermediate links *xof-{\text{pl}}* and *za-{\text{pl}}*, both of which are the second links of the two chains in (5).

However, LO still cannot rule out outward-looking phonologically conditioned allomorphy, based on the grammar in (6). In (8) the two output candidates are equally harmonic. Hence, further derivations based on them are valid. The next round of derivations will result in *xof-u* and *za-u* so that outward-looking phonologically conditioned allomorphy will be observed, as shown in (6).

⁶ Wolf (2008) assumes the ranking *ONSET* >> **x* >> **VOICED OBSTRUENT*. However, it is also reasonable to assume that **x* and **VOICED OBSTRUENT* are equally ranked.

(8) xof-{pl} vs. za-{pl} in a hypothetical language

Input: ROOT-{pl}	ONSET	*X	*VOICED OBSTRUENT
☞ a. xof-{pl}		*	
☞ b. za-{pl}			*

Wolf (2008) makes an additional stipulation that only one intermediate link under LO can be selected as optimal. Under this stipulation, either *xof*-{pl} or *za*-{pl} will be selected as the optimal link. Further derivations based on the other intermediate link, which is not selected as optimal, are invalid. Hence, no outward-looking phonologically conditioned allomorphy will be observed.

In Realization OT, no input allomorph set is assumed. An uninflected stem, which is to be affixed, is usually placed in an input while inflectional affixes are encoded in constraints. It is therefore predicted that uninflected stem allomorphy cannot be sensitive to inflectional affixation while inflectional affix allomorphy can be sensitive to stems.

There is one type of example which may pose a challenge to the prediction of no affix-conditioned stem allomorphy. In Romance languages such as Italian, stems can exhibit alternations, which can be conditioned by the stress pattern of their suffixes. For example, the preterite stem of *rompere* ‘to break’ appears as *rupp* when its suffix is unstressed while it appears as *romp* when its suffix is stressed (Carstairs 1990).⁷ Since inflectional affixes are encoded in constraints in Realization OT, it is predicted that outer affixes can condition inner affixation, if we do not refer to the above stipulations in Optimal Interleaving. There are at least several cases which may support this prediction (9).

- (9) a. Fulfulde (Southern Zaria district): General future active tense can be expressed by more than one exponent. The suffix *-Viɓ* occurs before *V_i*-initial suffixes. The suffix *-ay* occurs before consonant-initial ones. (Mary McIntosh, p.c.; Arnott 1970: 53, 213, 224, cited in Carstairs 1990)
- b. Italian: The augment */isk/* occurs after some stems when its following suffix does not bear stress: for example, *fin-isk-o* ‘I finish’ versus *fin-iamo* ‘we finish.’ (Hall 1948, cited in Paster 2009)
- c. Sanskrit: The empty morph *-i* occurs either word-finally or before consonant-initial case-number suffixes, such as *asth-i-bhiḥ* (‘bone’-EMPTY MORPH- {ins, pl}). The empty morph *-(a(:))n* occurs before vowel-initial suffixes, e.g., *asth-n-aḥ* (‘bone’-EMPTY MORPH-{gen, sg}). (Carstairs 1990)
- d. Midob (Nubian, Sudan): The verbal extension denoting “affirmation” takes the form *-nó* before a consonant-initial suffix

⁷ Carstairs (1990: 20) suggests that “the right way to look at the alternation between *rupp*- and *romp*- in the preterite ... is not in terms of inward conditioning of the stem by affixes but in terms of suprasegmental characteristics of the word as a whole.”

and *-nón* before a vowel-initial suffix: for example, *tii-nò-hèm* ('drink'-affirm-1sg.prf) 'I drank (completely/really),' *tii-nòn-ùwà* ('drink'-affirm-1sg.cont.ind) 'I really drink completely.' (Werner 1993, cited in Paster 2006)

- e. Kashaya (Pomoan, northern California): The negative suffix has two phonologically selected allomorphs, *-t^h* and *-t^{hi}*. The *-t^h* allomorph occurs before a vowel, while the *-t^{hi}* allomorph occurs before a consonant, and the [i] in the preconsonantal allomorph cannot be treated as epenthetic. (Buckley 1994: 334, cited in Paster 2006)

Frameworks such as Distributed Optimality (Trommer 2001) do not propose a clear mechanism of morphological realization so that it is hard to see their predictions with regard to the (non-)existence of outward-looking phonologically conditioned realization.

4 Optimality Theory and the Morphology-Phonology Interface: Approaches to Phonologically Conditioned Allomorphy

In this section, I compare three types of OT approaches to phonologically conditioned allomorphy in terms of whether an exponent is introduced via an input or output candidate or grammar. These frameworks are conventional OT, OI, and Realization OT. I argue that phonologically conditioned allomorphy is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar. Two types of phonologically conditioned allomorphy are discussed. In one type, allomorph selection is determined by independent phonological constraints and is phonologically optimizing. The other type is idiosyncratic in that allomorph selection references phonology but is not phonologically optimizing.

4.1 Phonologically Conditioned Allomorphy that Is Optimizing

Let us first look at the three types of OT approaches to phonologically conditioned allomorphy that is optimizing, using the Korean and Spanish data as points of comparison.⁸

The Korean accusative suffix has two allomorphs, *-lul* and *-ul*. The suffix *-lul* occurs after stems ending in a vowel while the suffix *-ul* occurs after stems ending in a consonant (10) (Lapointe 2001, cited in Bonet and Harbour 2012).

- (10) cho-lul (*cho-ul) 'cho-ACC'
 Kim-ul (*Kim-lul) 'Kim-ACC'

In conventional OT, there is no space for morphological realization. Every morph is placed in an input. An extra mechanism has been introduced into conventional OT to account for phonologically conditioned

⁸ See Carstairs (1988, 1990) for more examples of phonologically conditioned allomorphy.

allomorphy: that is, an input allomorph set, in which multiple input allomorphs are stipulated, such as {-lul, -ul} (Kager 1996; Lapointe 2001; Bonet 2004; Bonet et al. 2007; Mascaró 2007; Bonet and Harbour 2012). The alternation between -lul and -ul can be captured by the phonological constraints *ONSET* and *No CODA*. In (11) I give a conventional OT derivation with an input allomorph set as presented in Lapointe (2001), and cited in Bonet and Harbour (2012).⁹ In (11a), candidate b is ruled out by *ONSET*, which requires every syllable to have a consonant onset. In (11b), candidate b is ruled out because it contains two consonant codas and therefore violates *No CODA* twice.

- (11) A conventional OT approach with an input allomorph set to the Korean accusative allomorphy

a.

Input: cho, {lul, ul}	ONSET	NO CODA
a. cho.lul		*
b. cho.ul	*!	*

b.

Input: Kim, {lul, ul}	ONSET	NO CODA
a. Ki.mul		*
b. Kim.lul		**!

As pointed out by Paster (2006, 2009), however, a conventional OT approach assuming multiple input allomorphs incorrectly predicts that the numbers of cases of stem-sensitive affix allomorphy and affix-sensitive stem allomorphy should be equal, but there are many cases of stem-sensitive affix allomorphy while few cases of affix-sensitive stem allomorphy.

Additionally, Paster (2009) argues that phonologically conditioned allomorphy is sensitive to phonological elements in underlying or input forms, not in surface forms, while a conventional OT approach assuming multiple input allomorphs predicts that phonologically conditioned allomorphy is sensitive to phonological properties of surface forms, not underlying forms. Languages such as Turkish contradict the prediction of such a conventional OT approach. In Turkish, the third-person possessive suffix has the allomorphs /i/ and /si/ (Lewis 1967). The marker /i/ occurs when its stem ends in a consonant, while the marker /si/ occurs when its stem ends in a vowel. See the following examples (Aranovich et al. 2005 and Gizem Karaali p.c., cited in Paster 2009: 26). Vowel alternations are due to regular Turkish vowel harmony.

⁹ The independent phonological constraints involved in the following discussions are syllable structure constraints and OCP. See Paster (2006) and Nevins (2011) for other types of phonological constraints involved in cases of phonologically conditioned allomorphy that is optimizing.

- (12) bedel-i 'its price' deri-si 'its skin'
 ikiz-i 'its twin' elma-sı 'its apple'
 alet-i 'its tool' arı-sı 'its bee'

Paster (2009) remarks that the alternation between *-i* and *-si* in (12) looks like an output-based case motivated by syllable structure considerations, at first glance. However, the distribution of the two allomorphs is sometimes opaque due to the operation of a regular Velar Deletion rule (Sezer 1981) that deletes intervocalic /k/ (see Aranovich et al. 2005). See the following examples (Aranovich et al 2005 and Gizem Karaali p.c., cited in Paster 2009: 26).

- (13) açlı-ı 'its hunger' (cf. *açlık* 'hunger')
 bebe-i 'its baby' (cf. *bebek* 'baby')
 gerdanlı-ı 'its necklace' (cf. *gerdanlık* 'necklace')
 ekme-i 'its bread' (cf. *ekmek* 'bread')

As pointed out by Paster, these examples can be explained if we assume that the morphology first chooses the */i/* allomorph of the possessive suffix due to the presence of final /k/ in the underlying form of the root. The affixed forms are then passed on to the phonology. Due to the presence of the */i/* suffix, the /k/ is now in intervocalic position and is therefore deleted. The result is an opaque form exhibiting vowel hiatus. This situation is very easy to model in a framework in which morphology feeds phonology but it is problematic for a surface-based conventional OT approach.

In OI, in which lexical items are serially introduced into output candidates, the above two problems can be resolved. With the various types of stipulations which have been discussed in Section 3, OI predicts no outward-looking phonologically conditioned allomorphy and hence no affix-sensitive stem allomorphy. Additionally, derivations are serial in OI. It is natural to assume that the spellout of */i/* is followed by the deletion of the intervocalic /k/ so that the opacity in (13) can be accounted for.

In OI, the Korean stem *cho* would be spelled out first and then passed on to the next round of derivation. The relevant constraint MAX-M(F), defined in (14), requires that every abstract lexical morpheme or morphosyntactic feature value in an input should have a correspondent in the feature set of a lexical item in the output.

- (14) MAX-M(F): For every instance φ of the feature F at the morpheme level, assign a violation-mark if there is not an instance of φ' of F at the morph level, such that $\varphi \text{ R } \varphi'$. (Wolf 2008: 26)

In (15) the input consists of the stem *cho* and the morphosyntactic feature value {acc}. The suffixes *-lul* and *-ul* are inserted into output candidates via GEN. Candidate b is ruled out by ONSET. Candidate c is ruled out by MAX-M(F) because the input {acc} does not have a correspondent that is associated with a lexical item in this candidate.

(15) Derivation of Korean *cho-lul* in Optimal Interleaving

Input: cho, {acc}	MAX-M(F)	ONSET	NO CODA
a. cho.lul			*
b. cho.ul		*!	*
c. cho, {acc}	*!		

The Korean form *Kim-ul* can be derived via the same grammar (16).

(16) Derivation of Korean *Kim-ul* in Optimal Interleaving

Input: Kim, {acc}	MAX-M(F)	ONSET	NO CODA
a. Ki.mul			*
b. Kim.lul			**!
c. Kim, {acc}	*!		*

The problems for a conventional OT approach with an input allomorph set will not occur in Realization OT, either. In Realization OT, no input allomorph set is assumed. An uninflected stem is placed in an input while inflectional affixes are encoded in constraints. It is therefore predicted that uninflected stem allomorphy cannot be sensitive to inflectional affixation. Additionally, Realization OT assumes an autonomous morphological component of the grammar. Some phonological effects can be observed in the morphological component so that some phonological constraints can interact with morphological ones such as realization constraints. Morphological processes such as morphological realization take place before phonological processes such as consonant deletion.

(17) accounts for the derivation of the optimal output *cho-lul* in Realization OT. Candidate b is ruled out by ONSET. Candidate c is ruled out because it violates both the realization constraints, given that neither *-lul* nor *-ul* is spelled out. The illicit candidate **cho-lul-ul*, which does not occur in (17) and in which {acc} is doubly realized by *-lul* and *-ul*, can be ruled out by the markedness constraint *FEATURE SPLIT, which will be discussed in Section 5.1.

(17) Derivation of Korean *cho-lul* in Realization OT

Input: cho, {acc}	{acc}: -lul	{acc}: -ul	ONSET	NO CODA
a. acc cho.lul		*		*
b. acc cho.ul	*		*!	*
c. cho, {acc}	*	*!		

Notice that the two realization constraints, {acc}: *-lul* and {acc}: *-ul*, cannot rank lower than the two syllable structure constraints. Otherwise, *cho*{acc} would be incorrectly picked out as the optimal candidate because it does not violate either of the syllable structure constraints, in contrast to the other two output candidates in (17).

The Korean form *Kim-ul* can be derived via the same Realization OT grammar (18).

(18) Derivation of Korean *Kim-ul* in Realization OT

Input: Kim, {acc}	{acc}: <i>-lul</i>	{acc}: <i>-ul</i>	ONSET	NO CODA
a. acc Ki.mul	*			*
b. acc Kim.lul		*		**!
c. Kim, {acc}	*	*!		*

Bonet and Harbour (2012) discuss the Spanish situation in which there is an arbitrarily determined priority of spell-out between the conjunction allomorphs. The Spanish conjunction *y* [i] ‘and’ has the allomorph *e*, which is used only when the next word begins with [i]. The conjunction *o* ‘or’ has the allomorph *u*, which is used only when the next word begins with [o]. Following Mascaró (2007) and Bonet et al. (2007), Bonet and Harbour propose a conventional OT approach with the constraint PRIORITY. The two allomorphs [i] and [e] are placed in an input allomorph set, with a precedence relation in which [i] has priority of spell-out: {[i] > [e]}. The two allomorphs [o] and [u] are placed in an input allomorph set, with a precedence relation in which [o] has priority of spell-out: {[o] > [u]}. Choosing the allomorph which has no priority of spell-out violates PRIORITY.¹⁰

In (19a) from Bonet and Harbour (2012) candidate a is ruled out by the Obligatory Contour Principle (OCP) because there are two adjacent [o]s. In (19b), neither candidate violates OCP. Candidate b, in which [u] is selected, violates PRIORITY.

(19) A conventional OT approach to the Spanish conjunction allomorphy

a.

Input: {[o] > [u]} otro	OCP	PRIORITY
a. o otro	*!	
 b. u otro		*

¹⁰ See Wolf (2008: 98–9) for criticisms of PRIORITY in terms of how this constraint evaluates output candidates.

b.

Input: {[o] > [u]} alguno	OCP	PRIORITY
☞ a. o alguno		
b. u alguno		*!

Bonet and Harbour (2012) point out that without extraordinary mechanisms, OI has difficulties accounting for the selection of competing exponents whose priority of spell-out is arbitrarily determined. In OI, the allomorphs [o] and [u] would be considered equally harmonic without extraordinary mechanisms. In (20) the OI ranking $OCP \gg MAX-M(F)$ incorrectly selects *u alguno* as one of the two winning candidates. The symbol '●' indicates the candidate incorrectly predicted to win.

- (20) An Optimal Interleaving approach to the Spanish conjunction allomorphy

Input: {conj}, alguno	OCP	MAX-M(F)
☞ a. o alguno		
● b. u alguno		

We can make a Realization OT account of the above Spanish data by encoding the conjunction allomorphs in realization constraints. In (21a), candidate a is ruled out by OCP. Notice that OCP needs to outrank the two realization constraints in order to derive the output *u otro*. In (21b), candidate b is ruled out by the realization constraint that requires the conjunction feature to be expressed by *o*. This constraint ranks higher than the one that requires {conj} to be expressed by *u*.

- (21) A Realization OT approach to the Spanish conjunction allomorphy

a.

Input: {conj}, otro	OCP	{conj}: o	{conj}: u
a. o otro	*!		*
☞ b. u otro		*	

b.

Input: {conj}, alguno	OCP	{conj}: o	{conj}: u
☞ a. o alguno			*
b. u alguno		*!	

A realization type of approach has been criticized in Bonet (2004), Bonet et al. (2007), and Mascaró (2007). There are two major objections. First, using realization constraints instead of PRIORITY leaves open the possibility

of adding as many constraints as morphemes. Second, it has the unacceptable consequence of excluding allophonic variation of the morph.

These problems can easily be explained away. First, in conventional OT constraints are assumed to have universal status, but realization constraints are necessarily language-specific in that they realize arbitrary Saussurean signs. It is important to emphasize that the target of conventional OT is phonology while Realization OT mainly deals with morphology, which since at least Ferdinand de Saussure, has emphasized arbitrary associations of meaning and form. In other words, morphological realization is language-particular and arbitrary, in any framework. Realization OT is concerned with morphological realization, not with phonology, and language-particular realization constraints are crucial in dealing with morphological phenomena, by definition. Second, as Wolf (2008) points out, if we assume that morphological realization takes place before phonological processes such as assimilation (i.e., an output from the morphological component becomes an input to the phonological component), the so-called problem of excluding allophonic variation of a morph evaporates.

In terms of deriving the output in cases like the Spanish conjunction allomorphy, there is not much difference between ranking realization constraints and using PRIORITY to maintain the stipulated relation between two allomorphs in an input allomorph set.

4.2 Idiosyncratic Phonologically Conditioned Allomorphy

Dyirbal (Dixon 1972) is often cited as a language which exhibits cases of phonologically conditioned allomorphy that is not optimizing.¹¹ The ergative suffix *-ŋgu* occurs after a disyllabic stem while the ergative suffix *-gu* occurs elsewhere. Wolf (2008) argues that deriving the Dyirbal ergative allomorphs *-ŋgu* and *-gu* from a single underlying representation is questionable. (22) gives examples from Dixon (1972), cited in Wolf (2008: 61).¹²

- (22) Dyirbal ergative markers
- | | |
|-------------|---------------|
| jaɾa-ŋgu | ‘man-ERG’ |
| jamani-gu | ‘rainbow-ERG’ |
| palakara-gu | ‘they-ERG’ |

Conventional OT (e.g., McCarthy and Prince 2001) introduces exponents via an input and accounts for the morphotactic position of *ŋgu* by an alignment constraint, which requires it to occur after a head foot. But affix-specific alignment constraints should be part of the input in conventional OT, given that these constraints are idiosyncratic and an input usually introduces information from the lexicon where idiosyncratic information is stored while a grammar is assumed to consist of universal

¹¹ See Paster (2005b, 2006), Bye (2008), and Nevins (2011) for many other cases of idiosyncratic phonologically conditioned allomorphy.

¹² Wolf (2008) uses *-ŋku* and *-ku* while most other works use *-ŋgu* and *-gu*, which I use in this chapter.

phonological constraints. Additionally, McCarthy and Prince (2001) do not take the alternation between *-ŋgu* and *-gu* into account because they think it is outside the scope of their framework.

Bonet (2004) proposes a conventional OT approach to the above Dyirbal data which stipulates idiosyncratic information such as the subcategorization frame of *-ŋgu* in an input. The subcategorization frame requires that the stem which *-ŋgu* attaches to should end in a foot (ϕ). Moreover, *-ŋgu* has preference over *-gu* with regard to spell-out. These can be encoded in the formulation $/\{\phi\}\eta gu > gu/$. Bonet proposes the constraint RESPECT, which requires the output to respect subcategorization requirements.

One problem for Bonet's approach is that the priority of spell-out between the allomorphs *-ŋgu* and *-gu* is stipulated in an input, hence missing Pāṇini's Principle since the basic tenet of OT is that any general grammatical principle should be reflected in a grammar rather than in an input.

Without extraordinary mechanisms, OI cannot account for cases of idiosyncratic phonologically conditioned allomorphy that is not optimizing.¹³ If we take the normal assumption that both *-ŋgu* and *-gu* expone {erg}, an OI approach incorrectly predicts that *-gu* would always be a winning candidate, even after a disyllabic stem. Notice that one of the major premises of OI is that lexical insertion takes place in the phonological component of the grammar so that the shorter a form, the better it is. Using a longer form will in general result in more violations of phonological markedness constraints.¹⁴

The Dyirbal case is often cited as supporting evidence for a subcategorization approach such as the type advocated in Paster (2005b, 2006, 2009). Subcategorization has been proposed by Lieber (1980, 1992), Kiparsky (1982a, 1982b), Selkirk (1982), Inkelas (1990), Orgun (1996), Yu (2003, 2007), Paster (2005b, 2006, 2009), and others. The main idea, for the purpose of accounting for phonologically conditioned allomorphy, is that the representation of an affix includes requirements for stems to which it will attach. These requirements can include syntactic, semantic, and, crucially, phonological aspects of the stem. The subcategorization frames in (23) can be proposed to account for the distribution of *-ŋgu* and *-gu* in Dyirbal. The order of the subcategorization frames is subject to Pāṇini's Principle.

- (23) {erg}: *ŋgu* in the context of a stem_{(σσ)–}
 {erg}: *-gu* (elsewhere)

¹³ Wolf and McCarthy (2010) propose an approach to the alternation between *-ŋgu* and *-gu*. On this approach, *-gu* cannot be a competing candidate with *-ŋgu* after a head foot so that *-ŋgu* wins. Wolf (2008: 95) criticizes an earlier version of Wolf and McCarthy (2010) and remarks that: "[This approach] suffers from the conceptual drawback of having to impose an external mechanism of 'ordering of trying' to get the desired result. Since competition is the essence of OT, we would prefer on grounds of parsimony for competition like that between *-ŋgu* and *-gu* in Dyirbal to be hashed out *within* an OT grammar."

¹⁴ Following Halle and Vaux (1998), Wolf (2008) decomposes {erg} into a complex feature set: {-obl(ique), +str(uctural), +sup(erior), -fr(ee)}. Wolf analyzes *-ŋgu* as consisting of both *-ŋ* and *-gu*. Wolf also assumes that *-ŋ* realizes {-fr} and *-gu* realizes {-obl, +str, +sup} so that *-ŋ-gu* realizes a more specific morphosyntactic feature set than *-gu*. If an input contains {-obl, +str, +sup, -fr}, *-ŋ-gu* will win over *-gu*, which can be ruled out by Max-M(F). However, *-gu* can be analyzed as consisting of both $\emptyset$ and *-gu*, with $\emptyset$ realizing {-fr} so that $\emptyset-gu$ wins over *-ŋ-gu*, which violates the markedness constraint *[nasal] (Wolf 2008: 91).

Subcategorization frames can be easily incorporated into Realization OT. We can propose the following ranking schema for the Dyirbal case. The ranking of the following constraints is subject to Pāṇini's Principle. The constraint {erg}: ηgu / $\text{stem}_{(\sigma\sigma)\_}$ has three components: a process of morphological realization, the position of the affix with respect to its stem, and a selectional restriction on the stem which the affix attaches to. That is, {erg} is realized by ηgu , which is a suffix, and the stem which ηgu attaches to should be disyllabic (cf. Bye 2008).

(24) {erg}: ηgu / $\text{stem}_{(\sigma\sigma)\_}$ $>>$ {erg}: $-gu$

In Realization OT, it is assumed that phonological effects can be observed in the morphological component of the grammar. It predicts several types of attested interaction of phonological effects with morphological realization, which are listed below.

- Phonological constraints are outranked by realization constraints: for example, the alternation between the Korean accusative markers.
- Phonological constraints outrank realization constraints: for example, the alternation between the Spanish conjunction markers.
- Phonological conditions are built into realization constraints: for example, the alternation between ηgu and $-gu$ in Dyirbal.

Realization OT therefore provides a unified account of phonologically conditioned allomorphy in terms of the interaction of phonological effects with morphological realization.

5 Optimality Theory and Morphology Proper: Blocking and Extended Morphological Exponence, and Syncretism

Extending some of the assumptions of conventional OT into the domain of morphology proper can shed light on some well-known morphological issues such as blocking and extended morphological exponence as well as syncretism. I compare several types of OT approaches to these issues and discuss their mechanisms, advantages, and problems, showing some of the benefits of a Realization OT approach.

5.1 Blocking and Extended Morphological Exponence

Blocking and extended morphological exponence have been widely discussed in the theoretical literature on inflectional morphology (see, e.g., Matthews 1974, 1991; Anderson 1986, 2001, 2005b; Noyer 1992, 1997; Stump 2001; Müller 2007; Harris 2009; Xu and Aronoff 2011a; Caballero and Inkelas 2013). Blocking in inflectional morphology refers to a phenomenon in which a rule or affix prevents or “bleeds” (Kiparsky 1968) the

application of another rule or affix that expresses the same morphosyntactic feature value as the bleeding rule or affix (Anderson 1986; Noyer 1992, 1997; Stump 2001, among many others). Blocking thus prevents the occurrence of multiple exponents of a single morphosyntactic feature value. For example, the plural exponent of *ox* is *-en*, which blocks the regular plural exponent *-s /z/* in English so that the plural form **oxens* becomes illicit because its plural feature value is doubly realized. On the other hand, extended morphological exponence refers to cases in which a morphosyntactic feature value is realized by more than one exponent (Matthews 1991; Noyer 1992, 1997; Anderson 2001; Stump 2001, among many others). For example, in the Tamazight Berber verb *t-dawa-d* ‘cure, 2sg’ the feature value {2} is realized by both *t-* and *-d* (Abdel-Massih 1971: 171; Noyer 1992: 132; Stump 2001: 157). Natural languages exhibit both blocking and extended exponence, so any theory of morphology must accommodate both.

There are three major approaches to blocking and extended exponence based on the ordering of either affixes or rules. Noyer (1992, 1997), for example, proposes a feature discharge approach. On this approach, once a morphosyntactic feature value has been spelled out or discharged, it is no longer available for further realization, which therefore blocks the realization of another exponent that expresses the same feature value. On the other hand, in order to allow for extended exponence, Noyer makes a distinction between primary and secondary exponents. Only an exponent that realizes a morphosyntactic feature value as a primary exponent can block or get blocked by another exponent that also realizes the same feature value as a primary exponent. An exponent that realizes a morphosyntactic feature value as a secondary exponent cannot block or get blocked by another exponent that realizes the same feature value as either a primary or a secondary exponent. In cases of extended exponence like *t-dawa-d* in Tamazight Berber, in which *t-* realizes {2} and *-d* realizes {2, sg}, Noyer analyzes *t-* as a primary exponent of {2} and *-d* as both a primary exponent of {sg} and a secondary exponent of {2}. Therefore, no blocking takes place between *t-* and *-d*.

Noyer’s analysis of extended exponence has been subject to criticism. Stump (2001) argues that there are no good grounds for distinguishing between primary and secondary exponents. Müller (2007: 260) argues against a distinction between primary and secondary exponents. He remarks that:

secondary exponence is not an unproblematic concept. For one thing, it complicates the ontology. For another, it threatens to undermine the notion of feature discharge under fission. Furthermore, it may raise problems for determining specificity: Should secondary features be taken to count for the purposes of specificity or not?

Stump (2001) takes an approach to blocking and extended exponence within the framework of Paradigm Function Morphology (PFM). In PFM, an exponent is introduced via a realization rule. Blocking between exponents arises because of Pāṇini’s Principle, which is assumed to only apply within a rule

block. Rules encoding exponents that realize the same morphosyntactic feature value can belong to different rule blocks so that extended exponence arises. For example, in Tamazight Berber both *t-* and *-d* realize {2}. The rule realizing {2} by *t-* and the one realizing {2} by *-d* belong to two rule blocks so that the extended exponence of {2} arises.

In PFM, there are various requirements concerning rule blocks (Gregory Stump p.c.). Rules in the same block are disjunctive in their application. Rules apply in the sequence determined by the ordering of the blocks to which they belong. All else being equal, Occam's Razor entails that it is preferable to postulate fewer rule blocks. All else being equal, it is preferable for rules belonging to the same block to realize the same inflectional categories. Rules belong to the same rule block if the exponents encoded in them stand in paradigmatic opposition (Stump 1993). Paradigmatic opposition refers to a phenomenon in which two exponents never co-occur in a language's paradigmatic cells.

Like other rule-based frameworks, in PFM affix positions often determine the ordering of rule blocks, although affix positions do not always work in determining the ordering of rule application. A rule encoding an exponent closer to a root usually applies before a rule encoding an exponent farther away from the root. Rules encoding exponents in the same affix position often belong to the same rule block while rules encoding exponents occupying different affix positions often belong to different rule blocks. Hence, there remains a question of whether affix positions would have to be used as a criterion to determine whether two rules belong to the same rule block, given the above requirements concerning rule blocks.

Müller (2007) proposes a feature enrichment approach to extended exponence, on which a morphosyntactic feature can be inserted if necessary. For example, to account for the Tamazight Berber form *t-dawa-d*, in which {2} is realized by both *t-* and *-d*, Müller proposes a rule of enrichment (25).¹⁵ A second-person feature value is inserted in the context of {2} so that each {2} is realized by one exponent, either *t-* or *-d*.

(25) $\emptyset \rightarrow [2] / [2] \text{ —}$

Müller's approach circumvents the notion of extended exponence via a stipulative mechanism and hence makes no prediction of extended exponence. Harris (2009: 294) criticizes Müller's enrichment approach and remarks that "[i]n the case of extended exponence, our understanding of morphology is not advanced by claims of a one-to-one correspondence of morpheme to meaning, accompanied by ways of dealing with examples that do not meet this ideal. We learn more about the morphology of natural

¹⁵ Such a rule of feature insertion can also be formulated as $[2] \rightarrow [2] [2]$ (cf. Arregi and Nevins 2012; Arregi et al. 2013).

language by admitting the existence of such examples and producing theories that predict their existence.”

None of the above approaches provides a unified account of blocking and extended exponence. On these approaches, blocking is subject to Pāṇini's Principle while extended exponence is allowed for via either secondary exponence or rule blocks or got around with rules of feature enrichment.

Xu (2007, 2011) and Xu and Aronoff (2011a) argue for a unified account of blocking and extended exponence in Realization OT. The key device is the markedness constraint *FEATURE SPLIT, which forbids a morphosyntactic feature value being realized by more than one exponent. This constraint favors simple exponence, which is assumed to be morphologically unmarked (Wurzel 1989).¹⁶ By ranking *FEATURE SPLIT together with realization constraints, we can derive both blocking and extended exponence. If two constraints that realize the same morphosyntactic feature value outrank *FEATURE SPLIT, extended exponence will arise. Otherwise, blocking of exponents will be observed.

Spencer (2014) points out that Realization OT is problematic and falsifiable. (The following discussion of the problem for Realization OT in terms of how it accounts for blocking and extended exponence is based on Spencer (2014). Readers are referred to this manuscript for detailed discussion.) Consider the following Swahili past tense paradigm (Ashton 1947, cited in Caballero and Inkelaš 2013: 106). The prefix *ku-* is a marker of {pst, neg}.¹⁷ The prefix *si-* is a marker of {1, sg, neg}, which also occurs in contexts such as future and present indefinite. The prefix *ha-* is a marker of {neg}, which also occurs in contexts such as future and present indefinite.

(26) Swahili past tense paradigm

AFFIRMATIVE					NEGATIVE				
PAST	1sg	ni-	li-	tak-a	1sg	si-	ku-	tak-a	
	2sg	u-	li-	tak-a	2sg	ha- u-	ku-	tak-a	
	3sg	a-	li-	tak-a	3sg	ha- a-	ku-	tak-a	
	1pl	tu-	li-	tak-a	1pl	ha- tu-	ku-	tak-a	
	2pl	m-	li-	tak-a	2pl	ha- m-	ku-	tak-a	
	3pl	wa-	li-	tak-a	3pl	ha- wa-	ku-	tak-a	

¹⁶ Noyer (1993) and Ackema and Ad Neeleman (2005) propose similar constraints that encode the observation of Natural Morphology (Wurzel 1989) that a one-to-one correspondence between meaning and form is morphologically unmarked.

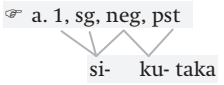
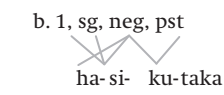
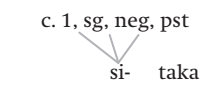
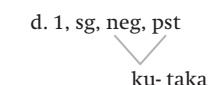
¹⁷ In Swahili, the prefix *ku-* is a polyfunctional morpheme: (i) it marks infinitives; (ii) it serves as a prosodically motivated stem extension in finite forms of monosyllabic verbs; (iii) it serves as a marker of past-tense negation in all verbs. Hence, the following problem for Realization OT arises only if *ku-* is analyzed as a marker of {pst, neg} in the data in question.

When an input contains the feature set {1, sg, neg, pst}, both *si-* and *ku-* are spelled out while *ha-* gets blocked. The Realization OT grammar in (27) would be proposed to account for this. Both the realization constraints {1, sg, neg}: *si-* and {pst, neg}: *ku-* outrank *FEATURE SPLIT so that {neg} is realized by both *si-* and *ku-*. By contrast, {neg}: *ha-* is outranked by *FEATURE SPLIT so that *ha-* can get blocked.

(27) {1, sg, neg}: *si-*, {pst, neg}: *ku-* >> *FEATURE SPLIT >> {neg}: *ha-*

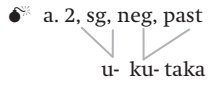
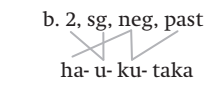
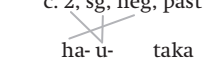
In (28) candidate a is optimal, even if it violates the lower ranked constraint *FEATURE SPLIT because {neg} is realized by both *si-* and *ku-*. Candidate b is ruled out because it violates *FEATURE SPLIT twice given that {neg} is realized by *ha-*, *si-*, and *ku-*, and assuming that *FEATURE SPLIT is satisfied if a morphosyntactic feature value is realized by one exponent and each additional exponent of the same feature value will cause one violation of it. Candidate c is ruled out by the constraint {pst, neg}: *ku-* because *ku-* is not spelled out. Candidate d is ruled out by the constraint {1, sg, neg}: *si-* because *si-* is not spelled out.

(28) Swahili *si-ku-taka* {1, sg, neg, pst}

Input: taka 1, sg, neg, pst	{1, sg, neg}: <i>si-</i>	{pst, neg}: <i>ku-</i>	*FEATURE SPLIT	{neg}: <i>ha-</i>
 a. 1, sg, neg, pst si- ku- taka			*	*
 b. 1, sg, neg, pst ha- si- ku- taka			**!	
 c. 1, sg, neg, pst si- taka		*!		*
 d. 1, sg, neg, pst ku- taka	*!			*

The grammar (27) incorrectly predicts that *ha-* would never occur in the context of {neg, pst} because otherwise the combination of *ku-* and *ha-*, both realizing {neg}, would be ruled out by *FEATURE SPLIT. In (29) the input contains {2, sg, neg, pst}. The constraint {2, sg}: *u-* is not shown in the tableau for simplicity of presentation. Candidate a is incorrectly chosen as the optimal candidate even if *ha-* is not spelled out.

(29) Swahili *ha-u-ku-taka* {2, sg, neg, pst}

Input: taka, 2, sg, neg, past	{1, sg, neg}: <i>si-</i>	{pst, neg}: <i>ku-</i>	*FEATURE SPLIT	{neg}: <i>ha-</i>
 a. 2, sg, neg, past u- ku- taka				*
 b. 2, sg, neg, past ha- u- ku- taka			*!	
 c. 2, sg, neg, past ha- u- taka		*!		

One solution to the above problem would be to assume that {neg}: *ha-* dominates *FEATURE SPLIT by default so that *ha-* can be spelled out in general while it is outranked by *FEATURE SPLIT in the context of {1, sg, neg} so that *ha-* gets blocked. That is, a specific morphosyntactic feature set such as {1, sg, neg} can have its own realization grammar. This approach is spiritually similar to Cophonology Theory (Orgun 1996; Inkelas et al. 1997; Inkelas 1998, to appear; Anttila 2002; Inkelas and Zoll 2007), in which different affixes can be associated with different phonological grammars. See also Hyman 2003, which argues that different morphosyntactic feature structures can have different rankings of morphotactic constraints on affix order in Bantu languages.

There are several alternative OT-based approaches to blocking and extended exponence. In conventional OT models such as McCarthy and Prince (2001), no reference is permitted to morphosyntactic information. There is no space for morphological realization. The phonological content of every affix is introduced via an input. Competing exponents that express the same morphosyntactic feature value would be stipulated in an input set in the style of Bonet (2004) and Mascaró (2007), which therefore predicts neither blocking nor extended exponence.

Without extra mechanisms, OI, either with or without LO, has difficulties accounting for cases of extended exponence in which the feature sets of competing exponents are either identical or exhibit a subset relation. For example, in the Tamazight Berber case *t-dawa-d* 'cure, 2sg,' *t-* realizes {2} and *-d* realizes {2, sg}. Consider the tableau (30) in which an OI account without LO is provided. In the spirit of OT-CC, OI assumes that GEN makes only one change of a previous link and inserts into an output candidate one lexical item at a time. Each of the output candidates in (30) is the final link of a harmonically improving chain, in which each non-initial link has one more lexical item than its previous link. Subscripted co-indexation indicates a correspondence either between two identical abstract lexical morphemes or between two identical morphosyntactic feature values, which are either

associated with a lexical item or not. Assume spell-out starts from the lexical morpheme DAWA and proceeds outwards. The grammar incorrectly chooses **dawa-d* as the winning candidate, which violates neither of the two constraints MAX-M(F) and *[t]. Candidate a has one more consonant [t] compared to the winning candidate, so it violates the phonological markedness constraint *[t]. OI assumes that lexical insertion takes place in the phonological component of the grammar so that “using a greater number of phonologically-overt morphs will in general result in more violations of phonological markedness constraints” (Wolf 2008: 64–5). Candidate c causes one violation of MAX-M(F) because the input {sg} does not have a correspondent that is associated with a lexical item in this candidate. Candidate d violates MAX-M(F) twice because neither {2} nor {sg} in the input has a correspondent that is associated with a lexical item in this candidate.

(30)

Input: DAWA ₁ , {2 ₂ , sg ₃ }	MAX-M(F)	*[t]
a. <i>t₂-dawa₁-d_{2,3}</i> <DAWA ₁ -{2 ₂ , sg ₃ }, <i>dawa₁-{2₂, sg₃}, t₂-dawa₁-{sg₃}, t₂-dawa₁-d_{2,3}</i> >		*!
☛ b. <i>dawa₁-d_{2,3}</i> <DAWA ₁ -{2 ₂ , sg ₃ }, <i>dawa₁-{2₂, sg₃}, dawa₁-d_{2,3}</i> >		
c. <i>t₂-dawa₁-{sg₃}</i> <DAWA ₁ -{2 ₂ , sg ₃ }, <i>dawa₁-{2₂, sg₃}, t₂-dawa₁-{sg₃}</i> >	*!	*
d. <i>dawa₁-{2₂, sg₃}</i> <DAWA ₁ -{2 ₂ , sg ₃ }, <i>dawa₁-{2₂, sg₃}</i> >	*!*	

An OI account with LO cannot derive the output *t-dawa-d*, either. The first links of the chains in the above tableau are identical. So are the second links. The third link is either *dawa-d* or *t-dawa-{sg}*. The form *dawa-d* is more optimal. Hence, only the chain <DAWA-{2, sg}, *dawa*-{2, sg}, *dawa-d*> is valid under LO. The output *t-dawa-d* cannot be further derived from *dawa-d* because the subchain <*dawa-d*, *t-dawa-d*> is not harmonically improving. The form *dawa-d* violates neither MAX-M(F) nor *[t] while *t-dawa-d* violates *[t].

Caballero and Inkelas (2013) attempt to account for both blocking and extended morphological exponence under Optimal Construction Morphology (OCM), “a theory of morphology that selects the optimal combination of lexical constructions to best achieve a target meaning” (Caballero and Inkelas 2013: 104). A construction is a pairing of form and meaning. Optimal Construction Morphology rejects markedness constraints such as *FEATURE SPLIT. Compared to Realization OT, which uses *FEATURE SPLIT only, OCM is a much more complicated framework in terms of accounting for cases of blocking and extended exponence which involve competing exponents. It refers to various mechanisms such as Local Optimality, a distinction between weak and strong exponents, inserting into an output candidate one lexical construction at a time, and labeling each lexical construction with a category

such as root, stem, or word.¹⁸ A weak exponent partially expones a morphosyntactic feature and is arbitrarily labeled with the numeral 0.5. By contrast, a strong exponent fully expones a morphosyntactic feature. Sometimes a distinction between stem1 and stem2 must be made. According to Caballero and Inkelas, a stem2 stands lower than a word but higher than a stem1, which stands higher than a root on the wordhood scale.

5.2 Syncretism

Stump (2001: 212) remarks that: “[i]n instances of syncretism, two or more cells within a lexeme’s paradigm are occupied by the same form. Syncretism is an extremely common phenomenon in languages with inflectional morphology, one which raises a number of fundamental issues for morphological theory.” Stump 2001 proposes four types of syncretism:

- Unstipulated syncretism, under which two paradigmatic cells with the same morphosyntactic feature value share the same morphophonological form.
- Unidirectional syncretism, under which a dependent paradigmatic cell copies the morphophonological form of a determinant paradigmatic cell.
- Bidirectional syncretism, under which there is a feature value x that takes the form associated with feature value y in some contexts, while in other contexts y takes the form associated with x .
- Symmetrical syncretism, under which two paradigmatic cells with the same morphophonological form do not share any morphosyntactic feature value and there is no discernible direction of syncretism.

In this section, I use the above types of syncretism to examine several OT frameworks for morphology.

A simple instance of unstipulated syncretism is from Hupa, an Athabaskan language (Golla 1970, cited in Embick and Halle 2005) (31). The first-person plural object marker is identical to the second-person plural object marker. That is, they share the same morphophonological form *noh*-.

(31) Hupa subject / object markers

	SUBJECT	OBJECT
1sg	W-	Wi-
2sg	n-	ni-
1pl	di-	noh-
2pl	oh-	noh-

To account for the syncretism, nearly all morphological frameworks would underspecify the person feature so that *noh*-, which expones {pl, obj}, can occur in both the slots of {1, pl, obj} and {2, pl, obj}.

By contrast, Müller (2011, 2013) rejects feature underspecification and proposes a feature changing framework in OT. He proposes the notion *leading form*. A leading form, which is introduced via an input, is an exponent whose

¹⁸ In OCM, a root is morphologically simplex while a stem is morphologically complex.

morphosyntactic feature set can be adjusted to the morphosyntactic feature set for realization on a stem. Assume that *noh-*, an exponent of {1, pl, obj}, and *ni-*, an exponent of {2, sg, obj}, are two leading forms. Assume also that the morphosyntactic feature set on a stem is {2, pl, obj}. The relevant constraints are presented in (32) (adapted from Müller 2011, 2013).

- (32)
- a. **MATCH**: The morphosyntactic feature values of stem and exponent are identical in the output.
 - b. **IDENT NUMBER**: The number feature value of an input exponent should not be changed in the output.
 - c. **IDENT PERSON**: The person feature value of an input exponent should not be changed in the output.

Consider the tableau in (33) (I: input, O: output). The input consists of a stem with the feature set {2, pl, obj} and an exponent inventory, which consists of leading forms such as *noh-* {1, pl, obj} and *ni-* {2, sg, obj}. Candidate a wins out, even if it violates the lowest ranked constraint **IDENT PERSON** given that the output feature set {2, pl, obj} of *noh-* is not identical to its input feature set in terms of person. Candidate b is ruled out by the higher ranked constraint **IDENT NUMBER** given that the output feature set {2, pl, obj} of *ni-* is not identical to its input feature set in terms of number. Candidate c is ruled out by the highest ranked constraint **MATCH** given that the output feature set {1, pl, obj} of *noh-* does not match the one on the stem, which is {2, pl, obj}.

(33)

Input: Exponent + Stem-{2, pl, obj}	MATCH	IDENT NUMBER	IDENT PERSON
a. <i>noh-</i> $\left\{ \begin{array}{l} \text{I: } \{1, \text{pl, obj}\} \\ \text{O: } \{2, \text{pl, obj}\} \end{array} \right\}$ + Stem-{2, pl, obj}			*
b. <i>ni-</i> $\left\{ \begin{array}{l} \text{I: } \{2, \text{sg, obj}\} \\ \text{O: } \{2, \text{pl, obj}\} \end{array} \right\}$ + Stem-{2, pl, obj}		*!	
c. <i>noh-</i> $\left\{ \begin{array}{l} \text{I: } \{1, \text{pl, obj}\} \\ \text{O: } \{1, \text{pl, obj}\} \end{array} \right\}$ + Stem-{2, pl, obj}	*!		

A major problem for Müller's approach is that the choice of a leading form can be arbitrary. Why can't *noh-* {2, pl, obj} act as a leading form instead? Hence, a feature underspecification approach is superior unless convincing evidence for the directional syncretism between {1, pl, obj} and {2, pl, obj} is presented.

In conventional OT, no reference is permitted to morphosyntactic information in general. Hence, the types of syncretism that are conditioned by morphosyntactic information, which are discussed in this section, are outside its scope.

An instance of unidirectional syncretism is from Rumanian (Stump 2001). In Rumanian, *-m* is the default marker of first-person plural agreement, as in the present indicative forms in (34).

- (34) Present indicative forms of two Rumanian verbs (adapted from Stump 2001: 214)

	A INVITA	A ȘTI
	'to invite'	'to know'
CONJUGATION	1	4
1sg	invít	ștí-u
2sg	invíț-i	ștí-i
3sg	invít-ă	ștí-e
1pl	invită-m	ștí-m
2pl	invită-ți	ștí-ți
3pl	invít-ă	ștí-u

According to Stump, the first-person singular forms must be seen as patterning after the first-person plural forms in the imperfect paradigms (35).

- (35) Imperfect forms of two Rumanian verbs (Stump 2001: 215)

	A CÂNTA	A AUZI
	'to sing'	'to hear'
CONJUGATION	1	4
1sg	cântá-m	auziá-m
2sg	cântá-i	auziá-i
3sg	cântá	auziá
1pl	cântá-m	auziá-m
2pl	cântá-ți	auziá-ți
3pl	cântá-u	auziá-u

In Müller's framework (36), to account for the above syncretism, *-m* {1, pl} would be selected as a leading form. Its morphosyntactic feature set can be changed into {1, sg}, which is spelled out by *-m*. In order to win over a competing leading form like *-i* {2, sg}, we can rank IDENT PERSON higher than IDENT NUMBER. Assume the input consists of the stem *cântá* and an exponent inventory which contains leading forms such as *-m* {1, pl} and *-i* {2, sg}. The morphosyntactic feature set that occurs on the stem is {1, sg}.

(36)

Input: cântá-{1, sg} + Exponent	MATCH	IDENT PERSON	IDENT NUMBER
a. cântá-{1, sg} + <i>-m</i> $\left\{ \begin{array}{l} \text{I: } \{1, \text{pl}\} \\ \text{O: } \{1, \text{sg}\} \end{array} \right\}$			*
b. cântá-{1, sg} + <i>-i</i> $\left\{ \begin{array}{l} \text{I: } \{2, \text{sg}\} \\ \text{O: } \{1, \text{sg}\} \end{array} \right\}$		*!	
c. cântá-{1, sg} + <i>-m</i> $\left\{ \begin{array}{l} \text{I: } \{1, \text{pl}\} \\ \text{O: } \{1, \text{pl}\} \end{array} \right\}$	*!		

In OI, the above syncretism can be accounted for under the ranking MAX-M(1) >> MAX-M(sg) (37). Candidate a wins out, even if it violates MAX-M(sg)

because the input {sg} does not have a correspondent in the feature set of *-m*. Candidate b is ruled out by MAX-M(1) because the input {1} does not have a correspondent in the feature set of *-i*.

(37)

Input: cântá, {1, sg}	MAX-M(1)	MAX-M(SG)
a. cântá-m _{1, pl}		*
b. cântá-i _{2, sg}	*!	

In Realization OT, the above syncretism can be accounted for by the paradigmatic output-to-output (OO) correspondence constraint MAX ({1, pl}: {1, sg}), which requires the morphophonological form of {1, pl} to realize {1, sg} (38). Output-to-output correspondence constraints make a derived form identical to another output form (Benua 1995; McCarthy and Prince 1995; Kenstowicz 1996; Kager 1999, among others). Candidate b is ruled out because *-m* does not occur.¹⁹

(38)

Input: cântá, {1, sg} Output: {1, pl}: -m	MAX ({1, pl}: {1, sg})
a. 1, sg ↘ cântá-m	
b. 1, sg ↘ cântá-i	*!

The grammars in Müller's and Wolf's frameworks predict that whenever directional syncretism occurs a determinant cell and its dependent cell must share some morphosyntactic feature value so that faithfulness constraints encoding this feature value can be ranked higher in order to rule out a competing exponent that does not share it. By contrast, Realization OT makes no such prediction.

However, cases like the directional syncretism between {3, sg} and {2, pl} in German verbal conjugations, which do not share any morphosyntactic feature value, contradict the above prediction in Müller's and Wolf's frameworks. Consider the following table (adapted from Duden 2006: 441–2). The marker of {2, pl} is *-t*. In indicative present, the form of {3, sg} refers to that of {2, pl}. Under Müller's and Wolf's grammars, without extraordinary mechanisms, the form of {2, sg}, for example, is a better candidate for the slot of {3, sg} than *-t* because it shares the number feature value with {3, sg}.

¹⁹ If a correspondence is established between *-m* and *-i*, candidate b can also be ruled out by an IDENT constraint.

(39) German weak verb *lachen* 'laugh'

	INDICATIVE PRESENT	INDICATIVE PRETERITE
1sg	lache	lachte
2sg	lachst	lachtest
3sg	lacht	lachte
1pl	lachen	lachten
2pl	lacht	lachtet
3pl	lachen	lachten

By contrast, Realization OT can easily account for the above syncretism in German. We can simply posit an OO correspondence constraint which requires the {2, pl} form to realize {3, sg} in indicative present.

The type of bidirectional syncretism in Stump (2001) is what Baerman (2004) calls divergent bidirectional syncretism (DBS), under which there is a feature value *x* that takes the form associated with feature value *y* in some contexts, while in other contexts *y* takes the form associated with *x*. A case of DBS is from the Latin second declension.²⁰ See (40) (adapted from Baerman 2004: 816, cited in Xu and Aronoff 2011b: 261). According to Baerman (2004), the suffix *-us* is the exponent of {nom, sg} and expresses {nom, sg} of both default masculine nouns and a group of neuter nouns such as *vulgus* 'crowd.' The suffix *-um* is the exponent of {acc, sg} and expresses {acc, sg} of both default neuter and default masculine nouns. The accusative singular of nouns such as *vulgus* takes the nominative singular marker *-us*. The nominative singular of default neuter nouns takes the accusative singular marker *-um*.

(40) Latin second declension

	DEFAULT NEUTER	DEFAULT MASCULINE	NOM AND ACC in <i>-us</i>
	'war'	'slave'	'crowd'
Nom sg	bell-um	serv-us	vulg-us
Acc sg	bell-um	serv-um	vulg-us
Gen sg	bell-ī	serv-ī	vulg-ī
Dat sg	bell-ō	serv-ō	vulg-ō
Abl sg	bell-ō	serv-ō	vulg-ō

Xu and Aronoff (2011b) argue that DBS poses problems for a feature impoverishment-plus-insertion approach (Noyer 1997, 1998; Bobaljik 2002) which stipulates that under directional syncretism it is always a more marked feature set that takes the form of a less marked one. By contrast, DBS can be easily accounted for with either OO correspondence constraints in Realization OT or rules of referral (e.g., Zwicky 1985; Stump 2001). Additionally, OO correspondence constraints have a wider scope of application than rules of referral because rules of referral only apply to two fully identical forms while OO correspondence constraints also apply to partially

²⁰ See Baerman (2004) for cases of DBS in other languages.

identical forms. For example, OO correspondence constraints can require the plural form of *man* to occur in the plural forms of a class of nouns which bear the morph *man* and express the sense of ‘human appearance,’ such as *snowmen*. Output-to-output correspondence constraints are therefore a more satisfying tool for linguists looking for a unified approach compared to rules of referral.

It is hard to imagine how DBS can be accounted for within the frameworks of Wolf (2008) and Müller (2011, 2013). Without extraordinary mechanisms, their frameworks incorrectly predict that in the case of Latin DBS, for example, the nominative singular of default neuter nouns would take the nominative singular marker *-us* and the accusative singular of nouns such as *vulgus* would take the accusative singular marker *-um*.

Lastly I consider a case of symmetrical syncretism from Hua, a language of New Guinea (Haiman 1980; Stump 2001). In the inflection of Hua verbs, 2sg and 1pl forms always carry the same termination and there is no discernible direction of syncretism between them. In the non-future-tense interrogative forms in (41), for example, both the 2sg and 1pl forms carry the suffix *-pe* and the default suffix is *-ve*.

- (41) Non-future-tense interrogative forms of three Hua verbs (Haiman 1980: 47–8, cited in Stump 2001: 216)

	Type I	Type II	Type III
	HU ‘do’	DO ‘eat’	MI ‘give’
1sg	hu-ve	do-ve	mu-ve
2sg	ha-pe	da-pe	mi-pe
3sg	hi-ve	de-ve	mi-ve
1du	hu-’-ve	do-’-ve	mu-’-ve
2/3du	ha-’-ve	da-’-ve	mi-’-ve
1pl	hu-pe	do-pe	mu-pe
2/3pl	ha-ve	da-ve	mi-ve

It is hard for a feature underspecification approach to account for the type of symmetrical syncretism in Hua because the morphosyntactic feature sets {2, sg} and {1, pl} do not form a natural class and the 2sg and 1pl suffix is not a default marker. Given that there is no discernible direction of syncretism, we cannot use either rules of referral or OO correspondence constraints to account for symmetrical syncretism. I leave the question of how to account for symmetrical syncretism in OT for future research.

6 Summary

In this chapter I have discussed the fundamental assumptions of conventional OT, some of which are taken in almost all OT frameworks for morphology. I have shown that conventional OT is not sufficient to account

for cases of the morphology-phonology interface such as phonologically conditioned allomorphy, which is essentially a phenomenon in which phonological effects are observed in the morphological component of the grammar. Extending some of the assumptions of conventional OT into the domain of morphology proper not only accounts for phonologically conditioned allomorphy, but also sheds light on some well-known morphological issues such as blocking and extended morphological exponence as well as syncretism. I have discussed the differences among various OT approaches to morphology in terms of their formal mechanisms. I have compared several OT frameworks and discussed their mechanisms, advantages, and problems with regard to morphological issues such as phonologically conditioned allomorphy, blocking and extended morphological exponence, and syncretism. These morphological issues by no means form an exhaustive list. There are many more morphological phenomena that have been and can be analyzed in OT.

I hope to have convinced readers of the following points. Conventional OT, whose major target is phonology, cannot handle morphology in general. Hence, alternative OT approaches to morphology are called for, with the assumptions that are not taken in conventional OT. Optimality Theory is a useful tool for doing morphology. Any OT framework for morphology must recognize an autonomous morphological component of the grammar, which interacts with other components of the grammar.

Many questions have not been addressed and therefore await future research. For example, since this chapter focuses on inflectional morphology, there remains a question of whether OT can be well applied to other morphological components such as derivational morphology, compounding, and clitics.²¹ Second, since OT approaches often differ in terms of their theoretical assumptions, how might different language data test the validity of these assumptions? Third, how might different language data test the quality of an OT morphological framework in comparison to its competing frameworks, either within OT or not? Fourth, how well can OT contribute to our understanding of the interface between morphology and other components of the grammar? Last but not least, can OT morphology be a useful framework for other linguistic sub-disciplines such as language acquisition, computational linguistics, and psycholinguistics? I hope more work will be done on these research questions.

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²¹ See Anderson (2005a) for an OT account of clitics.

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The Role of Morphology in Transformational Grammar

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1 Introduction

A common view of the history of morphological research within the tradition of Generative Grammar, and one that the present author has himself retailed on various occasions, goes as follows. As successors to the American Structuralists, early generative grammarians (especially Noam Chomsky, a student of Zellig Harris) inherited the structuralist theory of the morpheme as a basic component of linguistic expressions. On this picture, morphemes were seen as more or less Saussurean minimal signs: irreducible associations of (phonemic) form with grammatical or semantic content. Chomsky's own earlier work on the morphology of Hebrew (Chomsky 1979 [1951]) had made it clear to him that in the general case, the relation between morphemes and phonological form was much more complex and abstract than generally assumed in structuralist work, but discrete morphemes were still taken to serve as the link between form and content. Words, and by extension phrases, were to be analyzed as exhaustively composed of these morphemes, organized hierarchically into progressively larger structures.

Within Generative Grammar, the two substantive branches of morphological theory were both trivialized. On the one hand, the study of *allomorphy*, the variation in shape displayed by individual morphemes, was to be largely subsumed under the much broader conception of phonology held by generativists in comparison with their predecessors, leaving little residue beyond the listing of arbitrary, unsystematic, and suppletive alternants. On the other hand *morphotactics*, the study of the combination of morphemes into larger units, was to be seen simply as syntax, with morphemes serving as the terminal nodes of phrase markers. There is a

mild irony here, since a similar reduction in the opposite direction (with syntax taken as simply the morphotactics of increasingly large domains) characterized much structuralist thought.

These two consequences of the emerging approach to language in the 1950s and 1960s left little content for a theory of morphology *per se*, and the field more or less disappeared as a focus of interest. It was only beginning in the 1970s and 1980s—as evidence accumulated that the internal structure of words is interestingly distinct from that of phrases (see, e.g., Zwicky 1992), and that variation based on morphemic identity follows different principles from that based on purely phonological factors alone (see, e.g., Anderson 1992: 42ff.)—that morphology reappeared as a distinct focus of attention.

This picture of the intellectual history of our field is by no means altogether wrong, but a closer examination reveals that it somewhat oversimplifies things. In fact, morphological matters play more of a role in the literature of Transformational Grammar and its immediate descendants than has sometimes been appreciated, and the interplay of morphological and syntactic factors¹ has been somewhat more bidirectional than is sometimes assumed. The purpose of this chapter is to review these developments, identifying places in the syntactic literature where the view of morphology assumed (or explicitly presented) is not simply a matter of undigested adoption of structuralist assumptions. I focus here on the views of Noam Chomsky, as these constituted the center of theorizing on the issues at stake here from the beginnings of Transformational Grammar through its metamorphosis into later theories (Government/Binding Theory, Principles and Parameters, Minimalism).

I begin in Section 2 with the assumptions about morphology—derived largely from those of Harris (1951)—that appear in Chomsky's earliest work in the 1950s. In Section 3 I sketch the rather different view of morphology and its relation to syntax that appears in Chomsky (1965), most important for its view of inflection, and some of the motivation for the shift. Section 4 then follows the emergence of the “lexicalist” view of the relation between morphology and syntax, principally important for its notion of the place of derivational morphology.

2 Origins: Morphology in the Transformational Grammar of the 1950s

At its outset, Transformational Grammar as represented in Chomsky's work made major breaks with the prevailing views of American Structuralists. It is hard today to reconstruct the atmosphere of the time,

¹ The historical connections between morphology and generative phonology raise similar issues, but that discussion falls outside the scope of the present chapter.

in which discovery procedures – the formal manipulations of surface data through which an analysis was reached – were the core of theory and theoretical discussion;² but it was only in rejecting this approach that the field was able to focus on a view of language that treated the nature of speakers' knowledge as the object of inquiry, and not the series of steps organizing the data that the linguist was to perform. By rejecting the notion that the analysis had to start with the phonetics, proceed to a phonemic account of contrast relations, and then move on to the discovery of morphemes and (perhaps someday) to larger constituents, all without "mixing levels,"³ this new perspective on language made it possible to give serious attention to syntax as the central capacity underlying the creative aspect of language use. Very little of what linguists can be said to have accomplished since the 1950s would have been possible without the fundamental epistemological reorientation that lay at the heart of the emerging theory.

In its underlying ontology, however, Transformational Grammar was much more conservative. It is striking that while Chomsky and other writers of the time (and their successors) reject the procedural foundation of linguistic analyses central to structuralist approaches, they seldom really question the status of the basic terms of an analysis: in particular, are there "morphemes" in linguistic structure? Carrying over Harris' assumptions, Chomsky assumed that the terminal nodes of phrase markers are (or rather, correspond to) morphemes. These are abstract units, not to be identified either with the "meaning" (semantic or grammatical) that they bear or with their (morpho-)phonemic realization. They are "the more or less smallest meaning bearing elements."⁴

Words are composed of morphemes, although the correlation will not in general be direct since the mapping of morphemes onto words, the units that will be realized phonologically, is not necessarily order-preserving. Chomsky does not ask, though, whether in fact the existence of

² The author recalls vividly having a proposed analysis rejected by one of his own early teachers, a prominent American Structuralist, on the grounds that "I don't care how much it looks like the 'right' answer: what I want to know is how you got it!"

³ As a notable exception to this prohibition, Pike (1947, 1952) argued that higher-level information had to be taken into account in arriving at phonemic analyses – a stance that put him at odds with the rest of the American Structuralist establishment, which perhaps accounts for the exclusion of any of his work from the unofficial canon of the movement, Joos (1957).

⁴ Where "meaning" presumably includes "grammatical" as well as "semantic" content. This formulation is taken from a 2010 interview with Michael Schiffmann, suggesting that Chomsky's views on this matter have not changed greatly over the years. Taken literally, it would seem at odds with the observation (Chomsky 1957: 100) that "[s]uch morphemes as 'to' in 'I want to go' or the dummy carrier 'do' in 'did he come' can hardly be said to have a meaning in any independent sense, and it seems reasonable to assume that an independent notion of meaning, if clearly given, may assign meaning of some sort to such non-morphemes as *gl-* in 'gleam,' 'glimmer,' 'glow.' Thus we have counter-examples to the suggestion that morphemes be defined as minimal meaning-bearing elements." Much of Chomsky's writing about other linguists' views during the early period of Generative Grammar is devoted to attacks on appeals to meaning, and it can only be assumed that he sometimes uses the word as shorthand for "grammatically significant content" or the like.

morphemes as units independent of the content and form to which they are linked is actually justified. A word corresponds to a possibly complex combination of content elements (some components of lexical meaning, some grammatical categories, derivational material. . .) and it has a realization as a sequence of elements of external form, but from that it does not follow that a word always should (or even can) be decomposed into a sequence of discrete, non-overlapping units, each uniting a determinate subpart of the content with a determinate subpart of the form while remaining logically distinguishable from either. Of course, such a decomposition can obviously be made in the vast majority of words in the vast majority of languages. But there are cases where this is rather transparently artificial, as morphologists proposing word-based accounts⁵ have argued since the 1970s, and that suggests that morphemic structure does not constitute the general case. Nonetheless, Chomsky and those most closely associated with him do not seem to have taken seriously the possibility that there is a real question here, simply assuming that their analyses should be based on a rather traditional understanding of the nature of morphemes as intermediaries between form and content.

In his first significant publication on syntax, Chomsky (1953: 244) describes the fundamental units of a syntactic analysis as morphemes, where “[t]he linguist’s morphemes are classes of conforming minimal meaning-bearing units, e.g. ‘boy,’ ‘think,’ ‘of,’ ‘ing,’ the plural ‘s,’ etc. Forms such as ‘wife’ and ‘wive,’ with selection predictable given the context (thus ‘wive’ occurs only before ‘s’ plural, ‘wife’ only elsewhere), are called morpheme alternants and are considered to belong to the same morpheme. They are here considered to conform. See [Harris 1951: chapters 12, 13].” At this point in his intellectual development, Chomsky was attempting to work out the problems in Harris’ approach on the basis of that program’s methodological assumptions. The failure of that effort would lead him in later work to return to a more abstract and non-procedural view closer to that underlying his earlier work on Hebrew morphophonemics.

The formulation just cited suggests initially that a morpheme is to be construed as a sort of minimal sign (in the Saussurean sense) linking a determinate chunk of sound with the component(s) of meaning that it bears, but the notion is actually more abstract than that, as the description of “wife/wive” shows. In fact, for Harris and for Chomsky in this paper, a morpheme was identified not with a particular phoneme sequence, but rather with an abstract object, realized in any given context by one member of a set of such sequences. In many cases, this set contains only a single member (e.g., “boy”), while in others the set has multiple members which may or may not be close in phonological form. In the case of “wife/wive” the two differ only in the voicing of a single consonant, but in others, as we

⁵ See for example Matthews (1972), Aronoff (1976), Anderson (1992), Beard (1995), Stump (2001), among others.

shall see, the variation may be more extreme. Thus, “think/though(t)” correspond to a single morpheme, with variation dependent on the presence of a following “past,” while “is/are/am/was/were/be” are all alternants of a single morpheme “be.” Indeed, the only constraint on the alternants of a single morpheme was that they be in complementary distribution, with specifiable environments, and that they correspond to the same functional or semantic content.

As was appropriate for the journal in which this article appeared, the focus here was on the formal logic of descriptions, and virtually no real examples are offered from which we could derive further consequences. The abstract, set-theoretic nature of the morpheme emerges more prominently in later work, however, and has important consequences for the relation between morphological and syntactic analysis.

The central text for Chomsky’s ideas about syntax and morphology in the 1950s and early 1960s is Chomsky (1985 [1955–6]), a work that served as the source of his 1955 doctoral dissertation and also (less directly) for *Syntactic Structures* (Chomsky 1957), though it remained unpublished as a whole until 1975. This work characterizes the description of a language in terms of a number of levels, each with its own properties and each related in formalizable ways to others at higher and lower levels of abstraction. One of these is the level *M* on which linguistic objects are represented as sequences of morphemes. The fact that these units are not to be equated with strings of phonemes, but rather are abstract objects that are realized (first as words, and subsequently on the phonemic level) is made clear:

The correlation [between the representation of a linguistic object as a sequence of morphemes and as a sequence of phonemes] will not in general be direct. Morphemes may be discontinuous, a string of morphemes may correspond to a single word or phoneme sequence even if parts of this morpheme sequence do not correspond to parts of the word or phoneme sequence,⁶ morphemes may have null phonemic content, etc. (Chomsky 1985: 168)

The abstract nature of morphemes allows them to play roles in syntactic description that are flexible in important ways. Thus, we read in Chomsky (1957: 69, footnote 2) that a rule T_{W2} involved in the formation of questions can be defined as “the transformation that converts any string *Z* into *wh*+ *Z*, where *wh* is a morpheme. In the morphophonemics of English we shall have rules: *wh* + *he* → /huw/, *wh* + *him* → /huwɪm/, *wh* + *it* → /wat/.”

As opposed to the view that morphemes are related to phonological content simply by an operation of instantiation from within a set of specified allomorphs, Chomsky’s earlier work on Hebrew had resulted in the notion of a system of morphophonemic rules capable of relating complexes of morphemes to phonological strings in very complex ways. The content of

⁶ As in the case of what Hockett has called “portmanteau” forms. See “Problems of morphemic analysis” for this and other discussions of morphology. See also the relevant sections in Harris (1951) and Nida (1949).

Chomsky (1979 [1951]) was included in some versions of *The Logical Structure of Linguistic Theory* as an appendix; it does not appear in the most readily accessible current edition (Chomsky 1985 [1955–6]), but the notion of morphophonemics developed there must be taken into account in understanding the morphological assumptions of that work.

Strings of morphemes are thus mapped via the complex operations of morphophonemics onto strings of phonemes. The centrality of morphemes for syntactic analysis, in turn, derives from their role as elements corresponding to the terminal nodes of representations on the level of phrase structure. This relation is not entirely straightforward, as is made clear in its characterization in (Chomsky 1985 [1955–6]):

Since the systematic role of morphological analysis is to simplify the derivation of word sequences from phrase sequences, we can regard *M* as a level intermediate between the level *W* of words and the level *P* of phrase structure. This suggests that it might be useful to consider separately two classes of morphological elements, those that figure in the statement of phrase structure and those whose function is limited to the description of word structure. In the first class (call it $\bar{M}$) we have what we can call “morphological heads” as well as those affixes that function syntactically (e.g., morphemic long components⁷ expressing agreement in gender and number, etc.). In the second class we have such elements as English *ess* (*actress*, etc.) which do not themselves enter into the description of phrase structure, but which enter into the description of the minimal units that play some role in syntax. $\bar{M}$ can be pictured (for the time being) as embedded into the level *P*. Derivations in *P* thus lead from the representation *Sentence* to strings in $\bar{M}$. These derivations are then extended through the levels *M* and *W* by first analyzing the morphological heads into strings of morphemes, and then placing word boundaries (i.e., applying Φ^M).

$\bar{M}$ can thus be set up as a subalgebra of *M*. The primes of $\bar{M}$ are then a set *H* of morphological heads and a set *Af* of syntactically functioning affixes. $\bar{M}$ is the only part of *M* that need be considered on higher levels of syntax. (Chomsky 1985 [1955–6]: 168)

The rules of the syntax, then, distribute and manipulate morpheme-level elements rather than words, abstracting away from a subset of derivational morphemes that are only relevant to word-internal structure. This move is quite crucial, since it is this that allows transformational rules to introduce, delete, and, most importantly, permute morphemes independent of the larger domains (words) of which they will form a part. And such a move, in turn, is at the heart of the analysis that was probably more influential than any other factor in persuading the field of the merits of Transformational Grammar: the rule that has come to be known as “Affix-Hopping.”⁸

⁷ See Harris (1951: Chapter 17). The distinction we are drawing is essentially that between the morphological processes of inflection and composition. See Bloomfield (1933).

⁸ This name for the rule re-ordering an affix and a following verbal element was coined by Haj Ross, and has become standard.

In English, main verbs can appear alone, marked for tense, or preceded by various auxiliaries: sequences of a modal and/or aspectual auxiliary. Formulating the set of possible auxiliary sequences is a problem, because each auxiliary element imposes a requirement on the form of the element that follows it, rather than on its own shape. Chomsky's solution to this was to introduce auxiliary elements together with the affixes they require, and then reorder the resulting sequences so that the affixes follow the element with which they should be associated.

The analysis based on Affix-Hopping is present in full detail in Chomsky 1985 [1955–6]; I cite it here in the formulation found in *Syntactic Structures*, the most familiar source:

- (28) i. $Verb \rightarrow Aux + V$
 ii. $V \rightarrow \text{hit, take, walk, read, etc.}$
 iii. $Aux \rightarrow C(M) (\text{have}+en) (\text{be}+ing) (\text{be}+en)$
 iv. $M \rightarrow \text{will, can, may, shall, must}$
- (29) i. $C \rightarrow \begin{cases} S \text{ in the context } NP_{\text{sing}} \text{ —} \\ \emptyset \text{ in the context } NP_{\text{pl}} \\ \text{past} \end{cases}$
 ii. Let Af stand for any of the affixes *past*, *S*, $\emptyset$, *en*, *ing*. Let v stand for any M or V , or *have* or *be* (i.e., for any non-affix in the phrase *Verb*). Then:

$$Af + v \rightarrow v + Af \#$$
 where $\#$ is interpreted as word boundary.
 iii. Replace $+$ by $\#$ except in the context v_Af . Insert $\#$ initially and finally. (Chomsky 1957: 39)

The rules in (28) here are part of the phrase structure component of the grammar. These introduce both lexical elements and affixal morphemes as terminal nodes of phrase markers: the fact that the affixes, in particular, have this status is crucial to the success of the analysis. Rule (29i) realizes the non-terminal element C as either the third-person singular present verbal ending (S , realized as $[s]$, $[z]$, or $[\partial z]$ in the phonology), as null in other present tense contexts or as the morpheme *past*. The heart of the analysis is rule (29ii), “Affix-Hopping.” This is part of the transformational component of the grammar, and its effect is to reorder affixes (tense and aspect inflection, and also the *en* of the passive). Word boundaries inserted into the resulting structure will organize the affixal elements as suffixes to the verbal elements whose form is governed by a preceding auxiliary.

Without going into great detail, this system also accounts elegantly for additional structures. When the negative element *not* is introduced into a sentence, or an element A of contrastive affirmation, these interrupt $Af + v$ sequences so that rule (29ii) does not apply, and the result is to “strand” the affix. Such a stranded affix is directly preceded by $\#$ as a result of rule

(29iii), and the dummy verb *do* is then inserted by a subsequent transformation in the environment # *_Af* (as in *John does not like sardines* or *John does like sardines*). Similarly, in the formation of yes-no questions, an initial affix can itself be preposed, resulting in the same stranded configuration and the insertion of *do* (*Does John like sardines?*).

The Affix-Hopping analysis unites a wide range of facts about English verbal structures on the basis of a few simple rules. It is, as Chomsky emphasized, quite impossible to formulate in terms of phrase structure regularities alone, and thus furnished a direct and very persuasive argument for transformational rules in grammatical descriptions. For our present purposes, it is important to note that the formulation here relies on the notion of morphemes as terminal elements in syntactic structure: the affixes that are introduced by rules like Chomsky's (28iii) and (29i), and which are manipulated by rules in (29ii), do not constitute separate words, but they must be accessible as autonomous elements in the syntax if the analysis is to work as intended.

The details of the Affix-Hopping account, including the syntactic status of affixes it assumes, were questioned from various perspectives in later work (see for example Pullum and Wilson (1977), Gazdar et al. (1982), Chomsky (1993), Lasnik (1995), and from a very different point of view, Beard (1995)), but for linguists in the early days of Transformational Grammar, the analysis – and the assumptions it made about the relation between morphology and syntax – was a fundamental and virtually unquestionable achievement of the emerging view of linguistic structure.

The quotation from Chomsky (1985 [1955–6]) above also raises another issue. As we have seen, the distribution of many individual morphemes is governed by the operation of the syntax, but in some cases there is no reason to believe the syntax is involved. In a language like English, where no principle such as gender agreement would require (or motivate) syntactic access to the element *ess* in *actress*, *lioness*, *duchess*, *mistress*, etc., what accounts for the presence of this element in complex words? Chomsky describes the difference between syntactically relevant morphological formations and others as approximating that between inflection and “composition,” but what is the scope of the latter, and what principles govern it?

On the second point, the principles of word-internal syntactically irrelevant morphology, there was little or no discussion in the linguistic literature of the 1950s and early 1960s. The existence of such formations was widely acknowledged and discussed within the wider field: see, for example, the discussion in Hill (1962: 59) of precisely the set of pairs such as *count:countess*, *duke:duchess*, *lion:lioness* and whether these would motivate an analysis of *queen*, *wife* and so forth as **king-ess*, **husband-ess* and the like. Given the role of zero morphemes and the abstractness of morphemes in general, it is hard to see anything in the principles of Chomsky (1985 [1955–6]) that would prevent such an analysis, but the issue was never raised.

With regard to the scope of the notion of non-syntactic “composition,” it is tempting to equate this with “derivational morphology,” given Chomsky’s appeal to a traditional distinction. That would probably be mistaken, however, at least in any standard sense of “derivation.” Much of what is usually treated as derivational morphology was in fact described in the transformational literature of the period as produced by the syntax.

For example, we might think of the word *proving* in *proving that theorem* as *difficult* as a nominalization of the verb *prove*, since the phrase *proving that theorem* of which it is the head clearly fills the role of a noun phrase (NP) as the subject of the sentence. Chomsky (1957: 41), however, treats this in terms of a phrase structure rule $NP \rightarrow ing\ VP$. The element *ing* is thus introduced in the syntax; it permutes around the initial verb of the VP by the Affix-Hopping rule, and thus the structure of *proving* falls entirely within the scope of the syntax.

Such formations, always seen as somewhere on the border between syntax and morphology, are only the beginning of the encroachment of syntactic formation on the traditional domain of derivational morphology. A whole range of other de-verbal nouns were also seen as created by the introduction in the syntax of nominalizing elements: thus, Chomsky (1985: 499) proposes an element ν such that “*see*+ ν = *sight*, *fly*+ ν = *flight*, *refuse*+ ν = *refusal*, etc.” The syntactic relevance of the element ν ⁹ comes from its presumed role in transformational rules that derive such nominalizations from sentential paraphrases. Chomsky describes phrases such as *the sight of men working in the fields*, *the flight of birds*, *his refusal to come* as arising by transformation from *he saw men working in the fields*, *the birds flew*, *he refused to come*. Any such phrase with a sentential paraphrase was thus to be derived by transformation from a more basic structure underlying a simple sentence, and elements such as nominalizing ν were to be introduced by the transformation(s) involved. This line of analysis was developed and extended much further by Lees (1960) in the first doctoral dissertation produced within the new theory of Transformational Grammar.

A great deal of traditional derivational morphology falls on this view within the domain of the syntax. Chomsky recognized the potential existence of a certain residue, as indicated by his comments on *actress*, and so on, but the treatment of this residue (“composition”) was never substantively addressed.

Contrary to a common view of the history, it is apparent that early Transformational Grammar in the form of Chomsky’s work in the 1950s actually presented a rather intricate theory of morphology. This included views on the nature of the relation between morphemes and phonological form that incorporated most (if not all) of the puzzles that had previously

⁹ Following Chomsky, I use the Greek letter ν here, despite its somewhat confusing resemblance to a lower case “v.”

been raised in work such as that of Hockett (1947) and which would later be adduced as arguments against the coherence of analyses in terms of morphemes. It involved a rather specific role for morphemes in syntactic analysis, and a distinction between inflectional and derivational morphology, even if the line between them did not fall in the standard place.

Apart from serving as the basis for syntactic accounts such as that of Affix-Hopping, however, these assumptions about morphology attracted little or no discussion among generative grammarians of the period. The interest of the field lay in developing theories of syntax, not morphology, and that was where their efforts were expended. As a result, the specific assumptions made in the literature and the residual problems of a morphological nature that those assumptions raised (such as the nature and place of non-syntactic derivational morphology) remained unexamined, with the result that morphological structure in essentially the form developed by Harris (1951) (now founded on a different, non-procedural basis) remained the standard.

3 The Morphological Theory of Aspects

Morphological issues play at best a peripheral role in the literature of Transformational Grammar through the mid-1960s, but in a significant re-formulation of the theory, Chomsky (1965) proposed fundamental revisions of his earlier views on these as well as other matters.¹⁰ The original motivation for this lay in problems that had arisen with respect to the categorization of lexical items.

In the earlier theory, Chomsky (1957, 1985 [1955–6]) treated the members of major lexical categories (verbs, nouns, adjectives) as introduced directly by the phrase structure rules: cf. rules such as “ $V \rightarrow \textit{hit, take, walk, read, etc.}$ ” above, for example. The fact that these lexical categories have subcategories, however, where those subcategories are relevant for the statement of restrictions on the set of well-formed sentences, presents a serious problem.

Referring to earlier work by G. H. Matthews, Chomsky (1965: 79–80) observes that

The obvious suggestion is to deal with subcategorization by rewriting rules [of the sort just mentioned], and this was the assumption made in the first attempts to formalize generative grammars ... The difficulty is that this subcategorization is typically not strictly hierarchic, but involves rather cross-classification. Thus, for example, Nouns in English are either Proper

¹⁰ See Matthews (1993), especially pages 90ff., for a review of these developments within the larger context of morphological theory in America.

(*John, Egypt*) or Common (*boy, book*) and either Human (*John, boy*) or non-Human (*Egypt, book*). Certain rules (for example, some involving Determiners) apply to the Common/Proper distinction; others (for example, rules involving the choice of Relative Pronoun) to the Human/non-Human distinction. But if the subcategorization is given by rewriting rules, then one or the other of these distinctions will have to dominate, and the other will be unstatable in the natural way.

That is, in the example given, if the Proper/Common distinction is introduced first as a subcategorization of nouns, a category such as Human can only be referred as the disjunction “Proper-Human or Common-Human” and not as a unitary category in itself. And “[a]s the depth of the analysis increases, problems of this sort mount to the point where they indicate a serious inadequacy in a grammar that consists only of rewriting rules. Nor is this particular difficulty overcome, as many others are, when we add transformational rules to the grammar” Chomsky (1965: 80).

Chomsky’s solution to this difficulty is to revise the relation between syntactic structures and the lexical items that appear in them in a radical way. Instead of developing lexical subcategories by a hierarchical set of rewriting rules, and then introducing lexical items by rewriting a maximally specific subcategory symbol, he proposes to view the terminal elements of syntactic form as **complex symbols**: (unordered) collections of syntactically relevant features. The rules of the phrase structure component of a grammar then allow a lexical category symbol (e.g., noun) to be expanded as a complex symbol by rules such as these (Chomsky 1965: 85):

- i. $N \rightarrow [+N, \pm\text{Common}]$
- ii. $[+\text{Common}] \rightarrow [\pm\text{Count}]$
- iii. $[+\text{Count}] \rightarrow [\pm\text{Animate}]$
- iv. $[-\text{Common}] \rightarrow [\pm\text{Animate}]$
- v. $[+\text{Animate}] \rightarrow [\pm\text{Human}]$
- vi. $[-\text{Count}] \rightarrow [\pm\text{Abstract}]$

Concrete lexical items, in turn, are listed in a lexicon, each associated with a collection of features that characterize it: thus, *boy* is listed with its phonological form (and semantics) linked to a set of features including $[+\text{Common}, +\text{Animate}, +\text{Human}, +\text{Count}]$ (and perhaps others). A separate operation of **lexical insertion** then allows the association of an item from the lexicon with a terminal position in a phrase marker consisting of a complex symbol whose featural content is consistent with the features of the lexical item in question.

From the morphological point of view, this may appear to be a relatively minor technical move concerned only with the details of the relation between lexical items and syntactic positions, but in fact it has much more dramatic consequences. These are evoked somewhat schematically in the final chapter of the book, though the proposals made there had minimal impact on the practice of syntacticians.

Chomsky (1965: 170–84) compares two approaches to the description of inflectional morphology, on the basis of alternative accounts of an inflected form such as the German NP *der Brüder* ‘the brothers (masculine, genitive, plural)’. On one analysis, which he identifies with that of traditional grammar,

a particular occurrence of a Noun would be described in terms of its place in a system of paradigms defined by certain inflectional categories, namely the categories of gender, number, case and declensional type. Each of these categories constitutes an independent “dimension” of the paradigm, and each word has a particular “value” along each of these independent dimensions. Thus the word *Brüder* would be characterized as Masculine, Plural, Genitive, and belonging to a certain declensional class along with *Vater*, *Mutter*, etc. Chomsky (1965: 171–2)

He then notes that this description can be translated directly into an account of the sort developed earlier in the book for lexical items, treating the traditional “paradigm dimensions” in terms of syntactic features. On that basis, we would represent *Brüder* in the phrase *der Brüder* as associated with a complex symbol including the features [+Masculine, +Plural, +Genitive, 1 DC, . . .].¹¹ He then assumes that rules of interpretation in the phonological component will operate on the lexical item *Bruder* in the context of this feature combination to yield the surface form *Brüder*.

The features involved in the complex symbol that conditions the expression of *Bruder* as *Brüder* have various origins. The properties of gender ([+Masculine]) and declension class ([1 DC]) are inherent in the noun’s lexical entry, and so this noun could only be associated with a terminal position whose content included those values. The property [+Plural] is not inherent in the lexical entry, but represents a value on a paradigmatic dimension relevant for German nouns, and so can be introduced by the rules of the phrase structure component in expanding this position. The feature [+Genitive] “is introduced by a rule that does not belong to the base subcomponent of the syntax at all but rather to its transformational part” – that is, there is a transformational rule that assigns appropriate case on the basis of the larger configuration in which the word appears.

Notice that nowhere in this account is any role played by morphemes, in the sense of minimal structural elements linking form and content. The morphologically relevant features of gender, number, and case are part of the large complex symbol which *as a whole* determines the phonological realization of lexical *Bruder* as phonological /brüdər/. There are no structural units invoked which parcel out the realization into local content-form associations.

This absence of appeal to morphemes is no accident, as Chomsky shows by contrasting this description with an alternative:

¹¹ Chomsky actually represents values for gender, number, and case as numeric coefficients for the dimensions involved. The translation of that notation into binary values for specific genders, and so forth, for clarity here does not affect the overall line of the analysis.

The characteristic method of analysis of modern linguistics is rather different from the traditional approach that we have just restated in our terms. In place of the traditional categories (our features), this approach would substitute morphemes. Thus *Brüder* [above] would perhaps be represented [as below] in a completely consistent “item and arrangement” grammar:

Bruder $\frown$ DC1 $\frown$ Masculine $\frown$ Plural $\frown$ Genitive

where each of these elements is regarded as a single morpheme, *DC1* being a kind of “class marker.” Rules would then be given that would convert [this representation] into a sequence of phonemes. Chomsky (1965: 172–3)

Chomsky then provides arguments against the morpheme-based account, and in favor of his reinterpretation of the traditional (paradigm-based) analysis:

For one thing, many of these “morphemes” are not phonetically realized and must therefore be regarded, in particular contexts, as zero elements. In each such case a specific context-sensitive rule must be given stating that the morpheme in question is phonetically null. But this extensive set of rules is entirely superfluous and can be omitted under the alternative paradigmatic analysis.

...

More generally, the often suppletive character of inflectional systems, as well as the fact that (as in this example) the effect of the inflectional categories may be partially or even totally internal, causes cumbersome and inelegant formulation of rules when the representations to which they apply are in [the form of morpheme sequences]. However, suppletion and internal modification cause no special difficulty at all in the paradigmatic formulation. Similarly, with morphemic representations, it is necessary to refer to irrelevant morphemes in many of the grammatical rules. ... But in the paradigmatic representation, these elements, not being part of the terminal string, need not be referred to at all in the rules to which they are not relevant. Finally, notice that the order of morphemes is often quite arbitrary, whereas this arbitrariness is avoided in the paradigmatic treatment, the features being unordered.

I know of no compensating advantage for the modern descriptive reanalysis of traditional paradigmatic formulations in terms of morpheme sequences. This seems, therefore, to be an ill-advised theoretical innovation. (Chomsky 1965: 173–4)

Given that virtually all syntactic discussion (as well as much phonology) in this period and subsequently assumes representations in terms of sequences of morphemes, this passage cannot help but strike today’s reader as extraordinary. Indeed, Chomsky’s arguments here against morphemic analyses of inflection and in favor of the “paradigmatic” account are essentially the same as those offered in work developing more detailed morphological theories along lines similar to those suggested in *Aspects* (e.g., Matthews 1965, 1972; Anderson 1992; Stump 2001, and others), and have never been explicitly and effectively rebutted in the literature. “It is

therefore a remarkable tribute to the inertia of ideas that, when [Chomsky and Halle (1968)] addressed the phonology of English, it was the other, morpheme-based solution that they adopted” (Matthews 1993: 93). This is true not only for phonology, but also for the literature on syntax, which has largely disregarded with little or no discussion the proposals and arguments of *Aspects* concerning the treatment of inflection, and continues to assume morpheme-based representations. The disappearance with hardly a trace within mainstream generative thinking of Chomsky’s explicit and quite persuasive reasoning against that view is indeed remarkable.

There is also some discussion of derivational morphology in Chomsky (1965: 184–92), but this is quite inconclusive. In general, the analysis of derivation there is little different from that of earlier theories, with words like *destruction*, *refusal*, and so forth, “clearly” not entered in the lexicon as such, but rather represented as *nom* $\bar{\wedge}$ *destroy*, and so on, where *nom* is a nominalizing morpheme introduced by the transformation converting verbal expressions into nominals. In a footnote (fn. 42, p. 235) the possibility is raised that the nominalization element might be introduced not as a morpheme but rather as a feature, but this line is not pursued further in the text. One notable point, though, is the fact that in attempting to deal with the often limited productivity of derivational formations, “it may be necessary to extend the theory of the lexicon to permit some ‘internal computation,’ in place of simple application of the general lexical rule” (Chomsky 1965: 187). This remark can be seen as a harbinger of the next stage of development of the theory of morphology-syntax interaction, as described in Section 4 below.

4 “Remarks on Nominalizations” and the Emergence of Lexicalism

While the morphological proposals of *Aspects* elicited little reaction, the suggestions there about the relation between syntactic structure and semantics got much more attention. One line of analysis emerging from this (and the prior work that underlay it) was to lead to the theory of Generative Semantics: a view on which a direct representation of meaning was to be taken literally as syntactic in nature, and mapped seamlessly onto surface form by the operation of a sequence of transformational rules.¹² While sympathetic to the initial formation of these ideas in Katz and Postal (1964), on which the syntactic representation produced by the phrase structure rules was the basis of semantic interpretation, Chomsky soon became hostile to the more extreme developments that came to characterize Generative Semantics.

¹² Discussion of the nature and development of Generative Semantics falls well outside the scope of the present article. For three somewhat different perspectives on these matters, see Newmeyer (1986), Harris (1993), and Huck and Goldsmith (1995).

In the fall of 1966, Chomsky was away from MIT at the University of California, Berkeley. During that term, classes taught at MIT by John R. (“Haj”) Ross and at Harvard by George Lakoff, building also on work by James McCawley and Paul Postal, elicited great interest in the emerging theory of Generative Semantics among syntacticians and students in Cambridge. When Chomsky returned in the spring of 1967, he found this view to have come to dominate discussion in the linguistic community. In the fall of 1967, he gave a series of lectures in a course at MIT that initiated a counter-attack, although he did not explicitly refer to Generative Semantics *per se* there. These lectures were written and circulated by the end of the year, and later appeared in published form as Chomsky (1970). While there are various consequences of the proposals made in that paper, it is important to see it as directed toward an agenda that would restrict the power of transformational operations, thus limiting the semantic adequacy of syntactic underlying forms and countering the proposals of the Generative Semanticists.

Our interest here is not directly in those syntactic and semantic issues, but rather in the consequences of the paper (henceforth “Remarks”) for morphology and the theory of the lexicon. The core proposal was superficially modest enough, and concerned a particular construction which had figured in much previous work: nominalizations in English. As noted above, in work up to Chomsky (1965), he had treated nominalizations uniformly as resulting from the transformation of a sentential source, a process that introduced (or depended on) an abstract nominalizing element that combines with a verb to give surface word-forms like *destruction*, *refusal*, and so on.

In “Remarks,” however, he observed that it is useful to distinguish two sorts of nominalizations of verbs in English:

- **derived** nominals, like *John’s refusal of the offer*; and
- **gerundive** nominals, like *John’s refusing the offer*.

At the time, both of these were assumed to be produced in the syntax, by rules that started with the same structure as the one underlying *John refuse(s) the offer*.

Chomsky pointed out, however, that the two types differ in several systematic ways:

- **Formal uniformity:** derived nominals have a great many distinct shapes (e.g., *laughter*, *marriage*, *construction*, *belief*, *doubt*, *difficulty*,...) while gerundives are always formed by stem plus *-ing* (*laughing*, *marrying*, *constructing*, *believing*, *doubting*, *being difficult*).
- **Semantic uniformity:** derived nominals like *recital*, *transmission*, *inflation*, *generation*, and so on, are commonly the locus of semantic idiosyncrasy, while the gerundives are semantically uniform.
- **Internal structure of projected phrases:** Cf. *Those first four completely unmotivated criticisms of my book which you had the temerity to raise*. Derived nominals take articles, adjectives, quantifiers, and plural form, and

their complements appear in PPs; but they don't take adverbs (*John's pointedly denying/*denial that he took a bribe*). In general, the derived ones appear in phrases with all of the internal syntax of NPs, while the gerundives appear in phrases with the internal syntax of S.

- **Syntactic unproductivity:** In general, the derived nominals do not appear in structures where they would have to have been formed from syntactically derived constructions. Thus, we get *John's *easiness/being easy to please*, *John's *appearance/appearing to like Albanian nouvelle cuisine*, and so on.

One commonly cited observation in this paper was the fact that derived nominals are frequently not meaning-preserving in relation to their presumed sentential source. But it is important to note that this was only one relatively minor point: the main thrust of the article (and of the lectures on which it was based) was the set of structural differences. Overall, that is, the “derived” nominals show all of the properties of nouns, and not those of verbs, as far as their syntax is concerned. And this suggests that deriving them from verbs in the syntax is problematic.

On the other hand, we still need to express in some way the fact that there is a relation between *refuse* and *refusal*. The syntactic solution to this is to derive both from the same word in the syntax. Chomsky's suggestion, in contrast, was that “we might allow the base rules to accommodate derived nominals directly.” That is, we could allow the relation between verbs and derived nominals to be described not in the syntax but in the part of the grammar responsible for providing words to the syntax: the lexicon. On this view, *refusal* is consistently a noun, as far as the syntax is concerned, and so it follows directly that it appears as the head of a noun phrase. This, in turn, implies that it will display the syntax of NP, not that of S.

Refusing, on the other hand, is a particular form of the verb *refuse*, so it is introduced as a verb in sentential structures. In terms of the syntax of the time, this was straightforward. In the kind of theory that came to prevail later, we can assume—as proposed by Kaiser (1998)—that there is some element that can be “merged” with a VP in the syntax and which has the effect of converting that VP into a NP while adding *-ing* to the verb:

$$F_{\text{GERUNDIVE}}: [\text{VP } [V \text{ X}] \text{ Y}] \Rightarrow [\text{NP } [N \text{ X+ING}] \text{ Y}]$$

Such a pseudo-formal representation should not be taken too seriously: the point is that somehow, verbal VPs can be converted into gerundive expressions in the syntax. There is of course more work to be done to get the resulting structure to look like an NP: the subject has to be marked genitive, for example, but these are matters of detail that do not appear especially problematic.

The real interest of the proposals in “Remarks,” however, is not in the gerundives, but rather in the phrases headed by derived nominals. On the account being considered, these are always nouns from the point of view of

the syntax, and so phrases headed by them have all and only the structure associated with NPs. The important difference is between lexical and syntactic formation of phrases that fill NP positions. To implement this, however, it is necessary to have not only basic verbs but also the derived nominals available in the lexicon to fill positions in syntactic structure. To that end, we need to assume that the lexicon contains rules of the sort briefly envisioned in *Aspects*, rules that perform a (perhaps limited) amount of internal computation to capture relations such as those between verbs and their associated derived nominals.

Localizing the formation of derived nominals in the lexicon, rather than in the syntax, provides a clear path to the registration of the idiosyncrasies of individual forms. Allowing for similar computations in the lexicon also helps us avoid a set of problems with the formation of compounds as this was envisioned in Lees (1960). In that account, the formation of compounds like *snowman*, *garbageman*, *mailman*, and so on is based on sentential sources (*the man is made of snow*, *the man takes away the garbage*, *the man brings the mail*, etc.). This formation, however, necessarily involves the deletion of semantically significant material, in the context of an extremely rich theory of transformational operations. Not producing such compounds in the syntax helps us avoid the unrecoverable deletions involved on the earlier analysis, thus contributing to the overall program of simplifying and constraining the theory, a central theme in Chomsky (1964, 1965, 1973 and subsequent work).

Now while the literal content of Chomsky's paper was quite modest (its central point was merely a proposal for a particular analytic decision in English), it gave credibility to the idea that there are really two entirely separate **classes** of rules: lexical rules, which relate lexical items to one another and govern their internal structure, and syntactic rules, which compose and relate phrasal structures. Having argued for this result, Chomsky (1970) has little to say about the specific form lexical rules should take. Others such as Jackendoff (1975) and Aronoff (1976) would subsequently pursue these matters in more detail, in ways that eventually gave rise to a rebirth of interest in strictly morphological issues in grammatical theory.

The consequences of distinguishing lexical rules from syntax *sensu stricto* were explored in a number of publications in the years following the appearance of "Remarks." These included Wasow (1977) and Anderson (1977), who derived a number of conclusions from the basic character of the distinction: to wit, lexical rules relate lexical items, and so in principle these operate on the basis of (all and only) the information present in a lexical entry. Syntactic rules, in contrast, operate over full syntactic representations, and so have access to information beyond the content of a single word, but on the other hand there is no reason to believe that they can access information concerning a lexical item apart from the content of the terminal node (complex symbol) with which it has been associated through lexical insertion. This suggests a number of differences in the ways the two sorts of rule operate:

- Lexical rules must be *structure preserving*, because both the basic and derived lexical items must fall within the same range of structures, those permitted by the lexicon of the language. Syntactic rules, in contrast, can perform adjunctions and thus create new structures not generated by the rules of the base (subject to other constraints).
- Lexical rules (and perhaps certain instances of “Merge” like $F_{\text{GERUNDIVE}}$) can *change category*, while there is no reason to believe that any such operation takes place within the syntax otherwise. Note that we would lose this result if we allowed the syntax to analyze and move affixes, treating them as lexical category heads (perhaps leading possibilities such as *John detests inflation* $\rightarrow$ **John('s) detestation inflate*).
- Lexical rules are necessarily *local* to the subcategorization frame of a lexical item. Syntactic rules are subject to a different notion of locality. Similarly, syntactic rules but not lexical ones can refer to A-bar positions, since the latter are by definition not sub-categorized and thus not mentioned in lexical entries.
- Lexical rules can see (and thus be sensitive to) the concrete *semantic* (or ‘ θ ’) roles assigned to particular arguments. There is no reason to believe this is true in the syntax: at most it is possible to argue that every argument expression must receive *some* θ -role, but that does not imply access or sensitivity to *which* such role a given argument bears.
- Lexical rules all have to *apply first*, “before” any of the syntax. Since lexical items are inserted into phrase markers, such rules cannot be fed by syntactic operations.
- Syntax is *structurally general* and productive, while the lexicon is preeminently the locus of idiosyncrasy and exceptionality.

The thrust of this, then, is that there seems to be a principled difference between the structural principles at work within words *versus* those that organize words into larger structures. This observation led to the emergence of the approach to syntax (and morphology) known as “Lexicalism,” grounded in the distinction between lexical processes relating words to one another and syntactic processes relating phrase markers. A number of variants of the basic underlying principle have been explored, discussion of which would go well beyond the present article’s historical concerns. One fairly restrictive formulation is the **Lexical Integrity Hypothesis**, according to which the syntax neither manipulates nor has access to the internal form of words. On this view the only way the syntax can affect the form of a word is through manipulation of the complex symbol with which lexical insertion has associated it, while the only aspects of a word’s structure that are accessible to the syntax are those reflected in the featural content of that complex symbol.

The Lexical Integrity Hypothesis as described in the preceding paragraph is one way of working out the program implicit in “Remarks”; others are described and discussed in a review article by Lieber and Scalise (2006),

which also summarizes various sorts of evidence which they feel might compromise this in its strong form.

5 Conclusion

The lexicalist theory of “Remarks” provided the basis for the development of X-bar theory (Jackendoff 1977), a notion that occupied linguists for some time in the 1970s and 1980s. The principal immediate impact of the paper was in its implications for phrasal structures rather than morphology, although work such as that of Selkirk (1982) developed extensions of $\bar{X}$ -theory to the internal structure of words.

In terms of the scope of this chapter, however, the class of theories properly called “Transformational Grammar” began to be supplanted by the mid-1970s by theories that progressively abandoned the construction-specific rules called transformations. This development is visible already in Chomsky (1973), where properties common to a number of such rules are abstracted from them. While the syntactic assumptions of “Remarks” have been largely superseded in subsequent years, the morphological issues that paper raises remain the subject of much lively discussion.

There is very little of morphological interest to be found in the syntactic literature of the 1970s, but by the early 1980s, syntactic analyses focusing on functional categories had begun to restore inflectional properties to their earlier status as syntactically autonomous elements—indeed, structural heads, each projecting layers of structure similar to those associated with basic lexical categories. Combined with the rise of Distributed Morphology (Halle and Marantz 1993), a view of word structure more popular with syntacticians than with morphologists, the result at the time of writing is a view of the syntax-morphology relation based on the syntactic primacy of morphemes of a rather traditional sort, overall rather like the picture presented in *The Logical Structure of Linguistic Theory* (Chomsky 1985). This reversion to an earlier view, without significant attention to the earlier arguments that suggested its inadequacy, has taken place in the syntactic literature despite the fact that many morphologists have pursued quite a different picture. But I leave the description of these post-transformational developments to others to recount.

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Morphology in Constraint-based Lexicalist Approaches to Grammar

Olivier Bonami and Berthold Crysmann

1 Introduction

1.1 Defining the Terms

The term “constraint-based lexicalism” (CBL) was coined in the mid-1990s to denote a set of linguistic theories sharing two main design properties:¹

Strong lexicalism Morphology and syntax are separate dimensions of language, modeled by discrete components of a theory of grammar. The *word* is the interface between morphology and syntax: words are atoms of syntactic description, while morphology describes relations between words and/or relations between words and more abstract lexical entities (roots, stems, lexemes, affixes, morphophonological processes, etc.).

Constraint-based architecture A grammar is best stated as a set of constraints on possible linguistic objects. As in all formal theories of grammar, utterances and other linguistic objects are modeled by mathematical structures. What sets apart constraint-based theories is the use of a description logic (or set of such description logics) whose model theory makes explicit under what conditions a grammatical constraint is satisfied by a model.

Two immediate terminological clarifications are in order. First, one should not confuse **lexicalist theories of grammar** with **lexical theories of morphology**. While laying out a typology of morphological frameworks, Stump (2001) makes a distinction between **lexical** and **inferential** approaches. In a **lexical** approach, affixes are licensed by a lexicon of bound morphemes, whereas in an **inferential** approach they are licensed by syn-categorematic rules. Stump’s distinction says nothing about the relation

¹ The term was also used in psycholinguistics to denote approaches to sentence processing (e.g., Trueswell and Tanenhaus 1994) that attribute central roles to lexical information and incremental processing in multiple dimensions.

between morphology and syntax—and indeed, non-lexicalist theories of grammar are usually lexical in their approach to morphology.

Second, in phonology, the term “constraint-based” is used in quite a different fashion, and characterizes the family of approaches, such as Optimality Theory (Prince and Smolensky 1993) and Harmonic Grammar (Smolensky and Legendre 2006), that rely on constraint competition rather than rule conspiracies to derive surface forms from underlying representations. The difference between this usage of “constraint-based” and the one relevant here cannot be overstated. First, within constraint-based lexicalist approaches, the logic of constraint interaction is based on conjunction rather than competition: any well-formed linguistic object has to satisfy simultaneously all constraints on objects of that type. By contrast, in Optimality Theory and related frameworks, output representations explicitly do not have to satisfy all constraints, and deciding which constraints have to be satisfied is the main analytic device. Second, constraint-based lexicalist approaches focus much attention on the precise formalization of constraints and thus on the exact structural properties of models of linguistic reality. Most work in Optimality Theory and related frameworks takes the precise formulation of constraints as unimportant, and focuses instead on the elaboration of the meta-theory of constraint interaction. While it is entirely possible to combine an optimality-theoretic approach to phonology with a lexicalist constraint-based approach to morphology (see, e.g., Orgun 1996)—and there have been important proposals for using constraint competition to address morphological issues (e.g., Aronoff and Xu 2010; Ryan 2010; Round 2013)—these two research traditions have developed largely independently of each other, and rely on very different intuitions on the adequate design of linguistic frameworks.

The two main contemporary theories that embrace both lexicalism and constraint-based architecture are **Lexical Functional Grammar** or LFG (Bresnan 1982) and **Head-driven Phrase Structure Grammar** or HPSG (Pollard and Sag 1987, 1994).² In this, they contrast strongly with mainstream generative grammar, including most versions of Government and Binding Theory, the Minimalist Program, and Distributed Morphology, which are neither lexicalist nor constraint-based.³

1.2 Morphological Analysis in CBL Frameworks

The hypothesis of strong lexicalism has put the focus of much work in CBL frameworks on the interface between morphology and syntax, with two

² LFG and HPSG also fall within the set of “non-transformational” or “surface-based” approaches (see Borsley and Börjars 2011 for a recent overview), along with, among others, **Tree Adjoining Grammar** and **Categorial Grammar**; however, the most popular formulations of these frameworks are not constraint-based. We will not devote much attention to the “surface-based” nature of the frameworks under consideration, as this is of little consequence to the modeling of morphology.

³ Of course the two properties are independent of one another. Most versions of Categorial Grammar are lexicalist but not constraint-based, relying on a proof-theoretic rather than model-theoretic approach to the modeling of syntactic relations. On the other hand, some model-theoretic approaches to syntax fall in the constraint-based camp without being lexicalist, such as the model-theoretic interpretation of Government and Binding Theory in Rogers (1998).

main areas of research. On the one hand, research on the relation between featural representations in syntax and morphology has focused on case stacking (Nordlinger 1998; Malouf 2000; Sadler and Nordlinger 2004), deponency (Vincent and Börjars 1996; Sadler and Spencer 2001), agreement features (Pollard and Sag 1994; Kathol 1999; Wechsler and Zlatić 2003), and syncretism (Ingria 1990; Dalrymple and Kaplan 2000; Daniels 2002; Levy and Pollard 2002; Sag 2003; Crysmann 2009; Dalrymple et al. 2009). On the other hand, much attention has been devoted to linguistic phenomena presenting apparent challenges to strong lexicalism, including pronominal affixes or clitics (Miller 1992; Miller and Sag 1997; Monachesi 1999 2000; Penn 1999; Crysmann 2003a, 2003b; Bonami and Boyé 2007; Samvelian and Tseng 2010), portmanteau elements (Bender and Sag 2000; Wescoat 2002; Abeillé et al. 2003; Wescoat 2007), particle verbs (Ackerman and Webelhuth 1998; Kathol 2000; Müller 2003), and discontinuous affixation (Borsley 1999; Kupść and Tseng 2005; Crysmann 1999, 2010a, 2010b; Broadwell 2008; Fokkens et al. 2009). Periphrastic realisation of tense, aspect, and mood has been a topic of much attention, with a clear contrast between reductionist approaches that treat the relation between auxiliary and main verb as purely syntactic (Hinrichs and Nakazawa 1989; Bresnan 2001; Abeillé and Godard 2002; Müller 2002; Frank and Zaenen 2004) and the line of research initiated by Vincent and Börjars (1996) and Ackerman and Webelhuth (1998) which attempts to address paradigmatic aspects of periphrasis within a lexicalist framework (Sadler and Spencer 2001; Ackerman et al. 2011; Bonami and Samvelian 2009, 2015; Bonami 2015).

Although a hypothesis about morphology is at the heart of the CBL view of grammar, it is striking that relatively little attention has been devoted within extant CBL theories to the modeling of morphology proper. Bresnan's (1982) celebrated lexical analysis of the English passive set the tone for much of the subsequent literature: while the paper provides strong arguments in favor of a morphological analysis of the English passive, and lays out consequences of that analysis for morphological theory, it contributes very little (pp. 17–19) in terms of concrete morphological analysis. The extensive literature on refinements of and alternatives to the Passive Lexical Rule over the next three decades (see among many others Pollard and Sag 1987; Kathol 1994; Ackerman and Webelhuth 1998; Bresnan 2001; Müller 2002; Sag et al. 2003) makes little progress in the strictly morphological area. In this paper, we will focus on that sub-part of the CBL literature that deals with morphology itself.

The constraint-based lexicalist view of grammar entails few commitments as to the architecture of morphology, except for the commitment to lexicalism itself. In this context, it is telling that all of the three modes of morphological description envisioned by Hockett (1954) have been used by some authors. In LFG, an Item and Arrangement approach has been consistently consensual throughout the history of the framework, notably adopted in influential work such as Simpson (1991), Bresnan and

Mchombo (1995), Nordlinger (1998), and Bresnan (2001). More recently, Sadler and Nordlinger (2004, 2006) explicitly interface a Paradigm Function Morphology approach (a variety of Word and Paradigm morphology) with an LFG grammar. Item and Arrangement approaches have been less prominent within HPSG: Krieger et al. (1993) defend such an approach for derivation, explicitly building morphological tree structures analogous to syntactic phrase structure. However, their approach was quickly criticized by Koenig (1994, 1999) and Riehemann (1993, 1998), who defend instead an Item and Process approach, insisting that words have recursive structure but affixes are not signs. This has become the standard approach for derivation, and is adopted, with minor variation, in publications such as Müller (2003), Bonami and Boyé (2006), or Sag (2012). For inflection, two tendencies may be observed. On the one hand, many publications assume that the same kind of Item and Process view relevant to derivation also applies—see among others Koenig (1999), Sag et al. (2003), Goodman and Bender (2010). On the other hand, following initial insights from Pollard and Sag (1987: 213), many studies advocate the adoption of a Word and Paradigm approach to inflection (Krieger et al. 1993; Erjavec 1994; Bonami and Boyé 2002; Crysmann 2003b; Sag 2012; Crysmann and Bonami 2016).

1.3 Two Contrasting Architectures

LFG and HPSG belong to the class of “feature-based” or “unification-based” grammars, in which recursive feature structures and feature structure unification play a central role in modeling aspects of grammar. Despite this shared central property, however, these two frameworks are characterized by important architectural differences that do have a direct bearing on their approach to morphology.

The most distinguishing property of LFG is a multi-modular projection architecture where different modules of linguistic organization (constituent structure, functional structure, semantics, etc.) are handled by theories couched in different formalisms: context-free rewrite systems for constituency, a unification formalism for functional structure (including valency, case, and agreement), and, for example, linear logic for semantic structure. With respect to morphology and the lexicon, we observe a similar picture (i.e., a preference for distinct module-specific formalisms): in addition to finite-state approaches to morphology (Koskenniemi 1983; Karttunen et al. 1992; Kaplan and Kay 1994), which are somewhat predominant, Sadler and Nordlinger (2004, 2006) have argued for embedding Paradigm-function Morphology as a morphological module in the LFG architecture. Generalizations in the lexicon are typically captured using lexical rules. Grammars implemented on the XLE grammar engineering platform (Maxwell III and Kaplan 1993) additionally make use of macros in order to reuse information across classes of lexical entries. Thus, the choice of a particular formalism on the syntactic side does not have any

direct influence on the choice of formalism or theory in morphology, in line with the overall spirit of LFG's projection architecture.

Turning to HPSG, an entirely different picture emerges: in contrast to LFG, no formal distinction is drawn between constituent structure and functional structure. Instead, all aspects of syntax are equally represented as (typed) feature structures. This fundamental property, namely the use of a single formalism to express different linguistic sub-theories, receives the status of an architectural leitmotif: although different semantic theories have been integrated into HPSG over the years (Situation Semantics (Barwise and Perry 1983; Pollard and Sag 1994), UDRT (Reyle 1993; Frank and Reyle 1995), MRS (Copestake et al. 2005) or Montagovian Semantics (Richter and Sailer 2003)), all of them are represented in terms of typed feature structures. Similar observations can be made for other grammatical modules, as diverse as information structure (Engdahl and Vallduví 1994) or phonology (Bird and Klein 1994). Given this overall approach of using a single formalism, a typed feature logic, to express different linguistic sub-theories, the way in which generalizations over lexical and morphological knowledge are captured is intimately linked to the way shared properties are abstracted out in other parts of the grammar, namely underspecification in feature structure inheritance hierarchies. Given the lexicalist nature of the framework, most of this work took its starting point in the lexicon (Flickinger 1987), to be generalized to syntax (Sag 1997), semantics (Ginzburg and Sag 2000), and morphology (Krieger 1994; Riehemann 1998; Koenig 1999; Crysmann and Bonami 2016).

This contrast between the LFG and HPSG architectures clearly entails a different attitude towards morphology: HPSG, but not LFG, is committed to a tight integration of morphological with phonological, syntactic, and semantic description. This perhaps explains the comparatively larger HPSG literature on morphology, which attempts to redeploy analytic techniques of underspecification, monotonic constraint interaction, and rich ontologies that have been instrumental to the success of the framework in other areas of grammar: LFG morphology tends to take the form of some preexisting approach to morphology interfaced with LFG. This also entails that there are fewer commonalities between the two frameworks in the domain of morphology than there are in the area of key syntactic phenomena such as valence alternations, control, or extraction. Rather than presenting two parallel lines of research, the present chapter will focus mainly on the HPSG literature on morphology. We refer the reader to Nordlinger and Sadler (forthcoming) for an overview of work on morphology in LFG.

2 Generalization in the Lexicon

2.1 Feature Structures and Underspecification

Across a number of grammatical frameworks, features are employed to represent properties of linguistic entities, permitting generalization over

individual properties, thereby responding to the granularity problem associated with the labels of pure context-free grammars. What sets LFG and HPSG apart from other mainstream Generative Grammar is their use of feature *structures*, in contradistinction to mere feature bundles, and the privileged status they assign to unification as the primary operation on these structures.

Feature structures, as used in HPSG, extend the basic formalism with the introduction of types: in typed feature structures, every value is a type, defined by a type signature—that is, an ontology of admissible (linguistic) objects. The type signature defines not only which types exist, but also the subsumption relations between these types. For atomic values, the use of types allows natural classes of values to be represented in terms of sort hierarchies, as shown in Figure 22.1. These sortal hierarchies serve the further purpose of providing abstractions of subclasses suitable for under-specified descriptions. Since subsumption hierarchies are semi-lattices (not just trees), so are type hierarchies: in essence, it becomes possible to define cross-classifying sortal hierarchies, where a particular type may be defined as the subtype of two (or more) supertypes, like *acc* in Figure 22.1.

HPSG typed feature structures extend the concept of a hierarchy of values from atomic to complex feature structures (see Kasper and Rounds (1986), King (1989), Carpenter (1992), and Richter (2000) on the formal foundations of typed feature structures). Thus, classes of linguistic objects with properties represented as features can also be organized into type hierarchies. The concept of typed complex feature structures is exploited in several ways. First, just like atomic sorts, complex types are organized into a hierarchy of types, representing an ontology of (linguistic) objects with properties. Still parallel to atomic sorts, this hierarchy of types defines which types are compatible with each other. Second, complex types declare which features they introduce, together with their values, such that only those features are licit which are appropriate for this type. The appropriateness condition thus makes it possible to infer not only the features for any given type, but also the maximal type for any feature. Furthermore, since every super-type in a type hierarchy represents a more general class than its subtypes, it must naturally subsume its subtypes, so the logic of typed feature

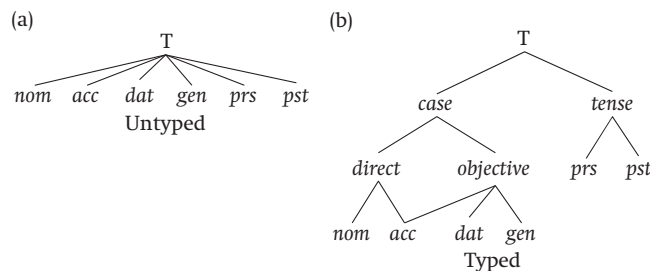


Figure 22.1. Hierarchies of atomic values in typed and untyped feature formalisms

structures is set up in such a way that any property asserted for a supertype must also hold for its subtypes. As a consequence, subtypes inherit all the properties that hold true of their supertype.

2.2 Inheritance Hierarchies (Vertical Redundancy)

A basic assumption of constraint-based lexicalism is that rich lexical descriptions provide many of the constraints that a word puts on its syntactic context. This places a certain burden on the lexical component. Thus, a rich and articulate lexicon must be matched with powerful mechanisms to eliminate redundancy. Within HPSG, the concept of typed feature structures has been exploited from early on to represent lexical knowledge in terms of structured ontologies.

The expression of generalizations in the lexicon is intimately linked to the elimination of redundancy. The task of eliminating redundancy from lexical description can be broken down into two complementary sub-tasks (Pollard and Sag 1987): so-called vertical redundancy, which relates to information shared by different (lexical) descriptions, and horizontal redundancy, which arises by virtue of systematic alternations observed for classes of descriptions.

Classificational devices such as type hierarchies are very good at eliminating vertical redundancy by means of class abstraction and inheritance: consider, for example, the class of transitive verbs that make up the bulk of the lexical entries for verbs in the lexicon of many languages. Instead of stating over and over again the characteristic properties of transitives for each instance, these properties can be assigned to a superclass to be inherited by each of its subtypes. Using cross-classification, more and more abstract generalizations can be expressed, for example to facilitate generalization of certain properties, like valency across major lexical classes, for example from verbs to prepositions (e.g., French *dans* ‘in’ vs. *dedans* ‘inside’), as illustrated in Figure 22.2.⁴

While successful at the task of eliminating vertical redundancy, static type hierarchies by themselves prove a blunt tool when confronted with horizontal redundancy. To illustrate the problem, let us consider the case of passives: horizontal redundancy does not involve what information is shared, but rather what information changes in systematic ways. While

⁴ HPSG uses a rich and evolving feature geometry which can be baffling at times to the casual observer. For the purposes of this paper we have aimed at standardizing the geometry, following mostly conventions from Sag et al. (2003), except when citing verbatim a published analysis. The following abbreviations are used in feature names: ACT: actor; AFF: affixes; AGR: agreement; CAT: syntactic category; COMPS: list of complements; CON: list of consonants; EVT: eventuality; IND: semantic index; M-DTRS: morphological daughters; MPH: set of morphs; MS: morphosyntactic property set; μ -FEAT: morphological features; MUD: morphology under discussion; NEG: negation; PC: position class index; PH: phonology; PREF: list of prefixes; RESTR: set of restrictions; RR: set of realization rules; SEM: semantics; SKEL: phonological skeleton; SL: supralaryngeal; SOA: state of affairs; SUBJ: subject; TNS: tense; UND: undergoer; VAL: valence; VOW: list of vowels.

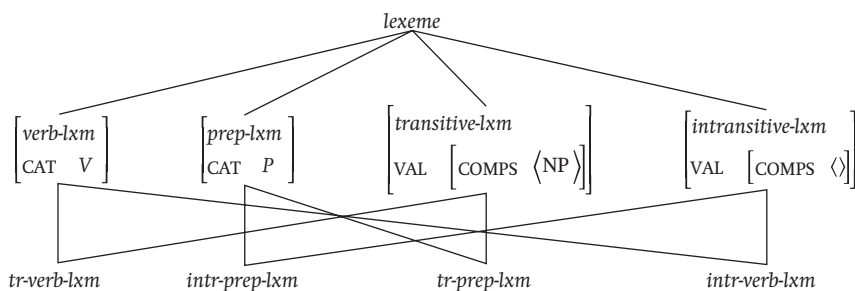


Figure 22.2. Cross-classification of category and valence properties

static type hierarchies *per se* may serve to generalize separately the properties of active and passive verbs, when taken in isolation they will fail to relate the class of active verbs to that of the corresponding passive ones.

From the viewpoint of morphology, classificational systems may go some way to abstract out shared properties of, for example, forms in a paradigm, both across all the cells of a single lexeme and across analogous cells of different lexemes. Owing to the static nature of such ontologies, however, each and every cell still needs to be listed, together with all its subtype relations. In other words, what is clearly missing is a generative device that would turn these static ontologies into dynamic ones.

2.3 Lexical Rules (Horizontal Redundancy)

Lexical rules have been the traditional device to attack the issue of horizontal redundancy in lexicalist theories, like LFG and HPSG. Despite the common name, the different concepts of lexical rules can be broken down along two binary oppositions: generative versus redundancy rules and meta-level versus description-level rules. Let us start with the rather well-known first distinction: while a redundancy rule interpretation may suffice to capture lexical relatedness, it does not reduce the size of the lexicon, at least when measured in terms of the number of lexical entries. Generative lexical rules, by contrast, do permit reduction of the lexicon, but, conversely, will not be sufficient by themselves to account for cases of limited productivity. Within LFG and HPSG, lexical rules are most commonly understood as being of the generative, rather than the redundancy, type.

The second distinction pertains to the status of such rules with respect to the general linguistic ontology: are they meta-statements that either generalize relationships between independently established lexical entries or serve to generate an extended lexicon from a basic one, or are they rather descriptions of possible lexical entities themselves? Traditionally, lexical rules in constraint-based lexicalism were of the former kind (Bresnan 1982; Pollard and Sag 1987, 1994).

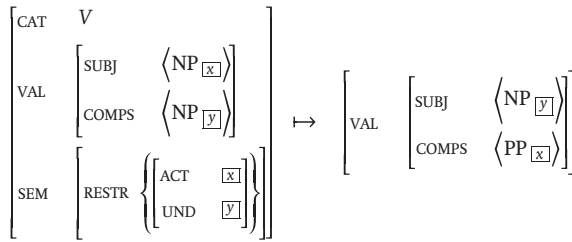


Figure 22.3. A sample passive lexical rule

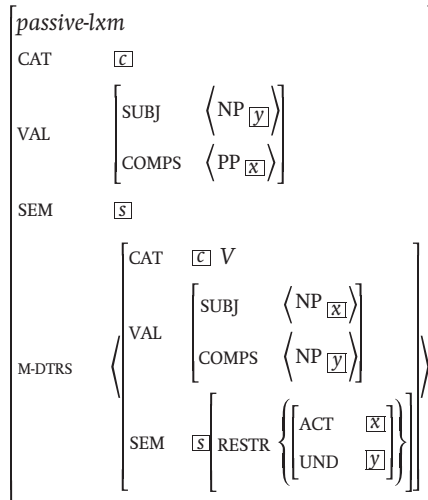


Figure 22.4. Passive lexical rule as underspecified description of lexemes

Within HPSG, consensus has clearly moved toward a description-level interpretation, regarding lexical rules as part of the lexicon itself (see, e.g., Meurers 2002). Possibly the most straightforward description-level representation of lexical rules is that of a unary rule where the outer feature structure corresponds to the derived lexical entry, whereas the inner feature structure corresponding to the base is embedded under a feature which we will call here *M-DTRS* (morphological daughters). Meurers (2002) provides a method that automatically expands the traditional format shown in Figure 22.3, where unmentioned features are assumed to be carried over, into a description-level format similar to the one in Figure 22.4 where identities are made fully explicit.

When represented like this, lexical rules are themselves nothing but typed feature structures, and thus become amenable to the kind of class abstraction offered by typed feature formalisms.

We shall see some practical application to morphology in the following sections. This move parallels similar developments in HPSG syntax (Sag 1997; Ginzburg and Sag 2000), where phrase structure rules are equally organized into type hierarchies, ultimately providing a formal interpretation of constructions.

2.4 Online Type Construction

An entirely different tack on solving the issue of horizontal redundancy in static lexical type hierarchies has been pursued by Koenig (Koenig and Jurafsky 1994; Koenig 1999): instead of relying on an external device such as lexical rules, he identifies the static, closed world nature of lexical type hierarchies as the source of the problem and argues for a conception of lexical type hierarchies as a generative device.

In essence, Koenig achieves this by means of two fundamental assumptions: first, he suggests that types in lexical hierarchies do not directly license lexeme categories, but that lexeme categories are instead inferable maximally specific (leaf) types. Second, he organizes the type hierarchy into (conjunctive) dimensions. Well-formed lexeme categories are then obtained by inheritance from exactly one leaf type in every dimension, under unification. Leaf types within each dimension are disjunctive, and thus define the available lexical alternations. The system of conjunctive dimensions then ensures that every well-formed lexical category is defined with respect to these alternations. Let us illustrate the workings of online type construction using a simplified version of the active/passive alternation: as detailed in Figure 22.5,⁵ crucial aspects of passive and active are abstracted out into separate underspecified lexeme types. Most crucially, lexical types capturing valence information (active vs. passive) are represented in a dimension distinct from the roots. In our example this is mostly the linking pattern for arguments. By way of systematic intersection of leaf types from each dimension of the minimal underspecified hierarchy (solid lines, white background), the full set of well-formed lexeme categories is derived (dashed lines, grey background). Thus elimination of horizontal redundancy is essentially reduced to dynamic cross-classification.

A particularly compelling property of online type construction is the integration of regular productive alternations (lexical or morphological) with exceptions, irregularities, and subregularities. The key to this integration is pre-typing: while regular alternations will be characterized by online type construction, nothing prevents us from pre-assigning exceptionally non-alternating items to a particular type in the relevant dimensions. For illustration, we shall have a look at exceptions to the active/passive alternation, in particular lexical *have* which happens not to passivize, despite having a suitable argument structure. Consider the partial lexical type hierarchy in Figure 22.6: contrary to lexemes such as *love*, *have* is not only a type in the ROOT dimension of the minimal hierarchy, but it is also pre-linked to a valence type, viz. *trans*. Since well-formed lexeme categories must be a subtype of exactly one type from each dimension, pre-linking trivially fulfills this requirement for the relevant dimensions. Moreover, since the leaf type for *have* already inherits from a type in the VALENCE

⁵ This is a didactic version of Koenig's account of valence alternation, leaving out a lot of detail and linguistic generalizations

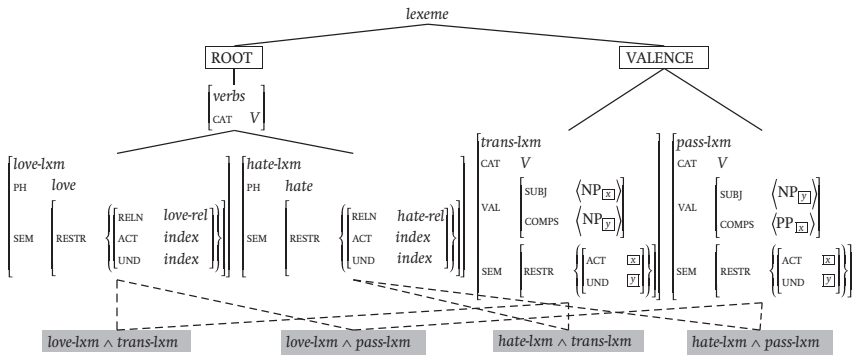


Figure 22.5. Online type construction

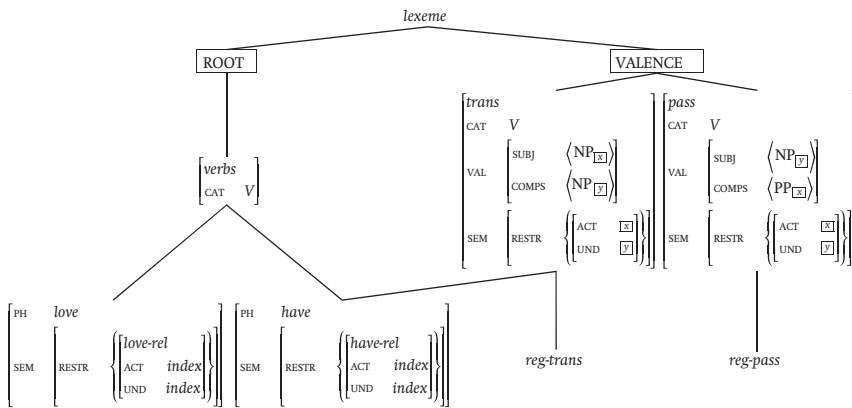


Figure 22.6. Exceptions via pre-typing

dimension, alternation is effectively blocked, given that types within a dimension are disjoint. Verbs undergoing regular alternation, by contrast, are still captured, since they can freely intersect with the “open” subtypes for active and passive valencies.

The distinction between free online type construction (under unification) and pre-typing serves a very general role in Koenig’s theory of the hierarchical lexicon. He draws a systematic distinction between regular productive classes, which are intensionally described by reference to properties alone, and sub-regular and irregular classes, which are extensionally defined (i.e., by enumerating class members). Still, common properties of sub-regular patterns can be abstracted out vertically into the supertype. For example, the sub-regular pattern of verb inflection witnessed by *ring* ~ *rang* will have all its members listed as subtypes, while capturing the systematicity of the unproductive pattern as a partial phonological description on the supertype. In a sense, supertypes in extensionally defined classes work like redundancy rules, whereas open types for intensionally defined classes work like generative rules.

Although they both address aspects of horizontal redundancy, online type construction and (description-level) lexical rules are not incompatible analytic devices: in fact Koenig (1999) explicitly argues for using a combination of both.⁶ This is most useful in the modeling of lexeme formation, as we will see in the next section.

3 Morphology in CBL Approaches

3.1 Lexeme Formation

3.1.1 Lexeme Formation Processes in the Hierarchical Lexicon

The success of inheritance hierarchies in capturing generalizations and avoiding redundancy in the lexicon promptly led to the idea of using hierarchical classification to address productive lexeme formation. After an initial proposal by Krieger et al. (1993) to introduce derivational affixes as such in lexical hierarchies, Riehemann (1993, 1998) and Koenig (1994, 1999) independently proposed an architecture that came to be adopted in most subsequent work on lexeme formation in HPSG. We illustrate this by presenting a simplified analysis of *-able* adjectives in French, directly inspired by the analysis of German *-bar* adjectives in Riehemann (1998).⁷

As already stated in Section 2.3, in recent versions of HPSG, lexical rules, and in particular lexeme formation rules, are seen as underspecified lexical entries with an open slot for a morphological base. This is best introduced through an example. Figure 22.7a is a possible lexical entry for the verb *laver* ‘wash,’ specifying its phonology /lav/, its category as that of a verb, its valence as transitive (i.e., as taking two NP arguments) and its semantics as a ternary relation between an event and the two entities denoted by the two NPs.⁸

Figure 22.7b is a reasonable enough lexical entry for the adjective *lavable* ‘washable’ in the same format. The rough semantic characterization is intended to capture the idea that *lavable* denotes the class of objects *y* such that for most events *e* and agents *x*, it is possible for *x* to wash *y* in *e*.

The lexical rule relating *laver* to *lavable* can then be recast as an underspecified lexical entry for an adjective, capturing what is common to regular *-able* adjectives, and relating their properties to that of their base

⁶ The necessity of lexical rules is motivated by the recursive character of derivational morphology which is beyond the expressive power of type hierarchies, as pointed out by Krieger (1996) on the basis of German examples like *vor-vor-vor-gestern* ‘before-before-before-yesterday (=4 days back).’ For non-recursive inflectional morphology, by contrast, the motivation for lexical rules is greatly reduced.

⁷ See Hathout et al. (2003) for a thorough description of the system of French *-able* adjectives. Although we sketch only a small subpart of the system, the data uncovered by Hathout et al. as a whole lends itself straightforwardly to the type of analysis illustrated here.

⁸ For simplicity and readability we adopt semantic representations in the style of Sag et al. (2003), and leave all quantificational aspects of semantic representations implicit. Nothing hinges on this presentational convenience.

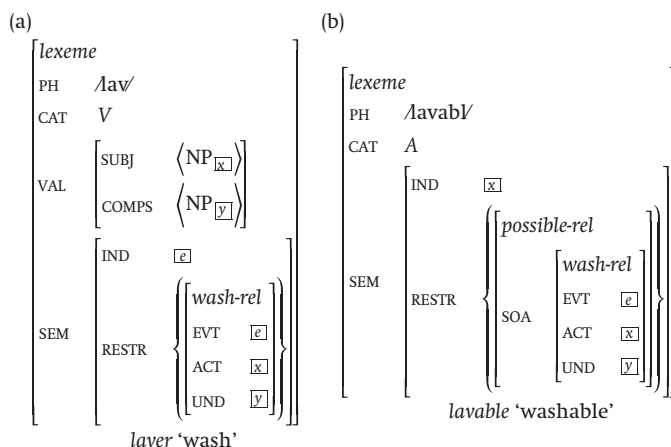


Figure 22.7. Sample entries of a French verb and its corresponding *-able* adjective

through the dedicated attribute *M-DTRS*, whose value is a partial description of the base.⁹

This is sketched in Figure 22.8. This schematic lexical entry is satisfied whenever one can find a transitive verb with phonology [1] expressing an agentive relation *R*, and specifies that to this verb corresponds an adjective with phonology [1] + /abl/ and appropriate semantics. The important point to note is that Figure 22.8 has exactly the same formal status as the descriptions in Figure 22.7: it is just a partial description of a set of lexemes, which happens to be strongly underspecified. Note that under this conception, lexeme formation rules are essentially indistinguishable from the constructional schemata later to be popularized by Booij (2010).

The striking advantage of modeling lexeme formation rules as underspecified lexical entries is that it allows one to capture simultaneously the productive nature of lexeme formation, the existence of lexicalized exceptions to the productive rule, and the commonalities between strict adherents to the productive rule and other cases. This can be done by carefully integrating productive rules in a lexical sub-hierarchy of *-able* adjectives. Consider the partial hierarchy in Figure 22.9, which is intended as a sub-part of a full hierarchical representation of the French lexicon.

This hierarchy groups together all adjectives that are perceived to belong to the class of *-able* adjectives, even where they exhibit an idiosyncratic semantic (*adorable* 'adorable,' meaning 'that should be adored' rather than 'that could be adored') or semantic (*fiable* 'reliable' based on a verb with an

⁹ Technically, *M-DTRS* is list-valued, to accommodate for the possibility of multiple bases in the case of compounding.

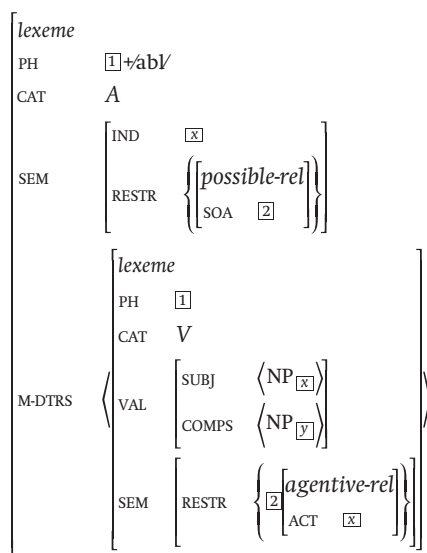


Figure 22.8. Lexical entry for *lavable* 'washable'

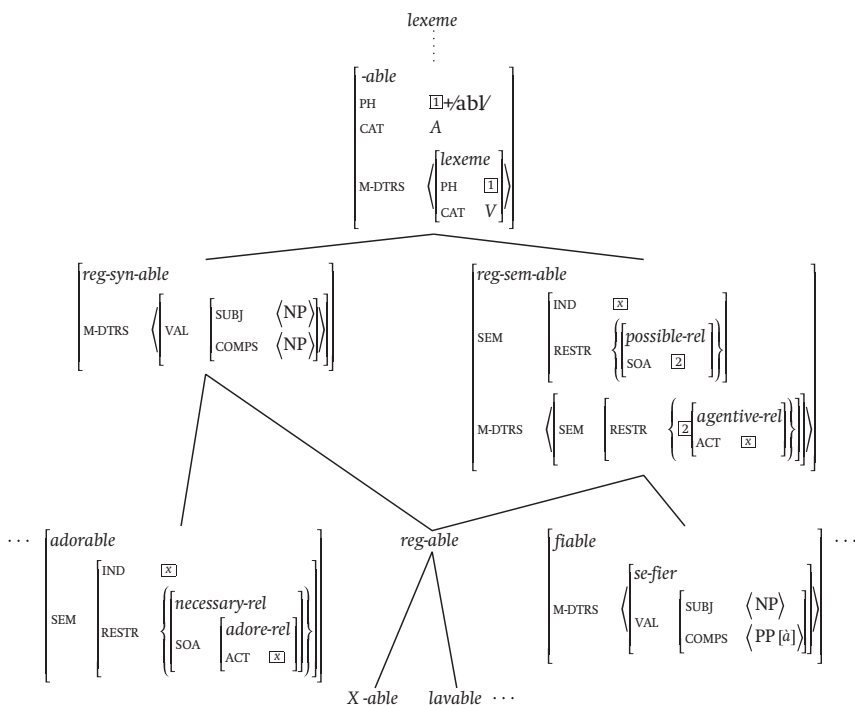


Figure 22.9. A partial hierarchy of French *-able* adjectives

indirect rather than direct object) relation to their base. Thus, as indicated in Figure 22.9, the only thing that is common to members of the *-able* type are the category and phonology alternations. Appropriate generalizations on syntax and semantics can be captured by the subtypes *reg-syn-able* and

reg-sem-able, while still allowing for the possibility of lexically listed exceptions to these generalizations for cases like *adorable* and *fiable*.

Fully regular *-able* adjectives belong to the type *reg-able*, and hence inherit both from regular syntax and semantics; in effect, *reg-able* is associated by inheritance with the constraint in Figure 22.8.

An appealing feature of the present approach is that it is agnostic as to the listing of redundant lexical information. Although not strictly necessary to attain descriptive adequacy, it is entirely possible to list explicitly particular instantiations of a lexeme formation rule, as this is done for *lavable* in Figure 22.9. This fits well with the observation that speakers do memorize frequent, yet predictable words (see, e.g., Bertram et al. 2000), but that what is redundantly lexicalized may vary from speaker to speaker.

Another appealing property of the approach is that it easily scales up to more complex systems of morphological relationships. Consider the existence of a nonproductive subclass of *-ible* adjectives sharing the same syntactic and semantic conditions as *-able* adjectives. Some adjectives (e.g., *divisible* ‘divisible’ based on *diviser* ‘divide,’ *exigible* ‘due’ based on *exiger* ‘require’) are formed just like *-able* adjectives, the only difference being vowel quality. Some others (e.g., *prédicible* ‘predictable,’ *audible* ‘audible’) are based on a learned root but are still arguably related to some contemporary French verb (*prédire* ‘predict,’ *ouïr* ‘hear’). Still others may fail to entertain a morphological relationship to any verb at all (*plausible* ‘plausible,’ *tangible* ‘tangible’). This situation can be captured using an enriched hierarchy and multiple inheritance, as indicated in Figure 22.10.

In this particular hierarchy, the type *-ble* just constrains its instances to be adjectives with phonology ending in /bl/. Types in the VOW dimension introduce different choices for the preceding vowel. Types in the other three dimensions specify the relationship of the adjective to its base, respectively in terms of phonology, syntax, and semantics. Each of these three dimensions contains a *regular* subtype stating the expected, normal situation; exceptions are pre-linked to the top of the dimension. It should be transparent how the constraints from the previous hierarchy in Figure 22.9 need to be redistributed on types *-ble*, *-able*, *reg-phon*, *reg-syn*, and *reg-sem*. The

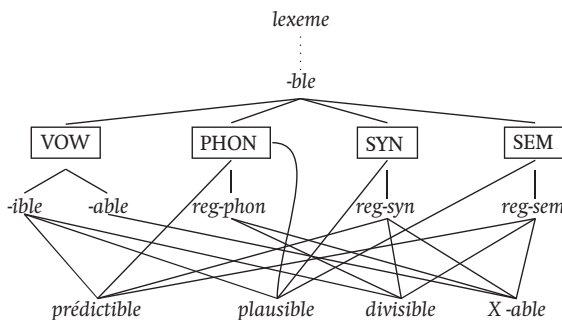


Figure 22.10. A joint partial hierarchy of *-able* and *-ible* adjectives

difference in productivity between *-ible* and *-able* is captured by the fact that *-able*, but not *-ible*, has a subtype leaving open the identity of the base lexeme. Among members of the *-ible* family, three situations are found. *Divisible* is maximally regular and derives all its properties from its base *diviser*. *Prédictible* is irregular in not deriving its phonology from that of its base *prédire*, but is still fully regular in syntax and semantics. *Plausible* is maximally irregular, and does not share any property with other members of the family besides ending in */-ibl/*.

3.1.2 Multidimensional Classification of Lexeme Formation Rules

In the preceding section we focused on addressing the diversity of instantiations of a single lexeme formation process. Recent work on word formation has highlighted the importance of rivalry between processes: more often than not, a language offers more than one means to fill the onomasiological need for a new lexeme *L'* expressing meaning *M'* on the basis of an existing lexeme *L* expressing meaning *M*. A relevant example is that of English denominal verbs: as argued at length by Plag (1999), processes such as *-ize* suffixation, *-ify* suffixation, *be-* prefixation, and conversion, give rise to overlapping types of meanings, so that in some instances any of the processes could have been used to fill the same lexical need. When combined with the well-known observation that individual processes themselves are polysemous (for a recent appraisal see Luschützky and Rainer 2013), this leads to the view that lexeme formation involves a many-to-many relation between formal processes and semantic relations to be expressed.

Table 22.1 illustrates this situation with examples from French deverbal nouns. Empty cells in the table correspond to situations where there is no productive formation, although a few stray examples may exist.¹⁰ As the examples in the table make clear, the many-to-many relation does not entail that there is no conventionalized association between form and meaning that needs to be encoded in an appropriate grammar: some processes definitely exclude some meanings (e.g., conversion never constructs agent nouns), and processes may be more or less selective as to the kinds of semantic relation they encode (compare *-eur* and compounding). Thus what is needed is some economical way to encode the similarities and differences between formation processes.

Inheritance hierarchies of lexeme formation rules again provide an adequate solution to the problem, as shown notably in Desmets and Villouing (2009) and Tribout (2010, 2012). For clarity we focus on the first three rows (Patient, Instrument and Agent) and three columns (*-oir*, *-age*, and *-eur*) of Table 22.1. Figure 22.11 presents an appropriate inheritance hierarchy.

¹⁰ Here we rely heavily on extant detailed empirical studies: Villouing (2002) for VN compounds, Namer and Villouing (2008) for *-oir* nouns, Tribout (2010) for conversion, Huygue and Tribout (2015) for *-eur* nouns.

Table 22.1. Examples of combinations of formal processes and meanings in French deverbal nouns

	-oir	-age	-eur	compounding	conversion
Patient	<i>tiroir</i> 'drawer'	—	—	—	<i>affiche</i> 'poster'
Instrument	<i>hachoir</i> 'chopper'	<i>maquillage</i> 'makeup'	<i>tracteur</i> 'tractor'	<i>essuie-glace</i> 'wiper'	<i>réveil</i> 'alarm clock'
Agent	—	—	<i>nageur</i> 'swimmer'	<i>garde-côte</i> 'coastguard'	—
Location	<i>lavoir</i> 'washing place'	<i>garage</i> 'garage'	—	<i>appui-tête</i> 'headrest'	<i>décharge</i> 'garbage dump'
Event	—	<i>guidage</i> 'guidance'	—	<i>rase-mottes</i> 'hedgehopping'	<i>dépose</i> 'removal'

Constraints on types in the PHON dimension are parallel to those posited earlier for *-able* adjectives. The constraints on types in the SEM dimension in Figure 22.11 are worth elaborating a bit. The type *agt-n* indicates that the base must denote a relation involving an agent, or *agentive-rel*, and constructs a noun denoting a typical agent of that relation. The type *pat-n* is entirely parallel, but this time involving patients rather than agents. The type *ins-n* is a bit more elaborate: the base has to be an agentive relation (instruments presuppose the existence of an agent using them to complete some action), and the derived noun denotes a class of objects used by an agent to bring about the action corresponding to that agentive relation – technically, the semantics of the noun embeds the relation *use-rel* between an agent $\boxed{y}$, a patient $\boxed{x}$ and a state of affairs $\boxed{3}$ such that $\boxed{y}$ uses $\boxed{x}$ to bring about $\boxed{3}$.

There are a number of distinct advantages to using this format to describe a system of lexeme formation processes. First, the multiple inheritance hierarchy is flexible enough to capture both situations where a process is associated with a natural class of those semantic relations and those where it is not. For instance, *-eur* suffixation selects those semantic relations that rely on an agentive base: this can readily be stated as a further constraint on type *x-eur*; on the other hand, other processes exemplified in Table 22.1 involve irreducible polysemy, which calls for an explicit listing of the possibilities. Second, the hierarchy can be readily interpreted as guiding both coining and parsing of new words. When coining a new word, a speaker knows what content she seeks to convey, and hence which subtype of SEM to use: the problem is to decide on an adequate PHON type to combine it with. When parsing an unknown word, the speaker can readily infer the PHON type, and needs to determine an appropriate SEM type to get to the intended meaning. Third, the analytic apparatus presented above in Section 3.1.1 can be redeployed to account for the

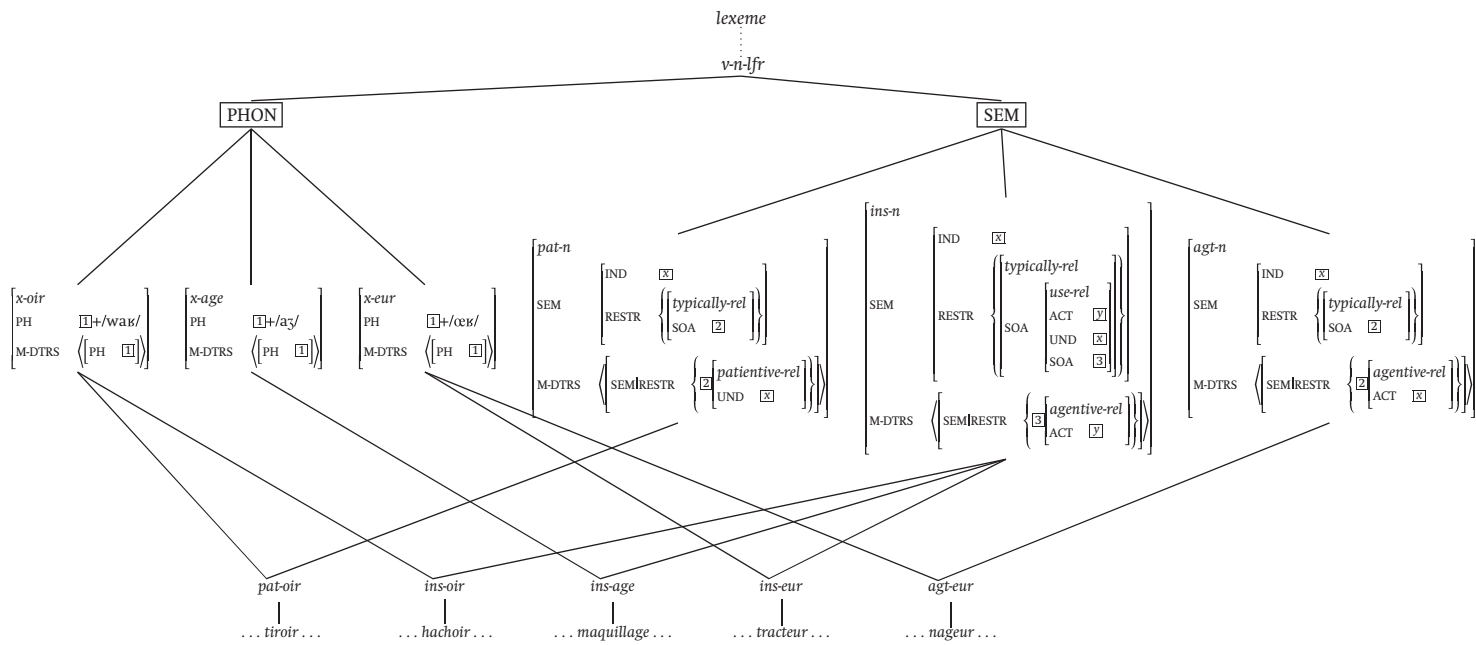


Figure 22.11. Multiple inheritance hierarchy of lexeme formation rules accounting for aspects of the French data set in Table 22.1

relationship between online creation of lexemes (through underspecified M-DTRS values) and lexicalized items. Fourth and finally, a multiple inheritance hierarchy of complex lexemes is a natural starting point to address the variable productivity of lexeme formation processes while taking into account the overall productivity of the formal operation and semantic relation they combine.

3.2 Inflectional Morphology

As we have observed above, the constraint-based perspective on syntax and semantics does not strictly entail a particular view on the kind of morphology to be adopted: thus, all three approaches identified by Hockett (Item and Arrangement, IA; Item and Position, IP; Word and Paradigm, WP) have at some point been adopted by different practitioners of HPSG and LFG. Apart from this purely historical fact, it is equally true that there is a somewhat stronger affinity in constraint-based lexicalist theories with IP and WP approaches than with IA.

The kind of phenomena subsumed under the label of grammatical function change (involving *inter alia* the active-passive and causative-inchoative alternations) have always enjoyed a pivotal role in lexicalist approaches to syntax and semantics. Owing to the fact that these kinds of alternations are standardly captured by means of lexical rules, it is quite natural to encode any morphophonological effect as part of such rule application. Thus, the wide-spread adoption of an IP approach can be considered as epiphenomenal to the way systematic lexical alternations have been captured within these frameworks. A more recent typology of inflectional theories has been proposed by Stump (2001), who classifies approaches along two binary distinctions: lexical versus inferential, and incremental versus realizational approaches. While classical morpheme-based theories (IA) are both lexical and incremental—morphological function is considered a lexical property of individual morphemes and complex functions are derived by incrementally combining morphemes into complex forms—WP approaches, by contrast, associate morphological function with the word as a whole (inferential) and allow for many-to-many correspondences in the mapping of form and function (realizational). The constraint-based perspective on grammar shares a high degree of similarity to the inferential view on inflection: owing to monotonicity, a lexemic description is typically understood to be compatible with each and every cell of the paradigm, and inflection rules, however implemented, merely serve to monotonically narrow down which set of paradigm cells a word may realize (Krieger and Nerbonne 1993).

Among inferential-realizational (WP) approaches to inflection, Paradigm Function Morphology (PFM; Stump 2001) has enjoyed a privileged status in both LFG and HPSG, for several reasons: first and foremost, the level of formal explicitness attained by PFM clearly surpasses that of other WP approaches, such as Anderson's A-morphous Morphology, which makes

PFM an adequate companion for these thoroughly formalized grammatical frameworks.¹¹ Second, compared to AM, PFM minimizes the amount of extrinsic ordering, being more compatible in spirit with the constraint-based enterprise. Third, the formal nature of PFM grammar, as functions from morphosyntactic properties to word-forms, makes for a straightforward integration into both LFG and HPSG, despite the underlying formal differences between PFM and feature logic.

In HPSG, several attempts have been made to integrate PFM-inspired inflectional morphology more seamlessly with the logic of typed feature structures (Erjavec 1994; Miller and Sag 1997; Bonami 2011; Sag 2012; Ackerman and Bonami in press), thereby providing a clean interface to syntax and semantics. As discussed in Erjavec (1994), once a notion of the Elsewhere Condition is in place, PFM can even be translated quite faithfully into a constraint-based theory such as HPSG. However, none of these approaches takes full advantage of the design properties of monotonic constraint-based approaches. In practice, the expression of inflection is usually relegated to a function that essentially plugs the input and output of a PFM grammar into HPSG.

3.2.1 Inferential Realization Morphology in Typed Featured Structure

More recently (Crysmann and Bonami 2012; Bonami and Crysmann 2013; Crysmann and Bonami 2016), the present authors, have developed an inferential-realizational model of inflectional morphology that seamlessly integrates with the declarative, model-theoretic framework of HPSG. The model systematically exploits feature structure underspecification in monotonic inheritance hierarchies to express generalizations across rules, replacing the procedural residue of AM and PFM with a purely information-based notion of wellformedness and competition.

We first present the basic workings of Information-based Morphology (henceforth IbM) and then argue that it is both more restrictive and less prone to arbitrary decisions than previous inferential-realizational approaches.

Figure 22.12 illustrates the IbM feature geometry by showing the word-level description of the English adjective *smaller*. The task of morphology is conceived as to relate a set of morphosyntactic properties (MS) to a phonological representation (PH). This relation is mediated by two intermediate representations: a set of realization rules (RR) and a set of morphs indexed for position (MPH). Each rule states that a given subset of morphosyntactic properties, referred to by MUD, is realized by some set of

¹¹ Contemporary lexical-realizational approaches such as Distributed Morphology have never been considered as suitable models of inflectional morphology for either LFG or HPSG, due to several reasons: first, incompatible assumptions about lexical integrity; second, the idiosyncratic assumptions about syntactic input structures; third, the reliance on destructive operations on features (checking, impoverishment); and fourth, the absence of sizeable and sufficiently formalized grammar fragments.

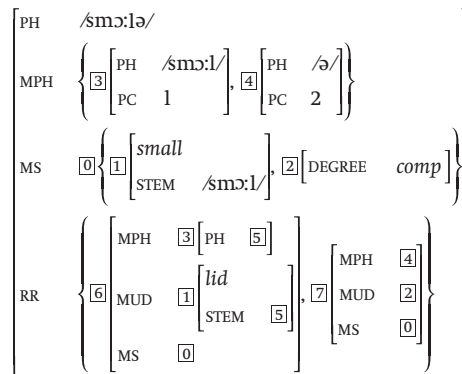


Figure 22.12. IBM representation for the English adjective *smaller*

morphs in a context that may be restricted through reference to other features in the set *ms*. In the case at hand, exactly two rules regulate the introduction of exactly two morphs: a rule of **stem introduction** ($\boxed{6}$) realizes lexical identity ($\boxed{1}$) by introducing the lexically specified stem ($\boxed{5}$) as the phonology of the morph in position 1 ($\boxed{3}$), and a simple rule of exponence ($\boxed{7}$) realizes comparative degree ($\boxed{2}$) as an appropriate morph in position 2 ($\boxed{4}$).

In accordance with lexicalism, the features *MPH* and *RR* are internal to the workings of morphology, and thus not visible to syntax: from the point of view of syntactic rules, words are pairings of phonology and (syntactic and semantic) content with no internal structure.¹² Thus the use of explicit segmented morphs as part of the morphological analysis of a word has no dire consequence on the morphology-syntax interface.

One of the most basic tasks of any inferential-realizational approach to morphology is the definition of morphological well-formedness: while in incremental approaches, completeness (properties must have a realization) and coherence (realizations must be licensed by properties) are warranted by the very workings of the approach, inferential approaches actually need to assert these properties in one way or another: otherwise even bare stems will be erroneously regarded as a full realization of every cell of the paradigm. While AM and PFM address this issue by postulating a sequence of rule blocks that needs to be processed in order to arrive at a well-formed word, IBM insists that well-formedness should rather be guaranteed in terms of the information to be expressed: every piece of the morphosyntactic property set must be licensed by exactly one

¹² One way of implementing this locality condition is to model signs and the constructions licensing them as separate entities (Sag 2012). Under such an approach *MPH* and *RR* would be modeled as part of an inflectional lexical construction.

$$\text{word} \rightarrow \left[\begin{array}{l} \text{MPH} \quad \boxed{e_1} \cup \dots \cup \boxed{e_n} \\ \text{MS} \quad \boxed{0} \quad (\boxed{m_1} \uplus \dots \uplus \boxed{m_n}) \\ \text{RR} \quad \left\{ \begin{array}{l} \left[\begin{array}{l} \text{MPH} \quad \boxed{e_1} \\ \text{MUD} \quad \boxed{m_1} \\ \text{MS} \quad \boxed{0} \end{array} \right], \dots, \left[\begin{array}{l} \text{MPH} \quad \boxed{e_n} \\ \text{MUD} \quad \boxed{m_n} \\ \text{MS} \quad \boxed{0} \end{array} \right] \end{array} \right\} \end{array} \right]$$

Figure 22.13. Morphological well-formedness: completeness and coherence

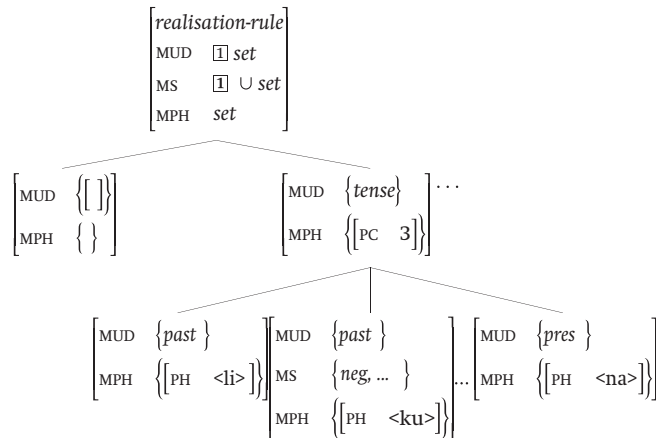


Figure 22.14. Hierarchy of tense realization rules in Swahili

realization rule. To this end, realization rules distinguish between properties they express (MUD) and properties they are merely conditioned on (MS). As stated by the principle in Figure 22.13, the MUD values of all the rules invoked must yield exactly the morphosyntactic property set MS of the word.

Realization rules themselves are organized in a type hierarchy, permitting vertical abstraction of properties shared across different rules, both on the side of morphosyntactic features being expressed, and on the side of exponence. Consider the partial hierarchy of realization rules for Swahili tense markers in Figure 22.14. Leaf types for progressive and past tense pair the morphosyntactic property that is expressed by the rule with an exponent (in MPH), describing its shape (PH). Position class information shared by all tense markers is represented as a property of the immediate supertype, which the subtypes will inherit. The type at the top of the hierarchy captures the highly general property holding for all realization rules, namely that morphosyntactic properties that are expressed must by necessity be part of the morphosyntactic property set MS. The rule type at the top left corresponds to what Stump (2001) has dubbed the Identity Function Default—in other words, a rule of zero exponence. In IbM, there is exactly one instance of this rule type, which

Table 22.2. *Swahili person markers*

PER	GEN	SUBJECT		OBJECT		RELATIVE	
		SG	PL	SG	PL	SG	PL
1		ni	tu	ni	tu		
2		u	m	ku	wa		
3	M/WA	a	wa	m	wa	ye	o
	M/MI	u	i	u	i	o	yo
	KI/VI	ki	vi	ki	vi	cho	vyo
	JI/MA	li	ya	li	ya	lo	yo
	N/N	i	zi	i	zi	yo	zo
	U	u	—	u	—	o	—
	U/N	u	zi	u	zi	o	zo
	KU	ku	—	ku	—	ko	—

is constrained to realize exactly one element of the morphosyntactic property set, not contributing any morphs. Note that IbM incorporates a version of Pāṇini's principle. Thus, leaf types in the hierarchy need not be manually declared as mutually exclusive: in cases of competition for realization of some MUD, only the rule putting the most specific constraint on MS can apply.¹³

Building on Koenig's Online Type Construction (see Section 2.4), systematic alternations in position can be captured by means of dynamic cross-classification of types from different dimensions. As Stump (1993) notes, exponents of subject and object agreement in Swahili are identical in shape in almost all cells of the paradigm, despite the fact that the markers of these distinct functions are realized in different positions of the inflectional template (see Table 22.2). By organizing the type hierarchy of realization rules into two dimensions, as shown in Figure 22.15, placement depending on grammatical function can be distributed over the rule types describing exponence, ultimately yielding the fully expanded leaf types at the bottom of the hierarchy.

Realization rules, as shown thus far, pair a morph with some morphosyntactic property it expresses. While such 1:1 correspondences arguably constitute the canonical case, IBM realization rules equally permit the statement of *m:n* correspondences. As a first deviation from the canon, we have already discussed zero exponence—that is, the (default) rule that may express some morphosyntactic property without introducing any exponent. Other deviations correspond to cumulative and extended exponence: the first case is illustrated by the rule for the Swahili negative first singular subject portmanteau *si* in Figure 22.16. The second case (i.e., where a single morphosyntactic property corresponds to multiple, possibly discontinuous

¹³ Technically, this is done by enriching the description of leaf types with the negation of the descriptions of all less specific competitors. This compilation step allows for incorporating the effects of Pāṇini's principle while staying true to the monotonous character of HPSG. See Crysmann and Bonami (2016) for the details of this view of Pāṇinian competition, which relies heavily on earlier work by Andrews (1990), Erjavec (1994), and Koenig (1999).

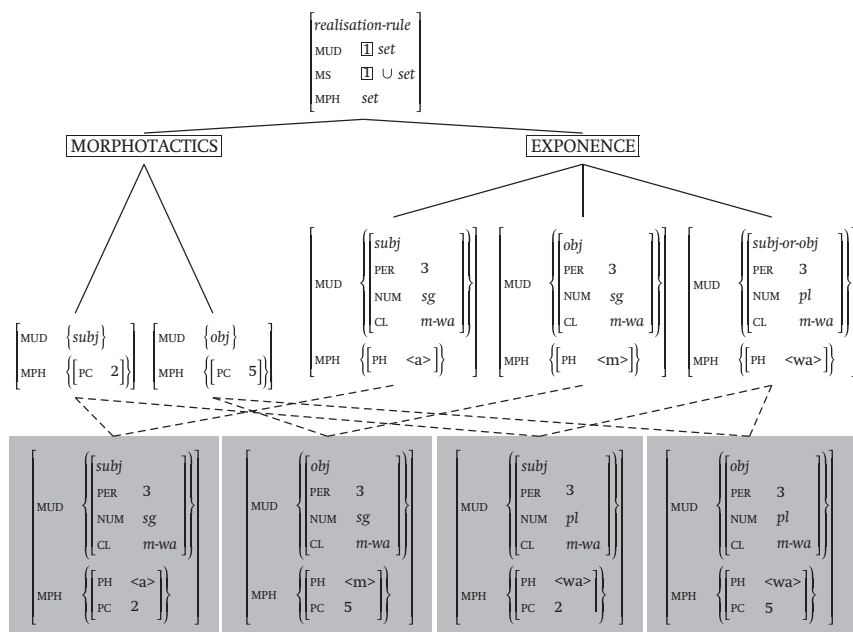


Figure 22.15. Rule type hierarchy for Swahili parallel position classes

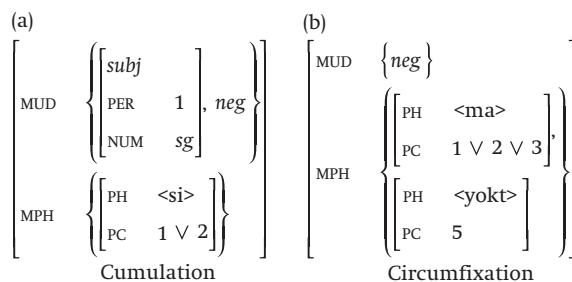


Figure 22.16. *m:n* correspondences between MUD and MPH

morphs) is exemplified by the Chintang negative circumfix.¹⁴ The possibility of capturing extended exponence head on by way of simultaneous introduction of exponents is opened up by the design decision for a morphous approach, where positional information is associated with the morphs themselves. In contrast to PFM or AM, IbM can capture *m:n* relations not only on the level of the word, but also on the level of individual rules, pairing multiple properties with multiple, possibly discontinuous exponents.

As should be clear from the previous discussion, Information-based Morphology shares crucial properties with other members of the family of extended word-and-paradigm approaches, like PFM or AM: it is

¹⁴ See Crysmann (in press) for simultaneous introduction of multiple morphs in Nyanja pre-prefixation.

realizational rather than lexical in the sense that expression of morphological properties is not associated with morphemes, but rather effected by rule application, which may introduce zero, one, or more than one exponent; and it is inferential, rather than incremental, as the morphosyntactic property set is associated with the word, rather than built up step by step by the application of rules.

We close this discussion of IbM by highlighting some of its conceptual advantages over alternative inferential-realizational frameworks.

3.2.1.1 Restrictiveness

An obvious property that contrasts inflectional morphology with both derivational morphology and syntax is its finiteness: for a given set of lexemes there is a finite bound both on the number of distinct words instantiating these lexemes and on the length of these words. IbM captures this boundedness straightforwardly by not using any recursive operation in the derivation of word-forms: words are sequences of morphs licensed by realization rules, and the number of realization rules in a word is bounded by the number of morphosyntactic properties to be expressed. This is in stark contrast with the situation in PFM, where conspiracies of rules of referral can in principle be stated so as to give rise to infinite derivations. Even disregarding rules of referral, the morphological structures generated by IbM evidently belong to a smaller class than those generated by PFM, as the derivation has the structure of a string (i.e., a structure with a single ordering relation) rather than a tree (i.e., a structure with two ordering relations).

3.2.1.2 Avoidance of arbitrary decision

One of the main motivations for the design of IbM was dissatisfaction with the notion of a rule block. In both AM and PFM, rule blocks assume the double role of (i) allowing for extended exponence by exempting exponents in different blocks from competing for realization, and (ii) regulating the order of exponents. While using a single device to address these two issues seems appealing at first, there are distinct drawbacks to both aspects of the solution. First, the block architecture prevents one from addressing the phenomenon of “discontinuous bleeding” (Noyer 1992) as Pāṇinian competition between elements in different syntagmatic classes. Second, the relative order of prefixal and suffixal rule blocks is in many cases an arbitrary decision (Crysmann and Bonami 2012):¹⁵ in a system with m prefixal positions and n suffixal positions, there are $2^{\min(m,n)}$ distinct but empirically equivalent ways of stating the system.

IbM avoids both issues. Pāṇinian competition is global: decision on the applicability of a realization rule is taken purely on the basis of the informativeness of the description; hence rules targeting different positions

¹⁵ In rare instances, phonological or morphological properties can be used to argue that some block must feed another block. In practice that is the exception rather than the rule.

do compete if their *MUD* features stand in a subset relation. Second, the position class index of a morph is strictly constrained by its linear position relative to other morphs, hence there is no arbitrary decision to be taken in that respect.

One place where IbM could be seen as prone to making arbitrary decisions is in the treatment of extended exponence. There are two ways of dealing with extended exponence in IbM. Where the two exponents realise exactly the same set of features, they are introduced simultaneously by a single rule, as in Figure 22.16b. In situations of overlapping exponence, IbM relies on a distinction between realization of a feature and allomorphic conditioning, formally cashed out as the distinction between a feature mentioned as part of *MUD* or *MS*. Although it sometimes occurs that more than one partition of the expressed features is conceivable, Crysmann (in press) shows that arbitrariness can be avoided by turning Carstairs' (1987) notion of Pure Sensitivity into a formal principle of the theory.

3.2.1.3 Morphousness

IbM departs from both AM and PFM in recognizing segmented morphs.¹⁶ This move is a crucial precondition to an adequate treatment of extended exponence that does not rely on rule blocks. It also allows for a statement of inflectional morphology that is clearly neutral as to generation versus parsing. This makes it obvious how IbM could be interfaced with a realistic model of human morphosyntactic processing, as partial representations of the content of words can be constructed incrementally on the basis of substrings identified as known morphs. IbM is thus readily compatible with the Competence Hypothesis (Kaplan and Bresnan 1982: 173): morphological analyses take a form that can be interpreted in terms of performance.

It is worth noticing that while IbM is decidedly morphous, Anderson's (1992) main argument against morphous approaches is entirely moot in the present context. Anderson's point is that morphological operations are never sensitive to the derivation history of their input; hence an appropriately restrictive theory should not make a record of that derivation history. This argument however relies on the presupposition that words are derived by a sequence of recursive operations. This is not the case in IbM: realization rules have no input; they are just pairings of content with sets of morphs. And there is no order to the application of realization rules, which are just all satisfied simultaneously.

In the present context, then, the situations that amorphousness was designed to avoid are already excluded by the very definition of realization rules. Hence there is no benefit in terms of restrictiveness to being

¹⁶ These segmented morphs are however not morphemes in any classical sense: words are *not* represented as sequences of minimal pairings of form and content, since the distribution of morphs is regulated by realization rules, and realization rules may introduce zero, one, two or more morphs. Words are rather represented as sequences of recurrent phonological strings, which stand in a nontrivial relation to content. See also Spencer (2003, 2013) for convergent proposals for the use of morph lists in inferential-realizational morphology.

amorphous, and morphousness plays a crucial role in making a more restrictive theory of morphological derivation possible.

3.2.2 Morphotactics

The treatment of morph order, in particular the treatment of complex templatic systems, has attracted quite a good deal of attention in HPSG morphology. Alongside more traditional IA or IP approaches which treat the issue of order as essentially an epiphenomenon of combinatory constraints, a number of dedicated approaches have been developed that specifically seek to capture linearization properties of position class systems in a more direct fashion.

3.2.2.1 Construction-based Morphotactics (Koenig 1999)

Probably the first such proposal has been developed by Koenig (1999), defending a construction-based view of Swahili position class morphology. Koenig takes as a starting point the claim advanced by Zwicky (1991) and Stump (1993) that the kind of dependencies observable between exponents in non-adjacent surface slots, as witnessed with Swahili negation, support a realizational, but not a constituent-structure based, view of morphology.

- (1) a. wa- li- som-a
 SBJ.3PL.M/WA PST read
 'they did read'
- b. ha- wa- ku- som-a
 NEG SBJ.3PL.M/WA NEG.PST read
 'they did not read'
- (2) a. wa- ta- som-a
 SBJ.3PL.M/WA FUT read
 'they will read'
- b. ha- wa- ta- som-a
 NEG SBJ.3PL.M/WA FUT read
 'they will not read'
- c. ni- ta- som-a
 SBJ.1SG FUT read
 'I will read'
- d. si- ta- som-a
 NEG.SBJ.1SG FUT read
 'I will not read'

In (1), the choice of past marker in slot 3 depends on the presence of negation in slot 1. Similarly, the negative first singular portmanteau in (2) constitutes a local dependency. Koenig shows that the difficulties faced by constituent structure approaches are not inherent to constituency *per se*, and shows how his constructional take on constituency in

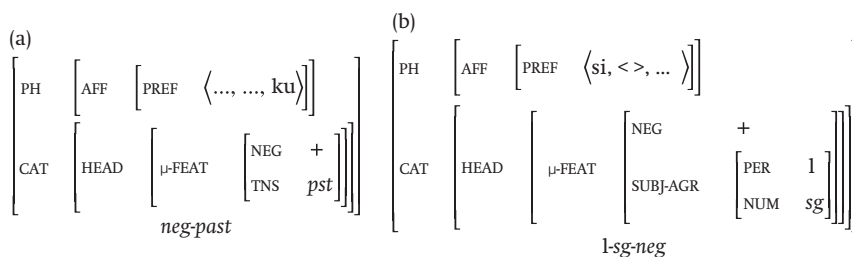


Figure 22.17. Sample types for Swahili

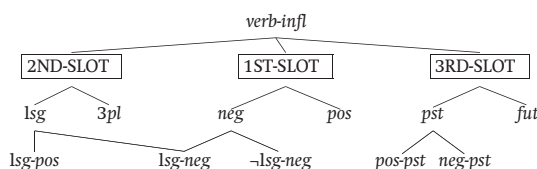


Figure 22.18. Koenig's constructional approach to Swahili position classes

morphology allows the insertion of parts of the template at once. Using cross-classification of construction types, however, this somewhat holistic perspective can be decomposed into constituting parts.

Consider the definition of *neg-past* in Figure 22.17a. The crucial point is that for position class systems, Koenig assumes that not just one affix is introduced, but that the types of the hierarchy in Figure 22.18 jointly constrain the three members of the *PREF* list: while *neg-pst* constrains the third element, intersection of this type with compatible types from the other two dimensions will select the appropriate affixes for the other slots. Koenig's approach to the Swahili template in terms of cross-classification of partial description is quite representative of construction-based HPSG in general, combining holistic description with decomposition into partial constraints.

There are, however, some problems associated with a direct encoding of template slots: in order to ensure that some slots must remain empty for some cells in the paradigm, Koenig is forced to stipulate zero morphs, as in Figure 22.17b, in contrast to realizational morphology which would rather demand the absence of morphs in such cases. Another problem directly related to the direct association of forms with template positions concerns the scalability of Koenig's proposal: as illustrated in Table 22.2, exponents for subject and object agreement in Swahili draw on an almost identical inventory of shapes. Positionally and functionally, subject and object markers are clearly distinct. Any direct encoding of a fixed template will make it impossible to capture their commonalities, since it precludes the systematic separation of the dimensions of position and shape. Swahili relative markers constitute a similar challenge: the markers listed in Table 22.2 undergo a

positional alternation between slots 4 and 7, essentially conditioned on tense properties (slot 3). This very conditioning on slot 3 will entail that the relative markers should be inserted on a prefix list together with tense, but assignment of these shapes to a fixed list position will preclude generalization of form across the different slots they may surface in.

3.2.2.2 Morphotactics by Precedence Constraints (Crysmann 2003b)

A different approach to position class morphology has been developed by Crysmann (2003b) in the context of pronominal affix clusters in European Portuguese and their placement interaction with TAM markers. Building on ideas initially discussed in an appendix to Stump (1993), he proposes a realizational approach to inflection where rules of exponence recursively license the presence of morphs on an essentially flat list representation. In order to describe the placement possibilities of these morphs by means of linear precedence statements, the morphs themselves are organized into type hierarchies of shapes, such that ordering constraints can target entire distributional classes, rather than having to be stated over and over again for each pair of morphs. While successful at achieving this task, Stump (personal communication) notes a certain degree of duplication between hierarchies of realization rules and these distributional hierarchies over exponents. A central aspect of using LP constraints pertains to the possibility of partial order specifications, which opens up the possibility that syntax and morphology may jointly determine order of phonological contributions. Apart from European Portuguese clitics, the approach has been applied to Polish mobile affixes (Crysmann 2010a), circumfixation to separable preverbs in Fox (Crysmann 1999), endo-cliticization in Udi (Crysmann 2003b), and in Sorani Kurdish (Bonami and Samvelian 2008).

3.2.2.3 Morphotactics in Information-based Morphology

Complex morphotactic systems have been the core phenomenon behind the development of IbM (see Section 3.2.1). Crysmann and Bonami (2012) reinvestigate the classical challenges of Swahili and Fula variable morphotactics and argue for a systematic division between exponence and position. Their initial approach, which stayed quite close to PFM in recognizing cascaded rule blocks, improved on Stump (1993) by using underspecified, cross-classifying descriptions, to capture generalization on order independently from those on shape, providing an account for ambifixal, reversible, portmanteau, and parallel position classes using a single descriptive device – that is, partial rule descriptions, organized in a multidimensional Koenig-style type hierarchy. The crucial change compared to PFM is to dissociate order from rule blocks and associate it directly with the exponents, thereby bringing position class indices into the scope of realization rule descriptions. Thus, in contrast to PFM, which employs several distinct devices to cope with non-canonical morphotactics, Crysmann and Bonami (2012) consistently exploit underspecification to generalize over exponence and morphotactics.

Rule blocks have been dropped entirely in subsequent work (Bonami and Crysmann 2013; Crysmann and Bonami 2016), yielding the purely information-based model presented in Section 3.2.1. To illustrate the workings of their approach for the description of variable morphotactics, consider the data in (3–4) and the corresponding analysis in Figure 22.19:

- (3) a. a-soma-ye
M/WA.S-read-M/WA.REL
'(person) who reads'
b. a-ki-soma-cho
M/WA.S-KI/VI.O-read-KI/VI.REL
'(book) which he reads'
- (4) a. a-na-ye-soma
M/WA.S-PRES-M/WA.REL-read
'(person) who is reading'
b. a-na-cho-ki-soma
M/WA.S-PRES-KI/VI.REL-KI/VI.REL-read
'(book) which he is reading'

As illustrated in (3), Swahili relative markers, which agree with the relativized subject or object, are realized in post-stem position 7 with affirmative definite tensed verbs, whereas they appear in slot 4 in all other

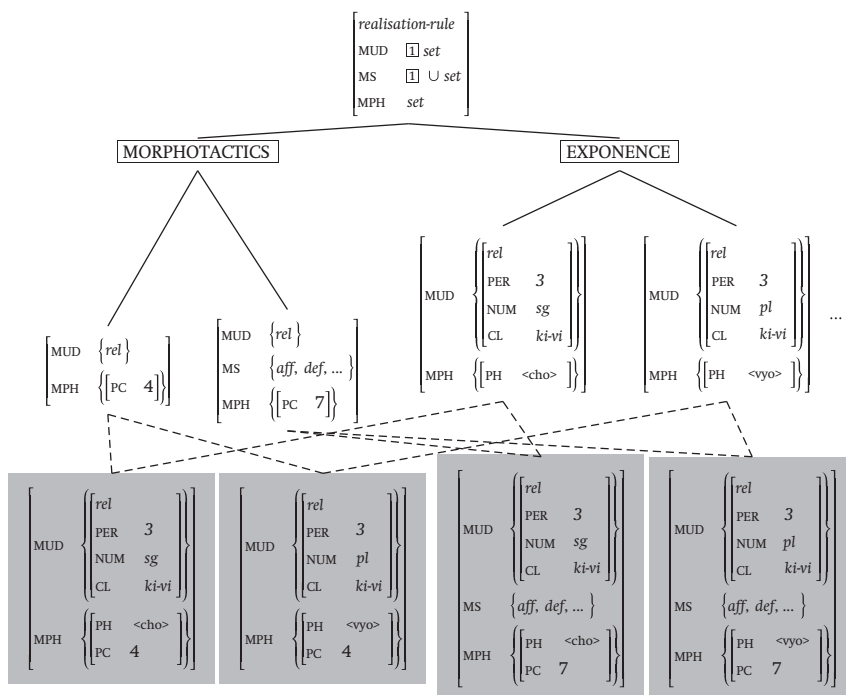


Figure 22.19. Partial hierarchy of Swahili relative markers (Crysmann and Bonami 2016)

tense/polarity combinations, as shown in (4). Despite the placement alternation, the shape of the relative marker remains constant across the paradigm of forms given in Table 22.2.

Using Koenig's Online Type Construction, rule descriptions are abstracted out into partial constraints on shape and constraints on order from which the actual rule instances (in grey) can be inferred by means of systematic intersection of the constraints from one dimension with those of the other. Note that on the level of formal devices being invoked, this analysis is strictly parallel to that of subject and object markers in Figure 22.15, the only difference between these phenomena being that morphotactic variation correlates with a conditioning property (MS) here, whereas it correlates with an expressed property (MUD) in the case of parallel position classes.

Backed by an extensive canonical typology of variable morphotactics, Crysmann and Bonami (2016) apply their basic underspecification approach to a wider array of phenomena, including free and partially constrained order in Chintang (Bickel et al. 2007) or Mari (Luutonen 1997), or placement relative to a pivot, as witnessed by second position affixes in Sorani Kurdish or mobile stems in Italian (Bonami and Crysmann 2013).

3.2.3 Morphophonology

Owing to the fact that both LFG and HPSG are not only theoretical, but also computational linguistic frameworks, their treatment of phonology, and therefore morphophonology, has been greatly influenced by research into Finite State methods and the usefulness of these approaches as a computational model of SPE-style cascaded rule systems (Koskenniemi 1983; Kaplan and Kay 1994). As for LFG, the projection architecture and the assumption of module-specific formalisms provide for a very easy and straightforward integration of these approaches. Within HPSG, Krieger et al. (1993) have shown how finite state transducers can be represented in terms of typed feature structures, permitting the mapping of lexical phonological representations onto surface phonology. They argue in particular that each step in a morphological derivation should be associated with such a mapping, thereby following quite closely the model of Lexical Phonology (Kiparsky 1982, 1985).

The early 1990s, however, have seen the emergence of Declarative Phonology (Scobbie 1991, 1993) or One-level Phonology (Bird and Ellison 1992; Bird and Klein 1994), which marks a more radical departure from the heritage of SPE-style Generative Phonology or Two-level Morphology (Koskenniemi 1983). In a true constraint-based spirit, well-formed surface strings are described directly by a set of inviolable universal and language specific constraints that narrow down the properties of the phonological representation. Thus, instead of turning a sequence of underlying, typically fully specified phonological representations into a surface phonological representation, generalizations are rather captured by means of combining partial descriptions of the surface representation. As stated by Bird (1995),

$$\neg \left\langle \dots \left[\text{SL} \left[\begin{array}{cc} \text{MANNER} & [\text{NASAL} \quad +] \\ \text{PLACE} & \boxed{1} \end{array} \right] \right], \left[\text{SL} \left[\begin{array}{cc} \text{MANNER} & [\text{CONT} \quad -] \\ \text{PLACE} & \neg \boxed{1} \end{array} \right] \right] \dots \right\rangle$$

Figure 22.20. Homorganic nasal assimilation (Bird and Klein 1994: 462)

One-level Phonology thus revives ideas from natural generative morphology, including the notion of archiphonemes—in other words, underspecified alternant sets that model surface alternation of phonological segments. Choice between alternants in the set is then effected by general surface constraints on the phonological representation.

The concrete phonological analyses developed within this framework incorporate a number of contemporary approaches to phonological description: in particular, feature structure representations are chosen to model feature trees as proposed in Feature Geometry (Clements 1985). As illustrated in Figure 22.20, phonological representations are lists of feature structure descriptions of phonological events, and general phonological constraints are expressed as (possibly recursive) constraints on these lists: in the case of homorganic nasal assimilation, the constraint invalidates any sequence where a nasal precedes a [–continuous] segment, yet place of articulation is not shared. Note that “feature spreading” is captured by way of token-identity—in other words structure sharing of feature values.

Furthermore, Bird and Klein (1994) and Bird (1995) incorporate ideas from Autosegmental Phonology (Leben 1973; Goldsmith 1976), and suggest representing linking of, for example, consonantal and vocalic tiers in Sierra Miwok by means of structure sharing. Owing to its commitment to monotonicity (namely, the information-preserving character of unification), concrete descriptive devices such as delinking are rejected.

For illustration, consider Bird and Klein’s (1994) analysis of Sierra Miwok templatic morphology: essentially, they propose that an autosegmental representation as in Figure 22.21 can be represented by the feature structure in Figure 22.22. They propose further to abstract out general class-specific properties into distinct types, as illustrated in Figure 22.23.

One of the criticisms that has been raised against the one-level approach pertains to the complete absence of feature changing operations, suggesting the generative power of the one-level approach to be insufficient to address the empirical patterns. Orgun (1996) cites data from Bengali that crucially illustrate this point:

- (5) fat b^hali – fadb^hali
 seven brothers
- (6) mɔd k^haoa – mɔtk^haoa
 alcohol drinking

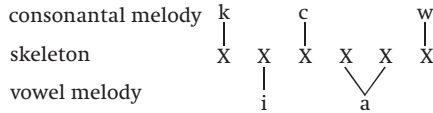


Figure 22.21. Autosegmental representation of Sierra Miwok *kicaaw* (Bird and Klein 1994: 471)

$$\begin{bmatrix} \text{CON} & \langle \boxed{1} \text{ k}, \boxed{3} \text{ c}, \boxed{5} \text{ w} \rangle \\ \text{VOW} & \langle \boxed{2} \text{ i}, \boxed{4} \text{ a} \rangle \\ \text{SKEL} & \langle \boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}, \boxed{4}, \boxed{5} \rangle \end{bmatrix}$$

Figure 22.22. AVM encoding of autosegmental representation (Bird and Klein 1994: 471)

(a)

$$\text{bleed-lex} \rightarrow \left[\text{PHON} \begin{bmatrix} \text{template-I} \\ \text{CON} \langle \text{k, c, w} \rangle \\ \text{VOW} \langle \text{i, a} \rangle \end{bmatrix} \right] \quad \text{quit-lex} \rightarrow \left[\text{PH} \begin{bmatrix} \text{template-II} \\ \text{CON} \langle \text{c, l, k} \rangle \\ \text{VOW} \langle \text{e, u} \rangle \end{bmatrix} \right]$$

Lexical entries

(b)

$$\text{template-I} \rightarrow \begin{bmatrix} \text{CON} \langle \boxed{1}, \boxed{3}, \boxed{5} \rangle \\ \text{VOW} \langle \boxed{2}, \boxed{4} \rangle \\ \text{SKEL} \langle \boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}, \boxed{4}, \boxed{5} \rangle \end{bmatrix} \quad \text{template-II} \rightarrow \begin{bmatrix} \text{CON} \langle \boxed{1}, \boxed{3}, \boxed{4} \rangle \\ \text{VOW} \langle \boxed{2}, \boxed{5} \rangle \\ \text{SKEL} \langle \boxed{1}, \boxed{2}, \boxed{3}, \boxed{4}, \boxed{5} \rangle \end{bmatrix}$$

Templates types

Figure 22.23. Separation of morphological templates from lexical entries

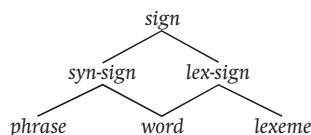
Since the final consonants of *fat* and *mɔd* surface as such prevocally, yet undergo voicing assimilation pre-consonantly, Orgun (1996) contends that the one-level model will be unable to distinguish these segments, assigning identical lexical representations, [PHON ⟨...,{d,t}⟩], to both cases.

An ingenious way to address this issue in a systematic way has been developed by Walther (1999): he suggests augmenting the representation of segments (which are actually constraints on the segments' properties) with constraints on the properties of their left and right neighbours.

Similar to his approach towards contextualized alternation, Walther (1999) proposes representing syllable structure in terms of role information on the segments themselves. In essence, this move lays the foundations toward a "lexicalized" representation of the entire prosodic hierarchy, as developed in Crysmann (2003b: Chapter 6). A particularly nice consequence of representing prosodic structure in terms of prosodic roles is that it obviates

Table 22.3. *Present indicative sub-paradigms and partial stem spaces of four French verbs*

	1SG	2SG	3SG	1PL	2PL	3PL	stem 1	stem 2	stem 3
LAVER 'wash'	lav	lav	lav	lavɔ̃	lave	lav	lav	lav	lav
FINIR 'finish'	fini	fini	fini	finisɔ̃	finise	finis	finis	finis	fini
BROYER 'grind'	bɔ̃wa	bɔ̃wa	bɔ̃wa	bɔ̃wajɔ̃	bɔ̃waje	bɔ̃wa	bɔ̃waj	bɔ̃wa	bɔ̃wa
BOIRE 'drink'	bwa	bwa	bwa	byvɔ̃	byve	bwav	byv	bwav	bwa

**Figure 22.25.** A standard HPSG hierarchy of signs

In Section 3.1 we have followed the practice of pedagogical presentations of HPSG such as Sag et al. (2003) and assumed that the phonological form taken by lexemes, like that of words and phrases, is characterized by a single phonological representation under the attribute *PHON*. This however disregards the prevalence of morphomic stem allomorphy (see among many others Aronoff 1994; Maiden 2005, and the papers collected in Bonami 2012). Since Bonami and Boyé (2006), it has become customary in HPSG work on morphology to assume that lexemes do not have a unique *PHON* but carry instead a **stem space**, a vector of possibly distinct stem allomorphs; different inflectional or derivational processes then pick one coordinate of the vector as their formal base.

For concreteness let us consider a subset of French morphology. French verbs distinguish up to three stem allomorphs in the present indicative, as illustrated in Table 22.3. We follow the indexing scheme of Bonami and Boyé (2006), and label ‘stem 1’ the default stem used in the indicative present first-person plural and second-person plural and in the imperfective, ‘stem 2’ the stem used in the present third-person plural, and ‘stem 3’ the stem used in the present singular.

The stem space can be modeled through a list-valued attribute *STEMS* carried by lexemes and lexemes alone. In the view of Bonami and Boyé (2006), the length of the stem space is characteristic of a part of speech: they assume a length 12 stem space for French verbs, but a length 2 stem space for adjectives. Inflection rules then need to pick out a particular stem for use in the realization of a paradigm cell. In the context of Information-based Morphology as characterized above, this is achieved by a rule of stem introduction that picks out one specific indexed stem as the phonology of a particular morph. As an illustration, example (7) shows a rule selecting the second element on the stem space as the realization of lexeme identity in the context of the present third-person plural and realizes it as a morph in position 0.

$$(7) \left[\begin{array}{l} \text{MUD} \left\{ \begin{array}{l} \text{lid} \\ \text{STEMS } \langle [\] , \boxed{1}, \dots \rangle \end{array} \right\} \\ \text{MS} \left\{ \text{prs}, 3\text{pl}, \dots \right\} \\ \text{MPH} \left\{ \begin{array}{l} \text{PH } \boxed{1} \\ \text{PC } 0 \end{array} \right\} \end{array} \right]$$

It is important to realize that the attribute *STEMS* is intended to *replace* *PHON* for lexemes: in general, there is no single phonological form that could be said to be the phonology of a lexeme. In this context then, lexeme formation rules derive one stem space from another. Bonami and Boyé (2006) lay out the formal consequences of that situation. (8) presents an adapted version of their rule for deriving adjectives in *-eur/-euse* from verbs. Note that the adjectival stem space has two elements, corresponding to the default masculine form and the default feminine form.¹⁷ These two stems are both deduced from the first stem of the base verb, correctly capturing the appropriate stem for examples like *la fièvre laveuse / finisseuse / broyeuse / buveuse* ‘the washing / finishing / grinding / drinking fever’

$$(8) \left[\begin{array}{l} \text{STEMS} \quad \langle \boxed{1} + \text{œk}, \boxed{1} + \text{øz} \rangle \\ \text{CAT} \quad A \\ \text{SEM} \quad \left[\begin{array}{l} \text{IND} \quad \boxed{x} \\ \text{RESTR} \quad \{ \boxed{2} \} \end{array} \right] \\ \text{M-DTRS} \quad \left\langle \begin{array}{l} \text{STEMS} \quad \langle \boxed{1}, \dots \rangle \\ \text{CAT} \quad \text{verb} \\ \text{SEM} \quad \boxed{1} \end{array} \right\rangle \end{array} \right]$$

Crucially, other lexeme formation rules select another stem of the input verb (Desmets and Villoing 2009; Tribout 2010). Likewise, this example illustrates an extreme situation that Bonami and Boyé (2006) call “derived irregularity”: both stems in the output need to be explicitly determined by the lexeme formation rule, as the allomorphic relation between those two stems is irregular from the point of view of the inflection system. In simpler cases where a derived lexeme obeys some regular inflection pattern, a single stem needs to be explicitly specified

¹⁷ The dual stem space is motivated among other things by suppletive adjectives such as *vieux* ‘old’: *M.SG* /vjø/, *F.SG* /vjɛj/. In *M.SG liaison* contexts, a complex stem selection rule decides which stem should be used. Further derivation from adjectives typically proceeds from stem 2.

by rule, and the rest of the stem space is deduced from generalisations over regular stem spaces stated in the lexical hierarchy.

3.4 Relation to Other Morphological Frameworks

By relying both on a sign-based architecture and on inheritance hierarchies, the framework for morphological analysis described in this chapter bears a striking resemblance to two other well-established frameworks, namely Construction Morphology (Booij 2010; Chapter 16 this volume) and Network Morphology (Brown and Hippiisley 2012; Hippiisley, Chapter 18 this volume). Here we briefly comment on the historical relations between these approaches and the differences between them.

The line of work on morphology in HPSG presented in this chapter can be seen as both a predecessor¹⁸ to and a formally explicit variant of Construction Morphology. Constructional schemata as defined by Booij are direct analogs of underspecified lexical entries such as that in Figure 22.8 above which embed a base without specifying its lexical identity; individual lexical entries such as that in Figure 22.7b correspond to Booij's "individual words"; the analog of Booij's "instantiation" relation is just the relation between a (lexical) leaf type (the instance) and a non-leaf type (the "schema"). The relation between "schemata" and "sub-schemata" is likewise directly captured in terms of a subtype relation between non-leaf types, as exemplified, for example, in Figures 22.9 and 22.11.

One superficial difference between the view of lexeme formation presented here and that of Booij (2010) lies in the fact that lexeme formation rules and lexicalized complex words are integrated in a single lexical hierarchy. This is, however, a rather superficial difference—and in fact Sag (2012) adopts a minor variant of the view presented in this section with separate hierarchies of lexemes and of morphological constructions licensing these lexemes. The one ingredient of Construction Morphology with no parallel in the HPSG view of lexeme formation is the notion of a second-order schema capturing paradigmatic relations beyond that between a base

¹⁸ Cross-fertilization between construction grammar and HPSG has been evident since the mid-1990s, as witnessed, for example, by work such as Sag (1997), Kay (2002), or the papers collected in Webelhuth et al. (1999), culminating in the design of *Sign-based Construction grammar* (Boas and Sag 2012), which is a variant of both HPSG and (Berkeley) Construction Grammar. Jean-Pierre Koenig's (1994) dissertation, which predates by a decade publications branding themselves as Construction Morphology, explicitly aimed at elaborating a credible approach to morphology within Construction Grammar, and introduced much of the analytic apparatus presented in this chapter. The relation between HPSG and Construction Grammar was close enough that the relevant parts of Koenig (1994) could be transparently ported to HPSG in Koenig (1999). Note also the contemporary elaboration, within HPSG, of constructional analyses of periphrastic inflection and lexeme formation (Ackerman and Webelhuth 1998) and idioms (Riehemann 2001).

and its derivative (van Marle 1984; Becker 1993; Bochner 1993). This, however, seems to be a contingent matter that is more due to the interests of practitioners of HPSG morphology than to limitations of the framework. Indeed, hierarchies of collections of signs in the same morphological family would constitute a natural generalization of the HPSG view of word formation capturing Bochner's notion of a cumulative pattern.

Network Morphology shares with the HPSG approaches to morphology described in this section commitments to formal explicitness, lexicalism, and the use of inheritance hierarchies. The main difference between the two frameworks result from their respective formal underpinnings: where HPSG is based on the logic of typed feature structures and usually relies on monotonic inheritance, Network Morphology theories are written in DATR (Evans and Gazdar 1996), a language for describing collections of paths (rather than feature structures) and designed to implement default inheritance.

In practice, both languages are expressive enough that the same morphological analyses can often be implemented in one or the other framework, although this is not always obviously apparent given different presentation conventions. Consider again the description of *-able* adjectives in Section 3.1.1 above. Many of the types in the HPSG type hierarchy in Figure 22.9 are motivated by the monotonic nature of inheritance: because some *-able* adjectives have unexpected syntax or semantics, constraints need to be distributed in appropriately restricted subtypes of the general type *-able*. Following Pollard and Sag (1994: 17–21), individual lexemes must belong to a single leaf type in the hierarchy, which makes necessary the introduction of the open subtype *X-able* of *reg-able* to distinguish lexicalized from non-lexicalized derivatives. A natural Network Morphology implementation of the same analysis would thus rely on a flatter hierarchy, with a single node *Able* listing all properties of regular *-able* adjectives, and irregular cases treated as nodes partially inheriting from this, as sketched in (9). The execution is different, but arguably, the underlying analysis is the same.

(9) *Able*:

```
<> == Lfr
<phon> == "<base phon>" a b l
<cat> == adjective
<sem ind> == "<base sem rel act>"
<sem rel> == possible
<sem rel soa> == "<base sem rel>"
<base cat> == verb
<base val> == NP NP
<base sem reltype> == agentive.
```

```

Lavable:
<> == Able
<base> == Laver:<>.

Fiable:
<> == Able
<base> == Se_fier:<>
<base val> == NP PP [à] .

Adorable:
<> == Able
<base> == Adorer:<>
<sem rel> == necessary
<sem rel soa> == "<base sem rel>"

```

The one distinct advantage of an HPSG approach to morphology that is not shared by Network Morphology is reliance on a formalism that is in wide use for the modeling of syntax, as well as lexical and compositional semantics. This has practical, methodological, and theoretical consequences. On a practical level, HPSG morphology may rely on a preexisting toolbox of formal mechanisms and analytic strategies. On a methodological level, morphological analyses are readily interfaced with fully explicit analyses in syntax and semantics, making the falsifiability of hypotheses on interface issues a concrete reality. On a theoretical level, the uniformity of the formalism assumed in HPSG makes a strong claim about the nature of human language, namely that symbolic linguistic knowledge can be described in a most general fashion using a single descriptive device, namely unification of typed feature structures, organized into monotonic inheritance hierarchies.

4 Conclusions

In this chapter we gave a broad outline of the status of morphology in constraint-based lexicalist approaches to grammar, and presented in more detail a family of approaches to morphological phenomena within HPSG that attempt to take stock of the state of the art in descriptive and theoretical morphology to elaborate a morphological framework that takes full advantage of the monotonic constraint-based architecture of HPSG and the descriptive devices it offers. As the examples discussed above hopefully make clear, such an approach has four major advantages. First, the high expressiveness of the typed feature structure formalism makes it possible to capture linguistic intuitions rather directly. Second, monotonic inheritance hierarchies prove successful in capturing morphological patterns at different levels of abstraction, while eschewing arbitrary decisions about what constitutes a default or non-default pattern. Third, the existence of carefully designed theories of syntax, lexical semantics, and

phonology based on the same formalism helps to make falsifiable claims on morphology that do not rely on unarticulated hypotheses about neighboring domains. Fourth and finally, the same holds in the opposite direction: claims about strong lexicalism within syntactic theories need to be substantiated by realistic articulated morphological analyses; the morphological framework outlined in Section 3 provides such a substantiation.

A sociological observation of the field of contemporary linguistics shows that much less effort is generally devoted to constructing formally explicit analyses within morphology than is typical in syntax or semantics. This seems to be caused at least in part by a feeling, among both morphologists and formal grammarians, that morphology is simple enough that detailed formalization is not worth the effort. We hope the present chapter will have shown otherwise: just as in other sub-fields, formal explicitness is an indispensable guide to both description and theory construction about complex morphological systems, and different formal architectures lead to different theories of morphology.

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Dependency Grammar

Richard Hudson

1 The Dependency Tradition

Dependency grammar (DG) is the modern continuation of the European tradition of grammatical analysis stretching back to classical antiquity, in contrast with the much shorter American tradition of constituency-based grammar which started with Leonard Bloomfield and was formalized by Noam Chomsky as Phrase Structure Grammar. This European tradition is also the source of Word-and-Paradigm (WP) morphology, so DG is normally combined, simply as a matter of history, with WP, in contrast with the American tradition which sees morphology simply as syntax below the word.

For example, take sentence (1).

(1) Small babies cried.

In the European grammatical tradition, strongly influenced as it was by analyses of Latin and Greek, the basic unit of grammar within the clause is the word, so there are three units of grammar: the words *small*, *babies*, and *cried*. Syntax can relate one word directly to another, so these words are all that is needed for the syntax, which allows *small* to modify *babies*, and *babies* (rather than *small babies*) to act as subject of *cried*. The word also defined the domain of morphology, so the relation between *cried* and the morphs *cry* and *-ed* is handled by morphology (traditionally called “accidence”), which is sharply separated from syntax. This tradition effectively forces the recognition of morphological structure as a distinct linguistic level, contrasting with syntax as well as with phonology. So the European tradition, including DG, combines three different assumptions:

- Dependency structure (DS): units are related by asymmetrical dependency rather than by part-whole relations.
- Lexical integrity: the units of syntax are words, not morphs.
- Morphological structure: morphology defines a distinct level of analysis.

On the other hand, although these assumptions tend strongly to be combined for historical (and geographical) reasons, they are logically separate, and indeed we shall see below that some recent work does separate them, and that the traditional packaging may in fact be unhelpful.

Since the main defining characteristic of DG is an approach to syntax which challenges one of the main assumptions underlying the mainstream PS tradition, we must start with an introduction to DS. The history of the choice between DS and PS has been ably summarized as follows by Mel'cuk, one of the leading proponents of dependency-based analysis:

Syntactic dependency has been used to talk about the structure of sentences from Antiquity and throughout the Middle Ages to modern times. All respectable pre-20th century grammatical traditions in syntax have been based on it, as has much language teaching. By the 8th century, Arab grammarians (e.g. Sibawaih, who died in 798) already distinguished the governor vs. the dependent in syntax and used this distinction when formulating rules for word order and inflection One finds dependency trees as a means of describing sentence structure in German syntax books from the 19th century In point of fact, constituency representation in syntax, i.e. what became known as phrase-structure, was first introduced . . . in the early 20th century. The dependency approach was properly presented for the first time in Tesnière 1959 . . . ; this profound treatise made syntactic dependency available for serious theorizing. Yet, due to the dominance of Chomskian Transformational-Generative Grammar—which used, as its main syntactic tool, the phrase-structure representation (i.e. constituency)—the [dependency] approach did not become popular in modern linguistics until the beginning of the 1980s. (Mel'cuk 2003: 22)

The difference between PS and DS emerges from a very simple question about our earlier example: What is the subject of *cried*, and what is it the subject of? According to PS, the entire noun phrase *small babies* is the subject of the entire clause *small babies cried*, but for DS, the subject relation involves just two words: the noun *babies* and the verb *cried*. The DS analysis gives no “official” status to the noun phrase and the clause, although they are implicit in the analysis; conversely, the PS analysis gives no explicit recognition to the relation between the words *babies* and *cried*, although this is again implicit. Each system of analysis has its own standard diagramming system: the PS tree and the DS “stemma” illustrated in Figure 23.1.

In both analyses the essential relations are asymmetrical, and in both diagramming systems the vertical dimension is used, iconically, to represent this asymmetry. In PS the essential relation is the part-whole relation between a smaller “constituent” and the larger one of which it is a part, whereas in DS it is the dependency relation between one word and the word

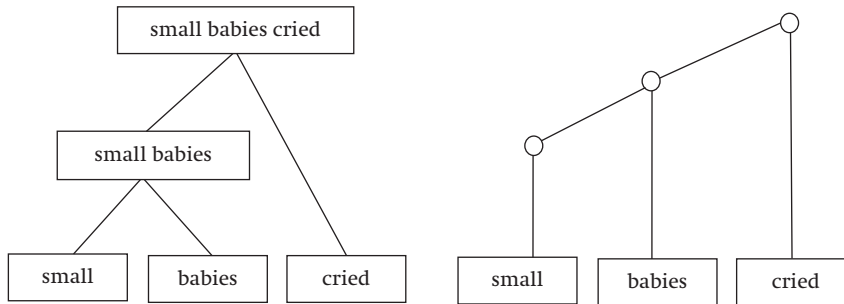


Figure 23.1. A PS tree and a DS stemma

on which it depends. (Unfortunately there is no generally accepted name for the latter word, so I shall use my own preferred term, “parent”; so in (1) *babies* is the parent of *small*, and *cried* is the parent of *babies*.)

However, it is important to recognize that DG is no more unified than PSG. The only unifying feature is, in fact, DS, and as we shall see below, at least one version of DG rejects the other two traditional partners of DS: lexical integrity and morphological structure. The DG tradition includes a large number of distinct theories (listed in §4), which are divided by deep theoretical issues. One of these concerns the notation for DS. One objection to the standard diagramming systems is that they place irrelevant limitations on our theoretical options. Since there is only one vertical dimension, each one only allows one asymmetrical relation. But what if there are good theoretical reasons for assuming more than one? This situation would arise in two cases:

- If we need to combine PS and DS analysis by recognizing a direct relation between two words in addition to some part-whole constituency relation.
- If we need to recognize mutual dependency between two words.

Although both PS and DS are widely assumed to preclude these possibilities, it may in fact be premature to rule them out—and indeed there is some evidence for both cases: evidence (discussed in §2) that Welsh mutation requires phrases to be recognized as such (Tallerman 2009) and evidence (reviewed briefly in §5) that extraction (in English as in other languages) with *wh*-pronouns requires mutual dependency (Hudson 2003b).

In short, we must abandon the vertical dimension for at least one of these relations, and my own preferred solution is to indicate asymmetrical dependency relations with arrows, as in Figure 23.2. These diagrams also show how a DS analysis may be enriched with functional labels such as “adjunct” or “subject.” The diagram on the left is pure DS, while the one on the right combines DS and PS. Even if this combined analysis is wrong, its wrongness should be established by theoretical and empirical debate rather than by being ruled out a priori by the notation.

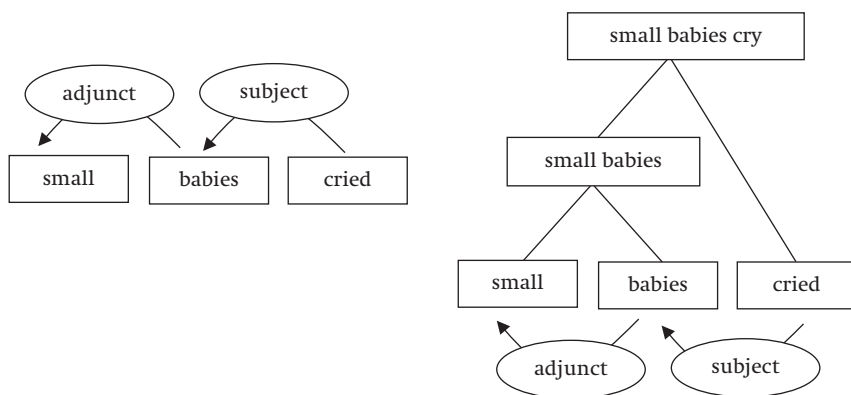


Figure 23.2. A dependency structure using arrows

The relative merits of PS and DS have hardly been debated in the theoretical literature; this is largely because of the social and numerical dominance of the PS community, which has by and large ignored the arguments for DS. This attitude was encouraged by some early articles which claimed that the two approaches were weakly equivalent (Hays 1964; Gaifman 1965; Robinson 1970)—a claim which is certainly true for some very limited versions of PS and DS, but which equally certainly does not apply to all possible versions. For example, a “non-projective” version of DS theory which allowed stemma lines to cross would certainly not be weakly equivalent to a standard version of PS theory. Similarly, and as suggested above, a version of DS might allow mutual dominance, which is completely impossible in PS. The following list summarizes some of the main arguments in favor of DS:

- **Simplicity:** A DS analysis requires just one node per word, so there are no phrasal nodes (unless, of course, DS is combined with PS).
- **Word order:** A DS analysis, as such, is neutral as to word order so it needs to be supplemented with some other system for fixing word order where needed; but this incompleteness is also a source of flexibility for accommodating different kinds of word-order systems. In contrast, word order is, at least in principle, built into PS, so some kinds of word-order phenomena such as “scrambling” are challenging even given the Generalized Phrase Structure Grammar separation of “immediate dominance” and “linear precedence” within a single phrase.
- **Semantics:** Syntactic dependencies are similar to the semantic roles with which they are paired, whereas PS requires part-whole relations to be mapped onto classified semantic roles such as “agent” or “instrument.”
- **Headedness:** For DS, every construction is endocentric by definition, because every construction is defined by dependency relations between its head word and the other words that depend on it. In contrast, PS

accommodates exocentric constructions as easily as endocentric, and it is only by theoretical stipulation that X-bar syntax bans the former. (Indeed, X-bar syntax already combines PS with DS by importing the latter's asymmetry into a PS analysis.) Unlike word order, therefore, DS is more restrictive than PS in that it requires headedness.

- **Valency:** For DS, most of syntax (or even the whole of syntax) is controlled by the syntactic requirements of individual words (including the requirements they inherit from more general categories). In the DS tradition, these requirements are called “valency” (a term introduced by Tesnière and applied in the first instance just to verbs), but the notion is similar to traditional government and modern subcategorization or functional completeness. The advantage of DS in this area is that valency requirements follow dependencies—in fact, the two notions are mutually defining—whereas PS does not provide any direct structural link between a word and the words that it governs.
- **Psychology:** The basic assumption of PS is that part-whole relations are the only relations that are available for syntax. Taken as a psychological claim this is absurd, given the wide range of relations that we are capable of recognizing outside language (e.g., between people). But if we are mentally able to recognize dependencies between words, why not allow such relations in syntactic theory (Hudson 2003a)?

In short, the arguments in favour of DS rather than PS are strong, and deserve to be taken much more seriously than they have been. Unfortunately, in the absence of proper debate, the choice between the two approaches is currently made largely on social and geographical grounds, with PS dominating in the USA and other anglophone countries and DS much stronger in Europe—a distinction which is interestingly reminiscent of the split in morphology between the American “Item and Arrangement” model and the European “Word and Paradigm” model (Robins 1959).

2 Morphological Evidence for Phrase Structure in Syntax

On the other hand, there does appear to be some evidence from morphology that DS may not be enough on its own. This case is based on so-called “edge phenomena” in morphology, where some syntactic property of an entire phrase is signalled by a purely morphological phenomenon applied to a word which is located on the edge of the phrase. Clearly, if the phrase's edge is a crucial element in the analysis, then to that extent the phrase itself is represented, though it is an open question whether anything more than the edges is ever needed. One prediction of “pure” DS (i.e., DS without PS) is that such phenomena are impossible, but there is good evidence for edge phenomena in some languages.

The crucial characteristics of the phenomena concerned are these:

- Some word W undergoes a change of form when it is on the edge of a syntactically relevant phrase.
- W is not always the head of the phrase.
- The change to W cannot be analyzed as the result of combining it with a clitic that is syntactically outside the phrase (as with the English “group genitive” in *the King of England’s daughter*).
- Nor can the change to W be explained in terms of regular phonological sandhi processes (such as assimilation or apocope).

According to these criteria, a number of languages offer clear evidence for edge phenomena (Anderson et al. 2006). One such language is Welsh, where the choice between PS and DS has been discussed in detail by Tallerman (2009).

The relevant phenomenon is soft mutation (e.g., the change from *llawn* ‘full’ to *lawn*, or from *dwy* ‘two’ to *ddwy*), which according to a widely accepted analysis called the “XP trigger hypothesis” applies to the first word of one complement phrase when it immediately follows another (Borsley et al. 2007). This immediately satisfies the first criterion for edge phenomena by applying to a word on the edge of a phrase. The second criterion is also satisfied because, although the mutated word usually is the head of this phrase, it need not be, as witness examples such as (2) and (3) (from Tallerman 2009). As in Tallerman’s article, the mutated word is underlined and its unmutated form is shown in brackets after the sentence. The brackets show the boundaries of the mutated phrase.

- (2) Dw i [lawn mor grac â chi] (llawn)
 be. PRES.1S I [full as angry as you]
 ‘I’m just as angry as you.’
- (3) Rhoddodd Elen y delyn [ddwy droedfedd i ffrwdd] (dwy)
 put. PAST.3S Elen the harp [two foot away]
 ‘Elen put the harp two feet away.’

The significance of these examples is that it would be virtually impossible to justify an analysis in which the mutated word was the head of its phrase; this is why soft mutation passes the second criterion. The third criterion is easy: there is nothing at all additive about mutation, so once again there is nothing to be said for an analysis in terms of a clitic external to the mutated phrase. And finally, mutation is definitely not due to regular phonological processes because it is strongly influenced by the lexical and syntactic context.

In short, syntactic soft mutation in Welsh is a clear example of a morphological edge phenomenon. That being so, it is strong evidence that a grammar needs to be able to refer to the edge of a phrase so, at least in that sense, it calls for the apparatus of PS. However, this

conclusion needs to be interpreted with care. The evidence does not prove any of the following propositions:

- that DS is not needed. After all, the arguments in favour of DS still hold true, so if anything the evidence favors a mixed theory which allows both DS and PS to coexist in the same structure (as hinted at in Figure 23.2).
- that the whole of PS is needed. In its familiar form, PS is equivalent to a labeled bracketing. Edge phenomena show the need for brackets (or equivalent) but not for labeling—in other words, for phrasal categories as such; so it is easy to imagine a marriage of DS and PS to which the latter contributes nothing but the edge marking.
- that edge marking is needed in every language. It seems likely that although phrasal edges are relevant to a grammar of Welsh, they are irrelevant and therefore non-existent in a grammar for English; and, in psychological terms, that Welsh speakers define phrasal edges and pay attention to them, but English speakers do not.

This discussion of morphological edge phenomena shows how important morphology can be to discussions of syntax, and in particular, how important it can be for the choice between DS and PS. We now turn to influence working in the other direction: how the choice between DS and PS affects theoretical choices in morphology.

3 Morphology as a Distinct Level of Analysis

One of the most fundamental choices facing any theory of morphology is whether to recognise morphology as a distinct level of analysis between syntax and phonology (Chapters 8, 10). This involves two separate questions about morphological patterning: Is it distinct from syntactic patterning? And is it distinct from phonological patterning? The first of these questions is about the word: are words sufficiently similar to sentences to require the same kind of analytical apparatus?

According to PS, a sentence consists of “constituents” of various sizes, all related to their parts in the same way. In this hierarchical structure, words are included among the constituents, and since they appear to have parts—their constituent morphs¹—it is reasonable to continue the analysis down inside the word. For example, in our earlier example *Small babies cry*, it is tempting to see the relation between the suffix *-s* and the word *babies* as an example of the same relation as the one between *babies* and *small babies*. In that analysis, words have no special status in the grammar; they are simply phrases, albeit small ones. Of course, it is also possible to reject this

¹ I use the term *morph* rather than *morpheme* in order to stress that these units are concrete rather than abstract. A morph is part of a word which has a position before or after other morphs and is realized phonologically.

conclusion, as many morphologists do, in favour of some version of the Word-and-Paradigm approach, so that PS applies just to sentence structure while some other model applies to word structure. But the point is that this decision is not required by the assumptions of PS.

In DS, on the other hand, words do have a very special status because (in the absence of phrases) they are the only units of grammar (Chapter 13). There is no hierarchy based on size in which words might be middle-sized units. DS is essentially a theory about how words are related to one another—a “bottom-up” theory about how words can be combined to form sentences, in contrast with the “top-down” PS theory of how sentences could be broken down into smaller parts. The special status of words in grammatical theory presumably reflects their special psychological status which allows even small children to insert word-spaces in their writing with very little teaching, and which also allowed words to be isolated very early in the history of writing (as in the word lists and verb paradigms of the Babylonian grammarians of four thousand years ago: Gragg (1994)). Indeed, one of the salient facts about the Western grammatical tradition is its lack of interest in morphological structure, in contrast with the attention lavished on sentence structure (Robins 1967: 56). Instead of dividing words into morphs, the Greek and Latin grammarians simply listed typical examples (“paradigms”), leaving learners to do their own analysis.

These assumptions about the place of words in DS lead logically to a single answer to our question: morphology is different from syntax. Of course, it is possible to ignore or deny this logic. In the PSG tradition the opposite position is occupied by Distributed Morphology (Chapter 15), and I shall explain in Section 4 that DS has sometimes been combined with the assumption that syntax in some sense includes morphology. However this assumption flies in the face of research evidence for “morphology-free syntax” (Chapter 9)—the idea that syntax is blind to purely morphological structure such as morphs (Zwicky 1992; Corbett 2009)—not to mention all the evidence in favour of the Word-and-Paradigm model.

One way to view the different implications of DS and PS would see DS as relevant to syntax, with PS as the model for morphology. After all, if *babies* is a unit of grammar where morphology and syntax meet, then one could see it as the whole of which the morphs {baby} and {z} are the parts, even if it is not itself a part of any larger unit. In this view, then, PS would be an appropriate model for the relation between words and morphs, with DS applying to the relations between words.

However, this simple view faces a serious objection: the part-whole relation requires the parts and the whole to exist on a similar level of abstraction. For example, a book can be viewed either as a physical object or in terms of its content. As a physical object, its parts are sheets of paper and a cover; but as content, its typical parts are a table of contents, a number of chapters, a list of references, and an index. Each of these is a

different “representational redescription” of the same book (Karmiloff-Smith 1994), with its own vocabulary and properties. Returning to morphology, the idea that a morph could be part of a word is like treating a sheet of paper as part of a book’s content. The Word-and-Paradigm approach assigns morphs and words to different levels of abstraction, with quite different properties. For example, whereas words are classified as nouns, verbs, and so on, morphs are classified as roots or affixes; and whereas words have meaning, morphs do not. Applied to English, this allows the {z} morph to occur, with completely different consequences, in both nouns and verbs. And in Latin, one of the languages for which WP was developed, it allows properties such as “first-person singular” to be expressed by many different indivisible morphs, such as the {o}, {am}, {i}, and {or} in *am-o* ‘I love,’ *am-āb-am* ‘I used to love,’ *am-av-ī* ‘I have loved,’ and *am-or* ‘I am loved,’ each of which expresses a number of other distinctions at the same time.

This argument leads to the conclusion that PS is not, in fact, a suitable model for relating words to morphs. Words and morphs exist on different levels of abstraction, so morphs cannot be parts of words. Instead, their relation must be an example of realization, the relation between one entity and another which makes it more “real”—less abstract (Stump 2001). However, this conclusion does not follow from the assumption of DS; as emphasized earlier, DS is independent of assumptions about lexical integrity and morphological structure.

On the other hand, there clearly is a sense in which {z} is part of a larger unit, even if this larger unit is morphological rather than a syntactic word. Indeed, one of the striking characteristics of morphological structure is its rigidity, which is just what we might expect from a whole which holds all its parts closely together. It seems, therefore, that we have a combination of relations: realization relating a word to its morphological structure, and part-whole relations between this structure and its parts. These part-whole relations call for an analysis in terms of PS, with larger units consisting of smaller ones. The structure of *babies* must therefore be something like Figure 23.3, where the curved arrows labelled “r” (or “realization”) show realization and the numbered straight arrows show parts. The dotted lines represent the relation between the syntactic word “BABY, plural” (the plural of BABY) and the more general categories BABY and “plural”; these dotted lines anticipate the “is-a” relation of Figure 23.8.

Once again we have to ask whether PS and DS are mutually exclusive. Is there any evidence of a dependency relation between the morphs? At one time a popular answer was that every word has an internal dependency structure in which the right-most element was always the head—the Right-hand Head Rule (Williams 1981). The claim is supported in part by English morphology because we use suffixes rather than prefixes for changing word classification, so in *babies* the suffix shows that the word is plural and in

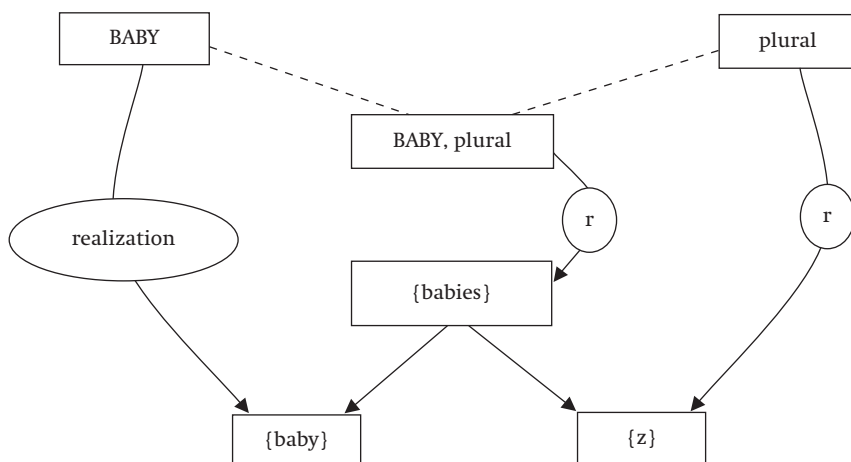


Figure 23.3. Syntax and morphology of *babies*

exploration the suffix indicates that it is a noun. If head-hood is merely a matter of word class and inflection, the claim is correct for English; but it faces a number of serious objections even when applied to English (Borer 1998). Perhaps the most important objection is that it confuses syntax with morphology. In purely morphological terms, the direction of dependency between a root and a suffix is clearly the reverse of the one claimed: the suffix must depend on the root. After all, that is precisely what “suffix” means – a secondary element added to the primary one, incapable of acting on its own, and with its position defined in relation to the primary one. The simple fact is that {baby} can occur without {z}, but {z} cannot occur without some lexical form to support it. The fact that {z} indicates a syntactic category is irrelevant to its status in morphology. After all, precisely the same is true of {baby}, which signals a different syntactic category (noun); and in an inflected verb such as *takes*, it is the lexeme realized by {take} that supplies all the syntactically vital information about valency.

This discussion already offers one argument for a dependency relation between affixes and roots, where the asymmetry is somewhat similar to that between a syntactic dependent and its parent in terms of autonomy, selection, and position. A part-whole analysis on its own does not show this asymmetry any more than PS did before the X-bar version incorporated asymmetry from DS. However, we can go further by exploring the selection relations among morphs. Take nominalization in English, for example. English has a number of alternative suffixes which are used for changing adjectives into nouns, as in *sincerity* and *gentleness* (Huddleston and Pullum 2002: 1702–3). These two words illustrate the two main alternatives: {ity} and {ness}. In a few words these are both possible (e.g., *clarity*, *clearness*), but in general they are selected by the morphological structure of the base to which they are added. In particular, there is a strong selection relation

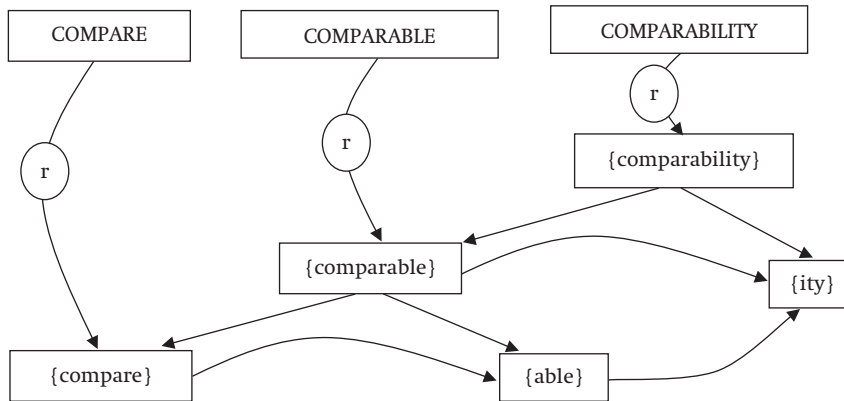


Figure 23.4. The morphological structure of *comparability*

between {able} and {ity}, as in *ability*, *capability*, *comparability*. Not only do we tend to favour {ity} after {able}, but we have a general morphophonological rule which realizes this pair of morphs as *ability*. The significance of these observations is that they conflict with a strictly PS analysis because the morph {able} is not a sister of {ity} in a word such as *capability*, where the sister of {ity} is the complex form {capable}; so in a word like this, {able} should not be able to influence {ity}. Consequently, the strong relation between these two morphs must be a dependency, coexisting with the PS structure. Figure 23.4 shows a possible analysis of the word *comparability*. The main point to note in this diagram is that it shows three dependencies, two of which point to {ity}; so this morph depends both on {comparable} and on {able}. This leads to a very general theoretical claim: that morphological structure requires both part-whole relations and dependency relations in order to reveal the complex relations among morphs, in addition to the realization relations between morphological patterns and words.

Another area of morphology where dependencies appear at first to be relevant is compounding, where single-word morphological compounds such as *postman* (meaning ‘man who delivers post’) are very similar in meaning and structure to two-word pairs such as *grocery man* (‘man who delivers groceries’), which are clearly related by dependency. The need for dependencies is especially clear in English because of the very unclear boundary between syntactic pairs and morphological compounds. For example, Google displays a typical level of uncertainty when asked to define *soap box* (with a space) by offering a definition of *soapbox* (no space) which, for good measure, includes the expression *soap-box*. At the same time, Google is aware of the differences because it gives a different frequency of occurrence for each of the three alternatives *soap box*, *soapbox*, and *soap-box*. However, it is quite unclear what this uncertainty tells us about morphological structure. Even in *soap box*, it is the words, not the morphs, that are linked by dependency; the morphs {soap} and {box} are simply juxtaposed, like any other pair of morphs realizing adjacent words. This being so, there

is no reason to assume a morphological dependency in *soap-box* or *soapbox*, or more generally between the parts of any compound word.

4 Theories of Dependency Grammar

The discussion so far has focused on very general ideas about syntactic structure and how they impact on morphology. After the general outline of the differences between DS and PS in Section 1, Section 2 argued that even if DS is preferred to PS in general, there is morphological evidence that at least the edges of phrases are sometimes an essential part of a structural analysis, implying a theory of syntax based on DS supplemented with ideas from PS. Section 3 then argued that the choice of DS in syntax leads naturally to a theory in which morphology is a distinct level of analysis mapped onto syntactic words by realization rules. In contrast with syntax, morphology needs PS for the obvious part-whole relations, but once again we actually need both approaches because PS needs to be supplemented with dependencies between morphological elements.

Given these important links between the DS/PS choice in syntax and the theory of morphology, one might expect advocates of dependency syntax to have developed morphological theories to match their theories of syntax. Unfortunately this is not the case, and most work on DS syntax has failed to develop a matching theory of morphology. I know of only three exceptions:

- recent work by Gross and Osborne within Catena theory
- longstanding work by Mel'cuk and others within the Meaning-text Model
- longstanding work by Hudson and others with Word Grammar.

To contextualize this work, I start with a brief review of DS-based syntactic theories.

Just like PS, DS has been developed in a large number of different directions, so there are almost as many competing theories based on DS as there are on PS. Here is an indicative but incomplete list:

- Generative Dependency Grammar (Vater 1975; Diaconescu 2002)
- Case Grammar (Anderson 1977)
- Functional Generative Description (Sgall et al. 1986)
- Lexicase (Starosta 1988)
- Tree-adjoining Grammar (Joshi and Rambow 2003)
- Link Grammar (Sleator and Temperley 1993)
- Catena Theory (Osborne et al. 2012)
- Meaning Text Theory (Mel'cuk 1974, 1988, 2003, 2009)
- Word Grammar (Hudson 1984, 1990, 2007, 2010)

The theories listed here are general academic theories of language structure, but DS is also widely used in computational linguistics (Kunze 1975;

Debusmann 2006; Kübler et al. 2009; Chapter 29 in this volume) and in books for school-teaching (Heringer 1993).

The last three theories listed are the ones where we find the most extended discussion of morphology, but (as noted in Gross and Osborne 2013, footnote 4) it has often been suggested that the minimal units of syntax are in fact morphs, or at least that syntactic rules can refer directly to morphs (Chapter 8). As I mentioned earlier, this assumption sits much more comfortably with PS than with DS; indeed, it is notable that the very ancient tradition based on DS paid little attention to morphological structure as such (in contrast with the paradigms illustrating different morphological patterns). However, the influence of PS reaches even into discussions of DS, so this PS-based assumption is accepted explicitly in many recent discussions of DS, including the first one, Hays 1964. The same is true of Catena Theory.

Catena theory is based on the term *catena*, which in this context means a chain of units which are linked by dependency. In syntax, the units are words, and the theory develops various claims about the role of catenae in the analysis of idioms, ellipsis, and other patterns (e.g., Osborne et al. 2012). The theory's main claim about morphology is that morphs are related by dependencies in the same way as whole words are, with roots depending on affixes as in some PS-based analyses. The German examples in Figure 23.5 are taken from Gross and Osborne 2013, but with their stemmas replaced by my horizontal arrows (pointing, as usual, toward the dependent). The third example shows how the morphological structure is simply part of the syntactic structure. (The discontinuities created by this analysis may allow the same raising analysis as purely syntactic discontinuities, but they are not discussed explicitly.)

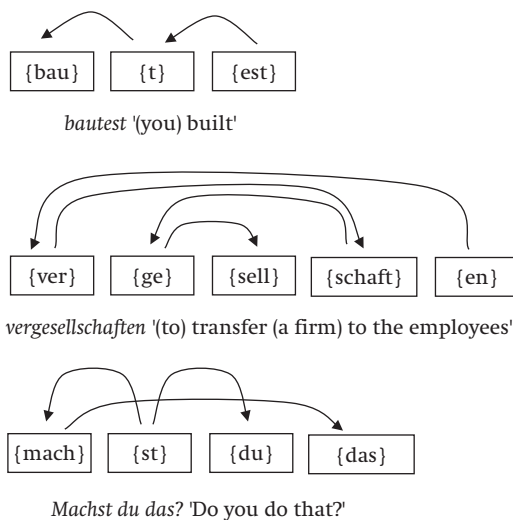


Figure 23.5. Morphological structure with catenae

As a theory of morphology, Catena Theory faces the same objections as similar theories based on PS (including the Right-hand Head Rule discussed earlier).

- The analysis of morphological structure is driven too strongly by the needs of syntax. Whenever the syntax needs a morphosyntactic category, this must be carried by a separate morph, regardless of the actual morphological facts. For example, if German infinitives are marked as such by the presence of the morph {en}, what about English infinitives? Must we assume a zero morph, which is never realized phonologically? And what about nonconcatenative morphological patterns such as umlaut or mutation, or the multiplicity of morphological markers found in German plural nouns?
- Moreover, the choice of relevant syntactic properties is arbitrary. Although some syntactic properties of a word are reflected by its affixes, others are determined by its lexical root. This is particularly true of government, where notions such as valency and transitivity apply to the lexeme, not to the inflectional categories. For example, the German verb *bautest* ‘you built’ is not only past-tense, second-person singular (as indicated by its inflectional endings), but it is also transitive, so it allows an object. Why should the first property determine the word’s internal structure, but not the second?

So far, the morphological sub-theory of Catena Theory has only been sketched in published form, so further work may address some of these objections.

In contrast, Mel’cuk has developed and described Meaning Text Theory (MTT) extremely thoroughly over several decades (Mel’cuk 1988, 1992–2000, 2003; Kahane 2004), and his work gives considerable attention to morphology (Mel’cuk 2008). One of the most impressive characteristics of this work is the range of languages and phenomena that it covers. I cannot do justice here to the depth and breadth of the work, so the focus will be on more general “architectural” features of the theory.

Meaning Text Theory assumes that a sentence’s complete analysis can be broken down into seven distinct, but related, structures, including one for semantics, two for syntax, two for morphology, and two for phonology. In each pair, one is “deep” and the other is “surface,” so unlike most theories of morphology, MTT provides two distinct structures, one oriented toward syntax and the other toward phonology. However, the terminology is misleading for outsiders, because word order is treated entirely as a matter of deep morphology, so MTT’s morphology includes an important part of what is elsewhere called “syntax” – linear order, but no dependencies. The following example of deep morphology is based on Mel’cuk’s analysis of his example *The people’s support for the prime minister amazes Mr Bumbo-Yumbo* (Mel’cuk 2008: 10). Figure 23.6 shows Mel’cuk’s deep morphological structure on the top line, and his surface morphological structure on the

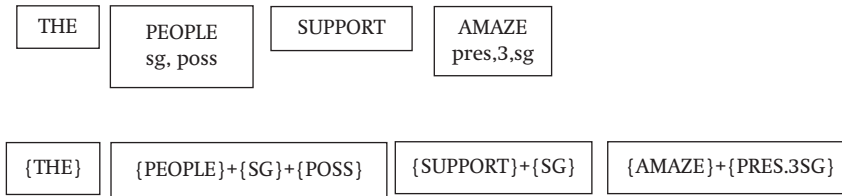


Figure 23.6. Morphology in MTT

second line. It can be seen that deep morphology shows morphologically unanalyzed words, identified in terms of lexical and morphosyntactic categories, while surface morphology interprets these categories in terms of morphemes, some of which are zero morphemes. It is only the surface morphological representation that clearly counts as morphological representation in the usual sense.

MTT is relevant to the present chapter because the two syntactic levels are both organized in terms of dependencies. In contrast, neither of the morphological levels shows dependencies, which illustrates the profound differences described earlier between syntax and morphology. Indeed, Mel’cuk’s notation for surface morphology assumes a part-whole relation between morphs and words, as suggested in Section 3. He also provides a rich specialized apparatus for changing one morphological pattern into another such as a rule for changing Tagalog nouns into adjectives by shifting stress (e.g. *álam* ‘knowledge’ becomes *alám* ‘known’):

$$A_{\text{PASSADJ}} = \langle \text{‘which underwent ...’}; / - ' - / \\ \Rightarrow / - - ' /; \sum = \text{applies to a noun, ...} \rangle$$

(Mel’cuk 2008: 304). These morphophonological rules are clearly unique to morphology, and in general MTT morphology is a clear example of a theory which combines DS in syntax with a distinct level of morphology.

On the other hand, MTT also recognizes “morphological dependency” as one of three main types of dependency: semantic, syntactic, and morphological (Mel’cuk 2003). Semantic dependencies exist on the level of semantics, and correspond to what others call semantic roles or argument structure. Similarly, syntactic dependencies apply to syntactic structures and are a mixture of universal and parochial syntactic relations such as “subjectival” and “determinative.” Morphological dependencies, however, mix syntax, semantics, and morphology by linking the morphology of one word to another word that determines it by agreement, government, or “congruence”—the agreement between an anaphor and its antecedent. In most versions of DS, agreement and government are taken as evidence for syntactic dependency relations, but MTT distinguishes such relations from those called “syntactic.” It is unclear how this terminological move improves the analysis; nor is it clear that agreement and government have anything in common with anaphor-antecedent relations, the third type of morphological dependency.

Returning to the MTT theory of morphology proper, its rich typological basis means that it offers a very useful summary of the phenomena that any theory needs to accommodate. It also offers a model of how to analyze morphology separately from syntax, and how this is encouraged by combining it with syntax based on DS. This separation of morphology from syntax is a strength. Arguable weaknesses of the theory include a lack of attention to morphological structure as such, beyond some rather simple part-whole structures, and a traditional lack of interest in similarities between morphology and anything outside language. Is morphology really totally *sui generis*? And in particular, is morphology similar to other things that we hold in our minds? To some extent of course it is a matter of personal taste whether or not to consider mental structures, but language is clearly a mental phenomenon so in the long run we must reconcile our theories of morphology with general psychological theory. The next section argues that this is possible and that a certain amount has already been achieved.

5 Network-based Morphology: Word Grammar

One of the clearest findings that emerges from syntax is that syntactic structure is complex—much too complex for the simple versions of either PS or DS without massive enrichment of some kind. For example, “raising” structures like (4) contain one word which has two parents (or, in PS terms, two mothers).

- (4) It stopped raining.

In this example the word *it* clearly depends (as subject) on *stopped*, but it must also depend (again as subject) on *raining*, because it satisfies the latter’s need for *it* as subject. Another kind of complexity is mutual dependency, which is found (among other places) in examples like (5) and (6).

- (5) Who came?
(6) I wonder who came.

The pronoun *who* is clearly the subject of *came* in both examples, but in (6) it is equally clearly dependent on *wonder*, a verb which requires some kind of question word as its complement. But if *who* depends on *wonder*, *came* must depend on *who*. In short, *who* and *came* depend on each other (Hudson 2007: 142).

This kind of complexity calls for a formal analytical apparatus which is much more flexible and powerful than the strictly hierarchical machinery of either standard PS or standard DS. These elementary models can be enriched in a number of ways, and one of the main items on the research agenda of theoretical linguistics has been the best way to enrich available models, with transformations and enriched feature structures among the

options considered. One particularly productive avenue of exploration has been the idea that syntactic structure is in fact a network rather than a hierarchy. This idea has generated interesting work in the branch of mathematics called graph theory (Ferrer i Cancho et al. 2004; Barabasi 2009; Solé et al. 2010), as well as in research on neural networks (Onnis et al. 2006). It also meshes well with the idea that we may use the same mental apparatus for syntax as we do for other areas of our mental life, given that we clearly use networks in general cognition. After all, one of the main conclusions of cognitive psychology is that memory is a network where each node is associated with many others (Reisberg 2007).

If our mental representations for syntax are indeed networks, then we can ask what the relations and units are without ruling out any possibilities on formal grounds. This idea provides the basis for two models of morphology: Network Morphology and Word Grammar. These two theories have a great many similarities (not least the central place they both give to the logic of default inheritance), but since Network Morphology is fully described in Chapter 18 in this volume I shall concentrate here on Word Grammar (WG: Hudson 1984, 1990, 2007, 2010; Gisborne 2010; Duran-Eppler 2011), which also has the distinction of combining a rich theory of morphology (presented in the previous references as well as in Rosta (1997), Creider and Hudson (1999), Camdzic and Hudson (2007), Hudson (forthcoming), Gisborne (forthcoming-a, forthcoming-b)) with a DS-based theory of syntax. The following account of WG includes some changes to the previously published versions of the theory in the light of the earlier arguments.

The earlier sections of this article concluded that both syntax and morphology need to combine DS with PS, though in different proportions: whereas syntax needs DS supplemented with parts of PS, morphology needs PS supplemented from DS. The main reason why morphology needs PS is that a typical word needs a single morphological realization, a single unit of morphology related (by realization) to a single unit of syntax. This morphological unit is a word-form, so just as the lexeme CAT is realized by the morph {cat}, the combination of CAT with 'plural' (called CAT, plural) is realized by the word-form {cats}. (In WG notation, {...} is used for morphology just as /.../ is for phonology, so any unit of morphology is written between braces regardless of its internal complexity.) We now have two morphological units, {cat} and {cats}, but the latter clearly contains the former, alongside another unit written {z}. In short, {cats} contains two parts, so the analysis requires PS. But, in contrast with Distributed Morphology, the morphological structure involves the word-form {cats} while the syntactic structure involves the word "CAT,plural"; the two meet via the realization relation between CAT,plural and {cats}, but they are completely separate.

On the other hand, there is also an asymmetrical relation between these parts whereby the affix depends on the root; like any syntactic dependency,

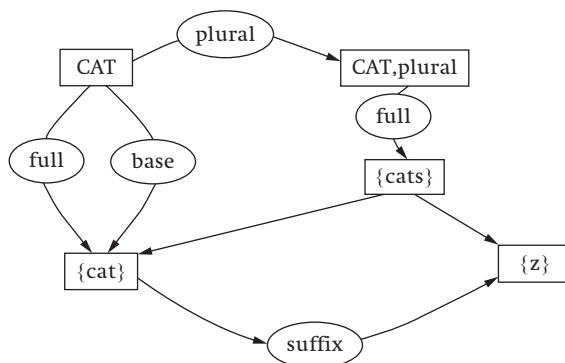


Figure 23.7. The morphology of *cats* in Word Grammar (1)

this morphological dependency brings together at least two properties, which in this case are:

- selection: {cat} selects {z} (in contrast with irregular noun roots such as {mouse} or {analysis})
- linear order: {z} is a suffix, so it follows {cat}.

Figure 23.7 shows this small area of the total morphological network for English, with simplifications that will be discussed below. The label “full” means “fully inflected form”—a particular kind of realization relation, contrasting (in this case) with the more familiar “base.” In words, the plural of CAT is CAT,plural, whose fully inflected form {cats} has two parts: {cat} and its suffix, {z}; {cat} is also, by default, both the base of the lexeme CAT and its fully inflected form. Every link and every unit can be justified, so at least this part of the grammar must have a much richer structure than a mere hierarchy—in short, it must be a network.

But although this network is not itself organized hierarchically, it clearly coexists with a purely hierarchical structure which provides the generalizations that allow and explain the network. For example, CAT is an example of a noun, and CAT,plural is an example of a plural noun, with the default morphology of this category. Every unit is related to a more general category from which it inherits properties; and the same is true of every relation. For example, both “full” and “base” are examples of the more general “realization” relation. This hierarchical organization is shown in Figure 23.8, where the small triangle signals an “is-a” relation; for example, a noun is a word, CAT is a noun, and so on. As in Network Morphology, the logic of generalization is default inheritance, so exceptions are handled with ease (Hudson forthcoming).

This very simple example already illustrates most of the formal apparatus of WG—a hierarchy of units ranging from the most general (word) to the most particular (CAT,plural), where each unit is also part of a non-hierarchical network which relates it to other units, and where each relation (other than is-a) is hierarchically related to other more or less

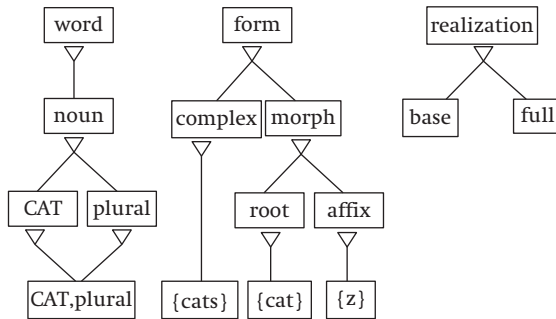


Figure 23.8. Three hierarchies in WG

general relations. Moreover, the formal apparatus is paired with an equally simple model of processing and learning, including default inheritance, node-creation and binding, and a model of activation and how it spreads and affects these processes (Hudson 2010). These cognitive elements play an important part in the grammar, but the formal apparatus can be seen in its own right simply as a theory of how language is organized.

One of the potential attractions of WG for morphologists is that it is not simply a theory of morphology; in fact, it is primarily a theory about syntax, so the interface with syntax is already available for inspection. This is important because morphology and syntax obviously have to be reconciled sooner or later, and there are areas of research where they have to be reconciled immediately. The obvious example is the analysis of clitics, which I discuss briefly below. On the other hand, it has to be admitted that WG has no proper theory of phonology (though it may be compatible with some existing theories such as Dependency Phonology: van der Hulst 2006). Nor does it have the typological range of MTT, having been developed mainly on the basis of English and other western European languages (with occasional glances at Semitic and Cushitic). But perhaps the most important research gap is the lack of a computer implementation comparable with the DATR-based implementation available for Network Morphology. The potential interactions in a network really need to be tested by computer, and especially so if they include cognitive patterns such as activation.

Turning to clitics, the WG theory of clitics has evolved through a series of studies (Hudson 2001, forthcoming; Camdzic and Hudson 2007), so the following account reflects the latest theory rather than a single unchanging theory. The leading idea is that clitics are full syntactic words which, exceptionally, are realized by affixes (Chapter 2). Like other affixes, these need a “host,” but in WG the host is a larger morphological structure which contains them rather than a syntactic word that they “lean” on (as suggested etymologically by the term *clitic*), so in (7) the suffix {ll} is part of the morphological complex {cats’ll}.

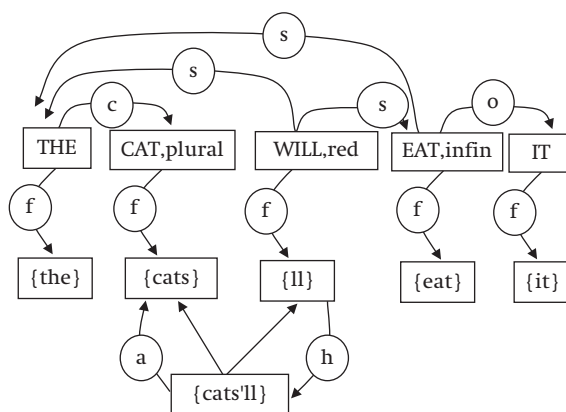


Figure 23.9. WG syntax and morphology for a simple clitic

(7) The cats'll eat it.

This is similar to the structure for *cats*, where $\{z\}$ is part of $\{cats\}$, except that where $\{cats\}$ is the realization of a syntactic word, $\{cats'll\}$ is not. This is a purely morphological entity called a “hostform” which does not realize anything. Since the ordinary word order rules apply, all the grammar has to say about $\{ll\}$ is that its host takes the realization of the previous word as its “anchor” (and as its first part). This structure is shown in Figure 23.9, which omits most of the morphological structure for *cats* as shown in Figure 23.7.

The syntactic structure is shown at the top of the diagram and the morphological at the bottom, so the two are mapped onto one another by the realization arrows labeled “f” (for “fully inflected form”). In the syntax, the root of the sentence is the finite verb *WILL* (subclassified here as “reduced”) with *THE* as its subject and the infinitive of *EAT* as its subject complement. These two dependents have further dependents of their own (*CAT,plural* as complement of *THE*, and *IT* as object of *EAT,infin*); but this is a raising structure, so *THE* is the subject of *EAT* as well as of *WILL*. In the morphology, almost every word is realized by a full word-form, with the exception of *WILL*, which (because of its classification as “reduced”) is realized by a mere affix $\{ll\}$. This brings with it a host, consisting of $\{ll\}$ and the anchor, which is whatever happens to be the preceding word. The diagram omits some details, such as the distinction between tokens and types (which in fact plays an important part in WG theory) and all the apparatus for linear order.

The theory can be extended to special clitics such as the clitic clusters of French (Hudson forthcoming) and Serbo-Croatian (Camdzic and Hudson 2007). Take an example such as the French (8), compared with a syntactically similar sentence without clitics such as (9).

- (8) Il la leur présentera
 he her to-them will-introduce
 ‘He will introduce her to them.’

- (9) Jean présentera Marie à ses amis
 John will-introduce Mary to his friends
 'John will introduce Mary to his friends.'

In this case, each clitic is once again a full syntactic word, with ordinary syntactic dependencies but (exceptionally) only an affix as its realization. But unlike English clitics, French ones have a structurally complex host which provides a template of "slots," with the clitic concerned already assigned to one of these slots; for example, *il* occupies the "subject" slot, while *la* and *leur* occupy slots for "third-person direct object" and "third-person indirect object." These relatively abstract slots are then mapped onto slots for linear order which vary according to the type of verb, to take account of the differences between affirmative imperatives, as in (10), and other verbs as in (8) above.

- (10) Présentez-la-leur!
 introduce her to-them
 Introduce her to them!

Figure 23.10 shows a partial structure for example (8). The top line shows the syntactic structure consisting of five words and their syntactic dependencies; for example, "3sg,m" is the pronoun *il*, and "PRÉSENT,fut,3sg" is *présentera*. The middle line shows the four morphological forms that realise these (with a fused realisation of the preposition *à* and the pronoun "3pl" as {leur}). And at the bottom is the single complex morphological form that contains all four of these forms.

This figure makes a number of controversial assumptions. Most obviously, it assumes that the clitic pronouns occupy their expected positions after the verb in syntax, leaving the morphology to show their actual positions. (This follows the practice of Autolexical Syntax, Sadock 1991.) Another assumption is that {leur} is a fused realization of two words, both the preposition *à* and the pronoun called "3pl," in just the same way that {au} realizes *à* and the plural article *les* in *aux hommes* 'to the men.' The example thus illustrates two major mismatches between the syntax and the morphology, as well as the WG treatment of special clitics as parts of a complex hostform.

This analysis of French clitic pronouns illustrates a number of strengths in the WG theory of morphology. The associated theory of syntax takes the word as its basic unit, leaving the internal structure of words to the morphology (Chapter 10). The strict separation of morphology from syntax allows mismatches between the two structures, such as the two noted above. Another attraction involves the logic of default inheritance, which accommodates alternative patterns in a deeply explanatory way; for example, it turns out that the default pattern for French clitics is in fact the one found in affirmative imperatives such as (10), which in turn follows precisely the same order of elements as the regular syntactic pattern. In

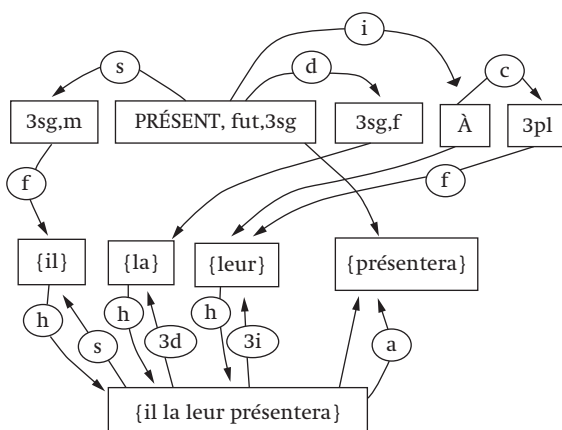


Figure 23.10. Syntax and semantics for special clitics

contrast, the exceptional, but more common, pattern found with other verbs can be explained in terms of the presence of two clitics, the subject and the negative (Hudson forthcoming). And finally, we can address the question of how clitics form clusters, given that each clitic introduces a new hostform. The WG answer builds on the theory of processing, which includes a process called “binding” that applies very generally and tends to identify compatible and highly active nodes. So if two clitics are both highly active at the same time, and both introduce a virtual hostform and anchor verb, the processor binds their hostforms and anchor verbs into one, creating a clitic cluster.

The discussion so far has concentrated on the WG treatment of morphosyntax, the interface between syntax and morphology, because this is the part of the theory which is most relevant to this chapter. The pairing with DS is less relevant to other topics in morphology such as allomorphy and syncretism, but WG morphology does provide for them as well (Hudson 2007: 63–116).

6 Conclusion

Although dependency grammar has so far contributed disappointingly few insights to the theory of morphology, it has great potential as the syntactic counterpart of a fully adequate theory of morphology. As argued in both MTT and WG, this is because dependency grammar generally takes the word as the basic unit of syntax, so syntax has to stop at the word and leave morphology to deal with the word’s internal structure, using partially different machinery. At the risk of simplifying, the dominant relation is the word-word dependency in syntax but the part-whole relation between word-forms and their parts in morphology. So although lexical

integrity is logically separate from DG, at least the existence of well-developed versions of DG shows that it is possible to combine lexical integrity with a theory of syntax.

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Part VI

Domains for the Evaluation of Morphological Theories

Frequency and Corpora

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This chapter considers the role of the linguistic corpus in morphology. We review the ways corpora are typically used, the inherent challenges of corpus-based morphology in synchronic as well as diachronic work, and the insights corpus linguistics gives to morphological theory. Work on corpora often explores the morphological relevance of frequency, and so results and challenges in this domain are highlighted.

1 What is a Corpus?

Empirical work in morphology draws its data from three primary sources: corpora, experimental results (see also Chapter 28 of this volume), and grammaticality judgments. An important attribute of a word-form that is best approximated through the use of corpora (as opposed to the other two sources) is its pattern of usage: its frequency and distribution of use. This chapter gives an overview of what a linguistic corpus is, how it can be used to assess a word-form's frequency and distributions, and how these are relevant to morphological theory.

As Manning and Schütze (1999) note, the loosest interpretation of a corpus can be found in statistical natural language processing, where *corpus* refers to a set of data from a certain domain of interest. In this sense, a collection of saccades recorded with an eye tracker, like the Dundee Corpus (Kennedy et al. 2003), is also a corpus, even if not a linguistic one.

Kilgarrieff and Grefenstette (2003: 334) offer a slightly more restrictive interpretation of a corpus as “a collection of texts when considered as an object of language or literary study.” Kilgarrieff and others, such as Zséder et al. (2012), argue that any large collection of text (often gathered from the

web) can be a valid subject of linguistic research because its size, along with the available computational and statistical methods, makes up for its lack of sampling and control. Gries and Newman (2013) add, however, that a prototypical corpus is expected to meet further requirements. It needs to be machine-readable to allow researchers a fast extraction of the patterns they are looking for. It should also be representative of a certain dialect, sociolect, or register, and it has to be balanced so that the aspects of the dialect (and other relevant factors) are sampled equally and thus weigh equally in an analysis. And while a corpus is often defined as “collection of texts,” it is important to note that “text” is interpreted fairly broadly. Both the medium (including audio or video recordings) and the register or genre of a corpus (spanning from transcripts of informal interviews to literary texts) can vary (see also Gries 2014a).

Kučera and Francis (1967) collected the Brown University Standard Corpus of Present-day American English during the course of the 1960s. This pioneering work of corpus linguistics is one of the earliest examples of what Gries calls a prototypical corpus, with a sample of written American English containing one million words from five hundred samples in fifteen genres. The arrival of corpora like the Brown Corpus, and others that followed, has grounded a significant bulk of empirical morphological research on the link between frequency, morphological structure and productivity. (CELEX is a widely used resource in linguistic research. It is not strictly speaking a corpus, but a database of word characteristics including frequency in given source corpora. For details see Baayen et al. (1993).)

It is usually argued that if we use large enough corpora, like The Corpus of Contemporary American English (Davies 2008) or the British National Corpus, the frequency of most forms approximates their probability in everyday use. While this is probably true for more frequent word-forms, one has to take note of the genre and the sources of a corpus before relying on it for distributional data. For example, different communities of practice can have different vocabularies with markedly different frequency patterns. Automatically collected, web-based corpora are filtered using spell-checkers, which eliminate most word-level variation, and corpora composed of sociolinguistic interviews will overuse the past tense because interviewees are prompted to talk about past events. (A detailed overview can be found in Gries (2011, 2014b) and Gries and Newman (2013).)

Corpora tend to build on written sources, and the written genre is notably different from speech in many respects, such as sentence length, the use of grammatical functions like present perfect or the passive voice, and, most importantly, vocabulary use. Word-formation also depends on the register and differs in the written and spoken genres (Plag et al. 1999). As Connine et al. (1990) have shown, frequency effects can be medium-specific, leading us to erroneous conclusions on the processing time of a word in an audio task if it has a larger frequency in written than in spoken

language. Furthermore, not everyone shares the same frequency distributions. Auer et al. (2000) show that processing patterns are notably different for hearing and deaf people, which they attribute to the difference in language experience. Walker and Hay (2011) find a correlation between whether a word is typically used by older or younger speakers and its processing speed when produced by an older or a younger speaker. Words typically used by younger speakers are processed faster if they are heard as spoken by a younger person and *vice versa*. This shows that both the background of the individual and the context of the utterance have an effect on frequency patterns in lexical processing.

It is clear that special care needs to be taken when assuming that frequencies collected from a particular corpus generalize to a particular speaker or speaker population that the researcher is trying to understand.

The new-found interest in linguistic corpora, whatever form they may assume, can partly be linked to the emergence of **usage-based functionalism** in theoretical linguistics. Proponents of this school argue that patterns of usage are crucial to understanding representation. As such, patterns which are only observable in the *parole*, such as the frequency or probability of a linguistic unit, are central to an adequate description of its behavior (see, e.g., Hay et al. 2003 for a summary). Morphemes have been shown to have different phonological patterning, to resist morphological change to a different degree, to be produced and processed more easily and to display a different degree of productivity, all depending on their frequency of use (see, e.g., Gries 2014a for a summary). Usage-based functionalism, in turn, is also heavily influenced by the last thirty years of research in psychology and categorization theory. Understanding the link between the frequency and distributions of a morphological pattern in a particular corpus on the one hand, and its familiarity or productivity (as measured by psycholinguistic experiments, for example) on the other hand, is far from trivial. While many are agreed that patterns and frequencies of usage are important, there are many ways in which the notion of frequency can be construed and measured.

2 What is Frequency?

It may, on the surface, seem unnecessary to devote a small section of this chapter to discussing what we actually mean when we use the word “frequency.” Surely frequency is simply a count of occurrence of how many times an object of interest appears in a corpus? There are, however, many different types of “objects of interest” that can be relevant to morphological work. It therefore seems sensible to delineate some different types of frequency that have been discussed and/or deemed relevant in the literature.

Take a simple word-form such as *unzipping*. There are a number of different frequencies that can be extracted from a corpus which may be relevant to understanding this word's behavior. The number of times that the whole word is represented—the **word-form frequency**, or **surface frequency**—is the frequency of *unzipping* in the corpus. This is sometimes taken as related to the strength of the representation of this morphologically complex word in the mental lexicon. The **lemma frequency** is the frequency of the “dictionary” form, collapsing together the various inflectional variants. (A variant of this is **lexeme frequency**; see Chapter 3 of this volume.) Thus, the lemma frequency would be the combined frequency of *unzip*, *unzips*, *unzipping*, and *unzipped*. This, too, is argued to relate to representation strength. Whether lemma frequency or word-form frequency is more important depends to some degree on one's theory about storage of inflected forms. However, experimental work suggests that at least some inflected forms are stored (Alegre and Gordon 1999; see also Chapter 28 of this volume).

The word-form is made up of a root (*zip*), and two affixes (*un-* and *-ing*). Each of these have their own frequency in the corpus, and each of these frequencies are relevant to the word's processing and storage, and the productivity of its parts. The frequency of an affix can be assessed by either **types** or **tokens**. The number of types is the number of observed distinct words containing that affix. *Un-*, for example, occurs in many different types: *untie*, *undo*, *unweave*, and so on. The number of different distinct words is the **type frequency**. Each of these types occurs with different frequencies. *Undo*, for example, is quite frequent, whereas *unweave* is likely to be encountered very infrequently. The total number of observations for *un-* is its **token frequency**. The token frequency will be contributed to much more by frequent words than infrequent words. As will be outlined below, the relationship between affix type and token frequency is an important consideration in assessing morphological productivity. Of course, not all morphological processes involve affixation, and any other morphological patterns can also be assessed in terms of **pattern frequency**, both by types and by tokens. Any type that is observed just once in a corpus is known as a **hapax legomenon**, and such forms have special status for the assessment of morphological productivity (Baayen 1992b).

In a bimorphemic word such as *unzip*, it has been argued that the **relative frequency** between the surface frequency and the **base frequency** (*zip*) is also relevant, with forms where the base is significantly less frequent than the whole word less likely to remain robustly decomposed (Hay 2001).

The base word, *zip*, also occurs in other words and compounds such as *zipper* and *ziplock*, which together form a word family. The number of distinct types in the family is known as the **word family size** (de Jong et al. 2000). The total number of observed tokens is known as **word family frequency** (de Jong et al. 2000). Other groups of relevant words are also

sometimes quantified, such as the size of “similar” groups of words, in the form of lexical neighbourhoods or lexical gangs.

Frequencies are extracted from corpora, and typically assumed to represent human experience in some form. The corpus count is generally regarded to be a measure of **objective frequency**. This is related to, but is not the same as, **subjective frequency**, which is the intuition that an individual has about the relative frequency or familiarity of words or other linguistic objects (see, e.g., Balota et al. 2001).

Some morphological work has also considered the frequency of phonological objects. This is particularly true of the phonemes near a morphological boundary. *Unzip*, for example, contains a low-frequency phonological sequence *-nz-*. Such transitions have been argued to work as a decomposition cue, which helps reinforce the morphological complexity of a word like *unzip* (Hay 2003). The consideration of frequencies of phonological sequences is known as **phonotactic frequency**. For phonotactics, it appears to be type frequency, rather than token frequency, which provides the most important metric.

A general methodological practice when using frequencies is to use **logarithmic frequency** instead of raw frequency. Baayen (2000) stresses that this is closer to how humans are likely to perceive frequency (with differences between lower frequencies appearing more salient, so that one pineapple versus five pineapples is more salient than 1,001 pineapples versus 1,005 pineapples). It also more closely approximates the assumptions required for linear regression.

All of the above concepts can be expressed as raw frequency, but they are often usefully recast as a **probability**. Starting with observed frequency distributions and then expressing them as probabilities has a number of advantages. First, it facilitates comparisons across data-sets. If an object is observed fifty times in a data-set, this number doesn't (by itself) tell us how many times we might expect to find it in a different, differently sized, data-set. However if we express this as the probability of it occurring in a given data-set (e.g., $50/1,000,000 = 0.0005$), then this can be usefully interpreted in other domains. Second, it enables flexible redefinition of the reference set, in the form of the **conditional probability**. For example, while the probability of encountering *zip* in a data-set might be quite low, the conditional probability of encountering it, given that we have just encountered the prefix *un-*, is likely to be considerably higher. Third, probabilities of events can be combined to establish the probability of a (possibly unobserved) joint event. Given the probability of *-n*, for example, and the probability of *z-*, we can calculate the probability of the two segments occurring next to each other, simply by chance. This can define the **expected frequency** of the co-occurrence. The expected frequency is sometimes compared to the observed frequencies in order to establish whether a given pattern is occurring to a greater or lesser degree than we might expect by chance (Frisch et al. 2004).

Moscoso del Prado Martín et al. (2004b) assume an information theoretic approach to the relationship between word frequency and word strength. They draw a parallel between various measures of word frequency and the information theoretic notion of average unpredictability or **entropy**. Moscoso del Prado Martín et al. (2004b) propose a new measure of the information content of a word, its **information residual**, combining gauges such as surface frequency and base frequency, inflectional ratio, cumulative root frequency, and morphological family size. In a series of experiments, they show that the information residual predicts lexical decision response latencies better than any other measure. (For more details on paradigm organization, see Chapter 12 of this volume.)

Milin et al. (2009) extend the information theoretic approach. Starting out on the basis of work done on Serbian nominal inflection by Kostić (1995; Kostić et al. 2003), they propose measures for the information content of morphological paradigms and lexical classes. The main insight of Kostić is that one cannot resort to relative frequencies of exponents in an inflectional paradigm, because the functional load of these will also differ, potentially contributing to the costs of lexical processing. The case of derivational morphology is even more complex, because derivational classes can be open and are consequently often unclear in size. Even more complex (and overlapping) inflectional paradigms, like verbal inflection, propose further challenges.

Before we turn to the question of how frequency might contribute to, for instance, morphological productivity, we have to acknowledge the conceptual leap inherent in establishing a connection between frequencies of word-forms in a language corpus and its *cognitive* aspects, reflected, for example, in its familiarity in an individual language user.

One way to join our corpus data with a finding that, for example, an English speaker is more comfortable with *wughood* than with *wugdom* is to assume that the frequencies we observe in a corpus are available to the individual speaker. **Exemplar-based** models of the lexicon (see also Langacker 1987) are thus attractive to morphologists in this respect because they offer an account in which frequency is an integral property of the word's representation (see, e.g. Hay and Baayen 2005).

A common set of assumptions in the literature is thus: (1) representations are updated with experience, and thus the frequency with which a form is encountered impacts its representation in some way, (2) the corpus we use to gain frequency data is a balanced sample of the ambient language, and therefore the frequencies found in the former reflect “frequencies in the world”; and (3) consequently, the *strength* of the word entry in the individual's lexicon is related (in some way) to its frequency in the corpus, and we can use corpus frequency as a rough proxy for cognitive frequency, or representation “strength.”

Note, however, that results such as reported by Tily et al. (2009) indicate that a simple raw-frequency based view of human lexical storage may

not be tenable, simply due to the sheer capacity that we would need to assume in order to account for the extent of the variation that is apparently affected by linguistic practice. Baayen (2011) and Baayen and Hendrix (2011) explore an alternative to simplistic rich-memory models of human storage, accommodating the observed detail without a combinatorial explosion of the required capacity. This work will be discussed more in Section 7.

3 Frequency and Morphological Processing

A large bulk of experimental research has concentrated on the effect of word frequency on the lexical processing of the individual (see Chapters 27–28 of this volume).

Primary research questions in this arena include: (1) Do (various types of) morphologically complex forms have stored representations (in which case we might see effects of word-form frequency in experiments), or are they actively composed in speech production and decomposed in speech perception? (2) What is the evidence for associations between various types of morphological relatives in the lexicon (as might be evidenced by affixal priming effects); and (3) (related to (1) and (2)) To what degree are the sub-parts of morphologically complex forms active during speech perception and production? (For examples see, e.g., Taft 1979; Baayen et al. 1997; Bertram et al. 2000).

This literature is extensive, and we do not outline it in any detail here. However, as outlined in Hay and Baayen (2005), there is good evidence for rather extensive storage of morphologically complex forms, and for wide variation in the degree to which these are decomposed by the individual (both in representation, and—interlinked—during speech perception). Higher degrees of decomposition seem to be facilitated by phonological and semantic transparency, and a high frequency of the parts (e.g., the base and affix) relative to the whole (see, e.g., Hay 2003). A low probability phonotactic sequence across the morphological boundary also seems to facilitate decomposition in English, which is likely a reflex of the more general strategy used by English listeners, who tend to use phonotactics to segment words from the speech stream (Saffran et al. 1996; Aslin et al. 1998). The balance of storage and computation is thus variable across word-forms (and likely across listeners and contexts). The relative contribution of storage and computation/decomposition has been modeled in a variety of ways (Burani and Caramazza 1987; Schreuder and Baayen 1995; Baayen et al. 1997; Gonnerman et al. 2007; Plag and Baayen 2009).

There is no shortage of interesting and relevant work that tries to establish the domain of influence of related (in some way) forms upon one another. For example Taft (1979) reports the results of an experiment

showing that reaction times in visual lexical decision to monomorphemic words in English are codetermined by the frequencies of the inflected variants. Baayen et al. (1997) observe a similar effect for Dutch. This essentially means that the lexical processing of a word-form is not only affected by its token frequency but also by the words belonging to the same *lemma*. The view of the lexical family as based on similarity in form is extended and partly shifted by Schreuder and Baayen (1997: 135), who argue that “[f]amily size appears to be an indicator of the extent to which a noun is incorporated in the network of semantic relations linking concepts in the mental lexicon.” They also observe that, according to their results on the processing of Dutch singulars with varying frequencies of related plurals, the main effect is not the token frequency of the related forms, but, rather, their type frequency—in other words, the size of the lexical family. They see family size as a later, central effect in processing, due to its semantic nature.

Dabrowska (2008) reports on the significant effect of type frequency and neighbourhood density in adult Polish speakers’ speed and aptitude in supplying dative forms of unfamiliar nouns. Neighbourhood density is similar to family size in the sense that it is a measure of the amount of words that are similar to the target, but, in this case, the similarity is purely formal and has nothing to do with the semantics. The relevance of similarity of forms, often formulated in terms of competing production *schemata*, has been shown in other languages as well, including English past tense formation (Prasada and Pinker 1993) or German plural formation (Köpcke 1988).

Moscoso del Prado Martín et al. (2004a) look at other languages to further support the relevance of family size in lexical processing. They report family size effects from Finnish and Hebrew, which, alongside the available Dutch and English data, leads them to argue that the organization of related words in morphological paradigms is an important factor in lexical processing. They also note that the type of the morphology used by the language is reflected in family size effects as well. In Hebrew, which has a nonconcatenative inflectional system of word-formation, the semantically related family members lead to facilitation while the semantically unrelated ones give rise to inhibition for words with homonym roots. In Finnish, which has a rich agglutinative inflection system, lexical processing of a complex word is only codetermined by the subset of words directly derived from the complex word. These patterns constitute further evidence for the role played by semantic factors in the family size effect.

This large literature clearly indicates that frequency is relevant to the processing and representation of morphological forms. It follows from this that we might expect to observe frequency-based effects in people’s usage of morphologically complex forms too, and it is with respect to this question that corpora are particularly useful.

4 Frequency and Morphological Productivity

Aronoff (1980), in a classic study on the psycholinguistic reflexes of productivity, discusses how the topic of word formation had mostly been eschewed in theoretical linguistics, precisely because—unlike in the case of syntactic or phonological rules—it does not suffice to say that a word formation rule is either *obligatory* (in expressing a certain function, for example) or *variable*. We also have to account for the extent of the variability of the word formation rule, which is only possible if we can approximate the distributions of its outputs. This is achievable in two ways. We can look at what human subjects do with novel word formations (whether they find them acceptable, and to what extent, or whether they show larger latency in making this decision, and so on). We can also look at the *frequency* of word-forms in a corpus to gain a picture of their *probability*.

In a comprehensive outline of the problems related to the concept, Baayen (2009) gives a tentative definition of productivity as a property of a lexical set that is capable of obtaining new members. In this sense, the set of verbs in English is a fully productive one, since it can always accommodate new members—any English word can function as a verb, including novel ones like *Google*, *Tumblr*, or *Netflix*. In comparison, the set of articles is non-productive, and is unlikely to attain new members beside *a(n)* and *the*.

The innovative early work of Joan Bybee and Harald Baayen emphasized the relevance of both type and token frequency in morphological productivity. Bybee (1985, 1995) and Baayen (1992a, 1992b) argue that high type frequency is related to high morphological productivity, but that some types matter more than others. Very high-token-frequency forms do not tend to contribute overly to the productivity of a pattern (as they are more fused, and less decomposable than lower-frequency forms (Bybee 1995)). Indeed, a large number of low-frequency types is a relatively good indicator of high productivity (Baayen 1992b). Another reason we tend to focus on types to assess productivity, as Baayen reflects, is that categories that are otherwise less productive (novel formations would be, for example, rejected by speakers to a larger extent) can supersede more productive categories in terms of total frequency of *tokens*. The reason for this is that the vast majority of tokens in a corpus of a natural language belong to a tiny minority of types, a distribution first observed by Zipf (1935).

Baayen (1992a) points out that productivity is likely a graded phenomenon as shown by the fact that sets are able to increase in size to varying extents. This is supported by the evidence surveyed by Hay and Baayen (2005). He adds that if we move beyond a binary interpretation of productivity, we have to tackle various interpretations of it. He takes note of three. **Realized productivity** is the size of a category, measured in number of **types**, which we can assess using a representative corpus.

Expanding productivity indicates the speed with which the category acquires new members. This is usually measured by counting the number of types belonging to the category that only occur once in the corpus, the **hapax legomena**. **Potential productivity** of a rule, indicating the extent to which the category is **saturated** (i.e., how much potential it has to acquire new members) is estimated by dividing the number of hapax legomena with the number of total types in the corpus. This measure estimates the growth rate of the vocabulary of the morphological category itself. What this type of productivity highlights is the fact that productivity can be a self-defeating process in the sense that once the onomasiological “market” is saturated (i.e., the number of remaining members in a category is very small), a rule cannot expand any further (Baayen 2009).

As Hay and Baayen (2002) parsing note, the productivity of an affix is closely related to morphological parsing. Affixes which tend to create phonotactic junctures which facilitate parsing also tend to be more productive. If the particular form is accessed through its parts, the suffix is activated, which means that its lexical storage is updated with a novel instance. Therefore, the form contributes to the relative strength (and thus productivity) of the suffix. In comparison, if a form is accessed as a whole, the suffix is not “recognized,” and if the suffix only ever occurs in word-forms that are not parsable into parts, it “dies out” and only remains as a non-productive ending. This is the case of the nominal ending *-th* in English, or, in a more general sense, the umlaut plural in German. Productivity, argue Hay and Baayen, is thus directly reinforced by decomposition in speech perception. Any factors that facilitate decomposition in perception will facilitate long-term productivity of an affix.

Baayen and Renouf (1996), in a longitudinal corpus study of morphological productivity, also observe that the productivity of an affix varies significantly with the morphological structure of the base word to which it attaches. That is, not all words contribute equally to the productivity of a suffix. Both the internal structure and, most importantly, the relative frequencies of the words have to be taken into consideration when assessing the productivity of a morphological class. (We return to diachronic aspects of morphological productivity in Section 6.)

Plag et al. (1999) have a look at morphological productivity in three parts of the British National Corpus, **written**, **context-driven spoken**, and **every-day spoken** language. They use two productivity measures, a measure of how much a certain morphological category contributes to the overall vocabulary size and the rate at which new types are to be expected to appear when *N* tokens have been sampled. They note how size differences between sub-parts of a corpora can constitute a considerable difficulty when using measures of productivity. They also find that the written register has a greater propensity to form new words and that there is variation in the extent to which suffixes are used across registers in general.

5 Bursty Words and Bursty Productivity

It is important to note that word-forms do not have a uniform distribution throughout our linguistic experience, and this is also true for the collected corpora. As Gries (2008) notes, the words *HIV*, *keeper*, and *lively* are about equally frequent in the British National Corpus, but *HIV* has a different distribution, being concentrated in just a small set of the parts that make up the corpus, unlike the latter two, which are more equally dispersed. Differences in dispersion relate to the **niche** of the word—that is, the types of people who use it and the registers or genres it occurs in, among other things.

Baayen (1994) approaches the question the other way around, performing text type categorization based on morphological productivity using a principal components analysis. He finds that literary authors can be differentiated to some extent when we rely on morphological productivity alone, such as by measures of their use of Latinate versus Germanic derivative suffixes.

This all suggests that morphological productivity does not behave uniformly throughout any given corpus. Altmann et al. (2009) and Pierrehumbert (2012) develop the concept of *burstiness*, the property of word frequency to be higher in a given domain. Working with a part of the USENET archive, Altmann et al. (2009) find that content words have a non-uniform distribution deviating from the exponential distribution we would expect them to have (the distribution first observed by Zipf (1935)).

They argue that the extent to which words have bursts and lulls in the overall distributions crucially relates to the extent to which word meanings have differential contextualizations. To put it very simply, a word that can be used in a variety of contexts will have a more uniform distribution, whereas a word that is specific to just one or two contexts will be very bursty in these but much less frequent in others, even if the two words have similar overall token frequencies. Burstiness, then, has strong consequences for word learnability and word survival.

The same point is made by Stefan Gries. Gries (2008) argues that, due to the uneven dispersion of forms in corpora, the use of raw frequencies is highly misleading. He goes on to review and compare various dispersion measures, noting that part-based ones that carve up the corpus into various parts are problematic if the parts are not similar in size, that some are sensitive to the number of corpus parts, which can be arbitrary, and that difference-based measures are, in general, sensitive to ordering. He proposes the dispersion measure DP (from “deviation of proportions”) which is based on computing the size of corpus parts and all pairwise absolute differences of observed and expected values of the frequency of the form in these corpus parts. Gries (2009) extends the discussion on DP and its applications.

Researchers including Baayen, Gries, and Pierrehumbert have very different aims in going into the analysis of word frequency distributions in

corpora. A primary relevance of recent work to the morphologist is that modeling the behaviour of morphological classes based on simple overall type frequencies is misleading. If we ignore the specifics of the distributions of words and word classes across corpora, a large amount of relevant patterns is lost.

Another good example of the relevance of lexical structure beyond the frequency or probability of a word or a pattern is the lexical neighborhood. Lexical neighbors, related to the target word by similarity of either function or form, are important factors in models of lexical productivity. **Nearest-neighbor** algorithms interpret words as consisting of a number of features and predict an unknown feature of the word based on the (known) behavior of other words which are most similar to it in terms of the known features. The nearest-neighbor algorithm is the main working principle of the Tilburg Memory Based Learner (TiMBL) (Daelemans et al. 2007), and is implemented in various other suites of machine learning software, like Weka (Witten et al. 1999). Other models of lexical productivity include Skousen's (2002) Analogical Modeling.

6 Diachronic Corpus Morphology

This section gives an overview of quantitative corpus morphology in the diachronic domain. The gradual refining of methods in corpus-based synchronic morphology is mirrored by work in diachronic morphology, which also shifted from dictionary-based work treating productivity as a binary primitive to a corpus-driven approach treating productivity as a complex, gradient epiphenomenon arising from language change. The trend manifests itself most clearly in the increasing number of multi-century diachronic corpora, such as the Helsinki Corpus, ARCHER, the Corpus of Early English Correspondence (CEEC), Corpus Histórico del Español en México, the Corpus del Español, or the Mainz Newspaper Corpus, just to mention a few.

Although it has been claimed that their small size and other characteristics pose problems for analysis, historical language corpora present an authentic, context-based section of language and, as such, they are now an essential tool in diachronic morphology. In this section, we outline the challenges of research on morphological change and give a brief overview of the methodologies developed in response to these challenges.

Dictionaries are widely used by morphologists as evidence for changing patterns of word-formation (see, e.g., Bauer 1994; Anshen and Aronoff 1997; Aronoff and Anshen 2001). However Bauer (2001) points out some of the potential pitfalls of work based on the Oxford English Dictionary. For example, it is not clear how long a word was used for or how frequent it was – first citations can be earlier than the general use and last citations can artificially pre- or postdate the vitality of a pattern.

Similarly, a rare persisting word may accumulate as many citations in the Oxford English Dictionary as common but short-lived words. Plag and others point out that dictionaries typically aim for a non-comprehensive account of the language, prioritizing less compositional and more idiosyncratic forms, leaving out much of the predictable forms, which are precisely the locus of productive behaviour (Baayen and Renouf 1996; Plag 1999; Dalton-Puffer and Cowie 2002). As a result, dictionaries are useful in distinguishing productive and non-productive processes, but fail to give us a good picture of the gradient within the productive set. Baayen and Renouf (1996), similarly to Plag, discourage the practice of combining corpus data with non-corpus-based dictionary data, as the presence of compositional forms in the dictionary is likely arbitrary.

Later works also rely on dictionaries in sorting out the role of hapaxes versus neologisms in evaluating diachronic productivity. Trips' Criterion of Productivity (Trips 2009: 38) requires that "A productive series of formations is defined as the occurrence of formations with a morphological category with at least two hapaxes where a hapax is a new type built by a new rule and a new type exploiting that new rule." Säily's (Säily 2008; Säily and Suomela 2009) approach is to make sure that the suffixed word has an extant base attested in the time period in which the types are counted. Furthermore, in order to avoid lexicalized forms creeping into the set of hapaxes, she sets an (arbitrary) "age" threshold for the word in the given time period.

Because of the various problems with dictionary research, corpus work has become increasingly popular. The measurement of morphological change in early corpus-based work was often operationalized through observed changes in type frequencies over time in diachronic corpora. For example, early works often compared percentages of the types of a given affix out of all words, or similar measures "normalizing" over *N* words across time intervals (e.g., Kučera 2007; Kaunisto 2009; Baker 2010; Berg 2011; Ciszek 2012). Besides making it impossible to evaluate the statistical significance of the differences, this practice also ignores two possible issues concerning the distributions of types. The first is that the number of types may grow at different rates for different processes. The second is that the number of types may also grow at a different rate than the number of tokens in the corpus. As a solution, early and/or low computation works often had the assumption that the amount of data is approximately the same size within the time intervals in the corpus and therefore type or token frequency obtained from each interval can be compared directly. Then, if the type counts differ by an order of magnitude, it may be possible to draw conclusions without paying attention to statistical significance (e.g. Dalton-Puffer (1996: 106)).

Thanks to the rise of larger diachronic corpora, token frequencies became available for models of morphological processes across time. The difference between type and token frequency is as relevant to the study of

language change as it is to the synchronic study of morphological productivity. It may shed light on different aspects of the synchronic representation of the word-form or pattern during the time intervals considered in the diachronic corpus.

Work on diachronic change shows that token frequency can be a conservative force protecting high-frequency structures from analogical leveling (Bybee and Thompson 1997). For instance, in English there has been continuous pressure to regularize irregular verb forms. Since the time of Old English, nearly 200 verbs have lost the stem vowel alternation and have adopted the regular past tense form. Synchronically, we find that most of the verbs that are still irregular are very frequent. Bybee and Thompson's hypothesis is that the frequent use has strengthened their representation in memory, which is why they have resisted the pressure from analogical change.

While token frequencies are often not directly available, indirect or intuitive frequencies have been used for their explanatory power. As an example, Enger (2004) found that an intuitive singular-plural bias explained the contemporary results of analogical processes in the gender/declension predictability of Norwegian. Based on dictionary-derived type counts, the declension of most Norwegian nouns is predicted on the basis of gender (the so-called **gender first** nouns). For some nouns, however, gender can be predicted on the basis of declension (the **declension first** nouns). According to Enger, whether gender or declension is taken as basic can be explained through intuitive token frequency disparities: if the plural form is more frequent than the singular (e.g., *berry* ~ *berries*), the plural will be taken as the basic form and gender will be predicted on the basis of the declension. If, however, the singular form is more frequent, it will be taken as basic and the declension can be predicted from the gender.

The data in this generation of diachronic morphological works often cross-tabulate the values and significance is evaluated with a chi-square test or parametric regression models, often in Varbrul (e.g., Nevalainen 2000; Pappas 2001; Laitinen 2008).

Only a few studies apply modern corpus-based methodology to assess productivity (as discussed in Section 3) diachronically. This may be due to the fact that diachronic corpora—as shown above—present a number of immediate methodological problems before one can move on to the calculation of the productivity of a given process, or it may be because commonly available statistical methods have to be reconsidered and adapted to diachronic data.

Baayen's corpus-based approach defines productivity as the likelihood of observing a new type when sampling a sufficiently large corpus. In his measure of potential productivity, the gradually increasing number of new types (type frequency, *V*) is seen as a function of token frequency (*N*): with the increasing number of tokens (i.e. an increase in corpus size), the number of types will also increase. This relation gives rise to the definition

of the **vocabulary growth curve** and to the notion of **vocabulary growth rate**, the latter being calculated by the proportion of hapaxes (V1) to the overall number of tokens (Baayen and Renouf 1996). In this approach, which yields a synchronic snapshot of productivity, an unproductive morphological category is characterized by few if any hapaxes, especially as the size of the corpus increases, and the vocabulary growth curve flattens out until the vocabulary is exhausted. Conversely, the availability of a productive word formation process guarantees that complex words of even the lowest frequency can be produced and understood if they display the process. Therefore, a large number of hapaxes is a strong evidence that the process is productive in the given time period in the corpus.

When it comes to quantifying the degree of productivity in a morphological change across time, Lüdeling and Evert's (2005) recommendation – based on Baayen (1992b) – is to calculate the synchronic growth rate in each time period first, then compare the degree of synchronic productivity across time. Comparing the confidence intervals around the vocabulary growth curves across time periods then offers a useful diagnostic to detect change: overlap between the confidence intervals of the growth curves of a process in the measured time periods suggests that there is no significant change in the productivity. However, in order to shed light on the (potentially qualitative) aspects of diachronic rivalry between forms, a similar diachronic analysis is needed to evaluate the selectional preference of the process, such as when the same noun displays a diachronically different pluralizing strategy, or when certain verb paradigms change to a different verb form to model other members of the paradigm on. To bring an example for growth curve comparisons, Stichauer (2009) calculated the vocabulary growth and Zipf-Mandelbrot estimates, then used interpolation to show the diachronic development of the Italian deverbal nominal suffixes *-mento*, *-zione*, and *-gione* between the thirteenth and sixteenth centuries in the Letteratura Italiana Zanichelli corpus (LIZ 4.0).

Hilpert and Gries (2009) set out to provide statistical tools tailored to analyzing trends in frequency changes in multi-stage diachronic corpora (Gries and Hilpert 2008, 2012; Hilpert 2011). They recommend Kendall's tau to detect trends and propose two iterative algorithms which can be used to periodize significant trends.

Gries and Hilpert (2010) draw on the syntactically parsed Corpus of Early English Correspondence (PCEEC) to explore the morphological shift from the third-person singular (*e*)*th* (as in *he giveth*) to (*e*)*s* (as in *he gives*). They use an iterative algorithm to derive periods, using text frequencies of the variant suffixes. Based on the clustering of the dataset, Gries and Hilpert distinguish five intervals. This periodization is one of the explanatory variables that is subsequently fed into a regression analysis that models the change in allomorphy, taking into account both language-external factors (derived periods and author gender) and language-internal factors

(phonological context of the suffix) to predict the observable variation. The model has a 95 percent success rate.

Medina Urrea (2009) tracks the development of Spanish affixes in the sixteenth to twentieth centuries. Medina Urrea operationalized the concept of affixality by quantifying frequency, entropy, economy, and compositionally competing word-forms of the affixes (see Chapter 12). The resulting diachronic morphological profiles provide new insight into the development of Spanish dialects, such as the emergence of Mexican Spanish before the eighteenth century. Additionally, Medina Urrea calculated pairwise Euclidean distances between the diachronic states and dialectal morphological profiles to study the evolution of Mexican Spanish as a distinct dialectal system and the development of Peninsular Spanish.

Nonparametric methods have also been used in diachronic morphology to some extent. For example, following Baayen's (2000: 24–32) computation of Monte Carlo confidence intervals for the accumulation curves of some lexical characteristics, Säily (2008) and Säily and Suomela (2009) calculate accumulation curves for types including hapaxes and then use Monte Carlo sampling to calculate the upper and lower bounds of the curves to compare the type accumulation of female writers against in certain time periods.

Gries and Hilpert (2010) successfully merged a traditional corpus linguistic tool, collocations, with quantitative diachronic morphology. Their model accounts for the *horror aequi* effect, a widespread and presumably universal tendency to avoid identical sequences of grammatical elements. In this context the *horror aequi* effect is interpreted as a sort of Obligatory Contour Principle acting across the word boundary, disfavoring the verbal suffix that ends in the phoneme the word to the immediate right of the verb begins with (e.g., *he give[th th]anks* vs. *he give[s th]anks*).

Finally, Chapman and Skousen's Analogical Modeling (AM) (2005) provides explicit constraints on analogy that allow for the explanation of how morphological changes begin, which forms most likely serve as patterns for analogy, and which forms are most likely to change. In AM the likelihood of being selected as an analog is calculated for each competing exemplar based on three properties: proximity in a network, gang effect of surrounding items having the same behavior, and heterogeneity of the surrounding exemplars intervening. In a promising test, AM was given the task of using forms containing negative prefixes for one time period to predict the prefixes that adjectives would take in the subsequent time period. For each of the roughly seventy-year periods in the corpus, AM was able to predict valid prefixes about 90 percent of the time.

With the faster development of methods than of corpora, it is common that the same variables (often mined from the same corpora) constitute a test case for increasingly more sophisticated tools and models. For examples see the treatment of the *subject ye/you* shift in Nevalainen (2000), Nevalainen and Raumolin-Brunberg (2003), Raumolin-Brunberg (2005), and Hinneburg et al. (2007); the *3sg -(e)th/-(e)s* shift in Nevalainen (2000), Gries

and Hilpert (2010); and the competition between nominalizing *-ity* and *-ness* in Aronoff and Anshen (2001), Dalton-Puffer and Cowie (2002), and Säily (2008, 2011).

7 Going Forward: Is Frequency really Frequency?

As outlined above, there are a plethora of morphological effects which appear to be associated with frequency, and so there is a large amount of work on this topic. However morphological work has engaged in somewhat less than desirable dialog about other potential effects with which frequency is confounded. One of these, for example, is Age of Acquisition (see, e.g. Johnston and Barry 2006). Earlier learned words appear to behave differently in a number of different domains, and age of acquisition is, of course, highly correlated with lexical frequency. A second factor is predictability in context, and the effects of repetition, both of which have been shown to be relevant in speech production (Bell et al. 2009). These are, of course, highly relevant, because frequent words are more likely to have been recently produced, and are also more likely to be contextually predictable.

There is also the question of whether the frequency of exposure to a word is the most relevant factor, or whether how familiar a word appears to an individual is more important. In an extensive review of preceding literature, supported by experimental data, Gernsbacher (1984) arrives at the conclusion that **subjective familiarity** is a better predictor of various measures of lexical processing than objective frequency. Subjective familiarity is, quite simply, the extent to which an individual participant finds a word-form familiar, measurable on a one-dimensional scale.

Connine et al. (1990) have another look at the effect of frequency and familiarity in lexical processing. They find that both objective frequency and subjective familiarity affect lexical decision and naming tasks in both reading and listening. They note, however, that objective frequency (based on written corpora, such as the Brown Corpus) is a better predictor of processing in a reading task (where the medium is kept constant) and that the importance of familiarity *vis-à-vis* objective frequency increases considerably in a delayed naming task. Balota et al. (2001) call attention to the inherent problems of the **subjective familiarity** concept, which arguably conflates distinct measures of familiarity, including semantics (whether the individual understands the word) and orthography (whether the word has a highly irregular spelling). To give an example, *birthday* and *architecture* have roughly the same token frequency in the CELEX corpus (352 and 340, respectively), but English speakers will know what the former is, while some might be uncertain about the meaning of the latter, resulting in a possible difference in familiarity ratings, one that has little to do with the probability of encountering either.

Balota et al. (2001) find a strong correlation between subjective estimates of word frequency and objective frequency, which leads them to conclude that frequency counts from corpora can be used to approximate word frequency in the ambient language of the individual.

Given the range of possible confounds, whenever we see what appears to be a direct relationship between frequency and behavior, we should always consider the degree to which we can be confident that it is really the driving force.

Most startling, in this regard, is the recent work of Harald Baayen and colleagues, within the naive discriminative learning paradigm. For example, Baayen (2010) reexamines the ubiquitous word frequency effect which has been reported for lexical decision times. He shows that 90 percent of variance in word frequencies in his data-set is actually predictable from other properties. These properties involve contextual measures capturing the contextual distribution of the word (such as syntactic and morphological family size, and syntactic entropy and dispersion). Once these properties are accounted for, the frequency of the word has very little explanatory power in predicting reaction times. Baayen argues that the word frequency effect is “an epiphenomenon of learning to link form to lexical meaning.”

If frequency effects are in fact largely artefactual, this would certainly recast many of the questions investigated in the literature outlined in this chapter, most of which encode frequency effects directly into the form’s representation—presupposing models which Baayen refers to as containing a “counter in the head” (Baayen 2010).

Indeed, in a related paper (Baayen et al. 2011), Baayen and collaborators carefully discuss many of the frequently reported frequency effects in morphology, and demonstrate that they emerge from their simple learning model. Their model does not include representations of morphemes, and does not directly encode frequency. Frequency effects for complex words and phrases emerge in the model without the presence of any overt whole-word or whole-phrase representations. They observe that their model “can be viewed as a formal, computational implementation of the notion of analogy in word and paradigm morphology” (Baayen et al. 2011; see also, e.g., Blevins 2003). This body of work seems to show that frequency is not important because it is stored in representations, and active in production and perception processes, but rather that it is an epiphenomenon of the effects of contextual predictability in learning.

This clearly provides many pathways for exploration and—if true—would turn much of the literature outlined in this chapter on its head. The observed correlations and phenomena in this literature will provide an important baseline for investigations, but many questions now remain about the representations and processes driving such phenomena. As Baayen has shown, careful work needs to be done to understand the mechanisms through which contextual factors and frequency are related,

and the degree to which each drives or reflects morphological learning, production, perception, and representation. The careful use of corpora will remain central in such explorations, as will carefully implemented computational models.

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Morphology in Typology

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1 Introduction

A primary goal of typology is redefining the foundations of linguistic theory from the bottom up (Miestamo and Wälchli 2007: 1). Twenty-first-century typology, instead of asking what is possible in language, increasingly seeks to explain what's where why (Bickel 2007: 239), and population typology is becoming prominent in the field and emphasizing in its explanations historical processes and probabilities of type shifts rather than universal constraints. Patterns and individual variables, rather than the whole-language and ideal types of twentieth-century typology, are focal to description and theory. Meanwhile, despite these bottom-up trends, formal, quantitative, cognitive, historical, and typological morphology, never especially far apart, continue to converge. This means that a chapter on morphological typology needs to cover all of morphology from a distributional perspective. Since that is clearly too much for one chapter, the focus here will be on asking what are the best type-defining, area-defining, and individual- or family-identifying morphological properties, and showing what morphological analysis of these properties facilitates what's-where-why comparison. It is intended as a guide to fieldworkers and language or family specialists seeking to make grammars consistent with current developments or maximally useful for comparative work, and for typologists designing cross-linguistic studies.

In general what's-where-why comparison requires multi-valued variables, or complex variables with nested or interdependent sets of subvariables and values, or clusters of variables. Only such metrics can yield finely grained differentiations within families or areas, and only finely grained differentiations can reveal incremental changes, evolutionary trends, subtle family biases, continuities across families and areas, gradual large-scale clines, and other such distributions that are essential to explaining attested linguistic geography. This chapter will also focus primarily on what

variables promote incremental comparison, and what has been learned so far (at this fairly early stage).

2 Typology and Universals

It has been observed for some time that candidates for typological universals are not manifested in every language. In recent years a consensus reconciliation of that fact with the concept of universal has emerged: a language universal is a bias in favor of one or another diachronic development (i.e., a higher-probability state transition) that is always likely to make itself felt but never inevitable (for distributional biases see Bickel 2013). A consequence is that cross-linguistic frequencies of phenomena can often be explained by the diachronic processes that can produce them: a phenomenon that can only be the result of two very specific interacting factors will necessarily be less frequent than one that can have several diachronic sources, or a single but simpler and more general one. For examples and discussion see Good (2008).

3 Wordhood

Wordhood is a relatively new term for a distinction that goes back to Dixon 1977 on Yidiny: the phonological word and the grammatical word are different things. In Yidiny, one grammatical word can contain more than one phonological word.

The distinction has been important in prosodic morphology (see Chapter 19), which posits a fixed universal set of levels (syllable, foot, phonological or prosodic word, phonological phrase, and higher units), and it has gained prominence in typology in recent years. While theoretical phonology and prosodic morphology posit a fixed universal set of levels (chiefly syllable, foot, prosodic word, phonological phrase), violable only where required for adherence to some higher principle, typological work has no fixed set of units and has attended primarily to phonological word versus grammatical (or syntactic) word and especially to mismatches between these two (see, e.g., Dixon and Aikhenvald 2002). Recent overviews of criteria for phonological versus grammatical word are Haspelmath (2011), Spencer and Luís (2013), and van Gijn and Zúñiga (2014); all contributors note that no criteria for phonological word and grammatical word are watertight (phonological ones are particularly problematic). The essential criteria generally include:

Phonological word:

- no internal pauses
- adherence to minimal phonological-word requirements of the language
- prosodic independence
- internal sandhi (between morphemes within the word).

Grammatical word:

- positional mobility (for example, gender agreement markers have positional mobility in those Nakh-Daghestanian languages in which they are prefixed to most verbs but infixes for some)
- free occurrence (as possible self-standing utterance)
- minimal selectivity (of/by surrounding words in context).

Relevant work has been done especially on Himalayan and Southeast Asian languages, where such mismatches are common and salient. In several Tibeto-Burman branches many grammatical morphemes have the phonological and prosodic properties of independent words, but lack the grammatical properties of wordhood. Hence there are languages (chiefly in the Kiranti branch of Tibeto-Burman: e.g., Chintang, Belhare) now generally recognized as polysynthetic but previously considered morphologically simple or even isolating as they have numerous affixes that are phonologically word-like but not grammatical words. Schiering et al. (2010) show that the fixed levels of prosodic morphology, and theoretical assumptions about their interrelation, are violated by Vietnamese, which gives no evidence of having a prosodic word level, and Limbu (Kiranti), which has two levels of prosodic word. Bickel et al. (2009) is a cross-linguistic survey of wordhood properties. They found considerable variation, not even much clustering, and only one universal: stress-defined domains tend to be different from, and larger than, other word-related domains. Both papers conclude that the word is not a fixed universal level but an emergent property; prosodic domains are “language-particular, intrinsic, and highly specific properties of individual phonological rules or constraints . . . the ‘word’ has no privileged or universal status in phonology, but only emerges through frequent reference of sound patterns to a given construction type in a given language” (Schiering et al. 2010: 657). Other work along these lines includes Hildebrandt (2007), Donohue (2008), Hyman (2008), Schiering (2009). The 2014 volume edited by van Gijn and Zúñiga contains five papers on wordhood phenomena in American languages (four of them South American) as well as an introduction and theoretical background.

4 Word Classes (Parts of Speech) and Word-class Flexibility

Word-class flexibility has been an issue since at least the mid-twentieth century,¹ made prominent for Wakashan and Salishan languages by the claim of Sapir and Swadesh (1939, 1946) that these languages have have only a single word class that can be inflected as either noun or verb. The issue came to theoretical prominence in typology and description with

¹ In the literature, *word class*, *lexical class*, and *part of speech* are all used in the same sense. Here I arbitrarily choose *word class*.

Jacobsen (1979); he argued (con Sapir and Swadesh and most subsequent literature) that there is a noun-verb distinction in Southern Wakashan, such that any word can function as predicate and be inflected like a verb, but only nouns can function as arguments without special derivation, formation of a headless relative, or the like. Important subsequent work on Salishan and Wakashan languages includes Kinkade (1983); he argues against a noun/verb distinction for Salish on the grounds that any full word can be inflected as a predicate, putative nouns are really stative verbs, and they can be rendered as “it is an X,” “that which is an X.” He includes good evidence that a linguistically trained native speaker perceived “nominal” meanings that way, but does not address Jacobsen’s argument that not all predicates can be inflected as arguments. Other descriptive work arguing against a noun/verb distinction includes Tchekhoff (1984) on Tongan (followed by others for Austronesian: e.g., Mosel and Hovdhaugen (1992) on Samoan), Thompson and Thompson (1992, 1996) on Thompson River Salish, and Peterson (2011) on Kharia (Munda) (discussed below). Salient typological work on the general issue includes Hengeveld et al. (2004), Evans and Osada (2005) (and commentary articles in the same journal issue), Ansaldo et al. (2010), and Rijkhoff and van Lier (2013).²

The criteria most invoked in the typological literature for determining word class are:

- (1) Function: ability to function referentially (noun), predicatively (verb), or attributively (adjective); or, defined syntactically, ability to function as argument, verb, or adnominal modifier (in typological work these are rarely defined in terms of phrasal configurations or heads—e.g., heading an NP, heading a VP—though these have been important in syntactic work).
- (2) Formal criteria: occurrence with (language-specific) inflectional and derivational categories.

Those most often invoked for establishing word-class flexibility are:

- (1) Ability to inflect as more than one word class (e.g., both noun and verb) and/or function syntactically as more than one of predicate, argument, and modifier; this supports flexibility.
- (2) Ability to inflect as more than one word class or take more than one syntactic function *without morphological modification* (this supports flexibility) versus only with derivational morphology, nominalization, conversion into a headless relative, or other means of nominalization (non-flexibility; this is Jacobsen’s approach, summarized above). The crucial difference between (1) and (2) is the italicized phrase in the preceding sentence here.

² Intriguingly, a number of works claiming that a language has no word-class distinctions also claim that all words are verbs.

- (3) Semantics of lexicalization: if a word or stem, lexicalized in different word classes, is semantically identical in the two classes (modulo the part-of-speech difference itself), it is flexible; if not, not. Examples: *rain* is arguably flexible because its senses as noun (e.g., *rain in the morning turning to snow*) and verb (*it rained all morning*) are lexico-semantically identical; *tree*, as noun (*an apple tree*) and verb (*the dogs treed a raccoon*), has a clear semantic difference. This criterion is taken as decisive by Evans and Osada (2005: 354–5), who argue that, for example, Mundari *buru* ‘mountain’ (noun) and ‘heap up, pile up’ (verb) are separately lexicalized – in other words, homophonous words and not a single flexible word. In this line of argumentation, languages claiming to lack a noun/verb distinction simply make extensive use of conversion. This criterion puts a heavy burden of proof on the proponent of flexibility, who must demonstrate that such examples do not involve conversion or zero derivation. (There is no question, of course, that the two forms are etymologically related. It should be noted that, especially as regards this criterion, arguments are often at cross-purposes – as is stated explicitly by some commentators to Evans and Osada in the same journal issue – but the facts themselves are usually not in dispute.)

Below I argue that criterion (1) is suggestive and interesting but not diagnostic, criterion (2) is diagnostic but depends on a proper distinction of derivational from stem-forming morphology, and criterion (3) is a red herring or a misunderstanding of how words come into existence.

A line of work going back to Himmelmann 1991 and well developed in recent formal work (notably Distributed Morphology; see Chapter 15 in this volume) considers not the word but the base of the derivational paradigm and describes that as precategorial – in other words, lacking any word class and assigned a word class only when derived, converted, or inflected. Typological work in this vein aims to establish precategoriality for specific languages, not as universal; for Austronesian see Foley (1998, forthcoming). Nichols and Nichols (2007) took this approach to a seventy-item wordlist and showed that sister languages tend to have similar percentages of noun-based and verb-based items, while areally related languages do not. Foley (forthcoming), Nichols (2016) use a standard 200-item wordlist, determine the derivational base of each item (and its word-family sisters), and typologize languages by the percentage of items that are noun-based, verb-based, and flexible; they too find typological, geographical, and historical implications, all based on percentages and degrees of difference.

Peterson (2011) describes Kharia (Munda) as entirely flexible, having an open class of simple contentive lexemes, more or less all of which can be used in predicative, referential, or attributive function, depending on whether they combine with case or with TAM/person markers. He describes

these as case and TAM/person **syntagmas** and gives a formal account in Peterson (2013). This approach is like the precategorial approach, but describes the distinction in terms of phrases, thus ascribing it to the grammar and not to the lexicon (and ascribing it to a single language—in fact, in its clearest form to a single dialect—and not to universal grammar).

Gil (2013) (summarizing many publications over the previous twenty years) describes Riau Indonesian as a language with extensive zero derivation or conversion (lexicalized, conventionalized, semantically unpredictable) and in this regard much like English; and in addition, unlike English, in the syntax there is extensive part-of-speech shifting, with any lexical word or phrase able to take any syntactic function.

Apart from work in the precategoriality vein, typological literature has tended to deal in whole-language types, categorizing languages as flexible (no word-class distinction) or rigid. Hengeveld et al. (2004) break this down into a few types based on what word classes exhibit flexibility: adjective=adverb, noun=adjective=adverb, verb=noun=adjective=adverb. Others deal with fewer types, chiefly just noun and verb. As is often pointed out (e.g., Beck 2013), most such works cite far too few examples to support a conclusion about the entire lexicon or its proper subsets. To quote Baker (2003: 177): “Mosel and Hovdhaugen (1992: 77) emphasize that in Samoan ‘many, perhaps the majority of, roots can be found in the function of verb phrase and noun phrase,’ but they concede that they have never observed *alu* ‘go’ as a noun or *mea* ‘thing’ as a verb. An important typological difference exists only if categorial ambiguity extends to an entire open class of inflectionally similar words, thereby affecting the overall grammar of the language.” Other commentators are less absolute, but the fact remains that the whole-language approach puts a heavy burden of proof on the proponent and makes it relatively easy for opponents to make much of counterexamples. It has been used to support one implicational generalization: Hengeveld et al. (2004) argue that flexibility type correlates with word-order type.

Jacobsen (1979) and, most explicitly, Beck (2013) show that there is unidirectional flexibility in Southern Wakashan and Salish languages: nearly any word can function as predicate and be inflected like a verb, but only nouns can function as arguments without derivation or other special adaptation (such as conversion or formation of a headless relative). Beck points out that this is a kind of neutralization, and in some form not uncommon crosslinguistically (many north Eurasian and North American languages are able to inflect a noun as a verb with the meaning “be an X”). This is a typological phenomenon in its own right and deserves more study.

The current consensus of typological opinion seems to favor the findings of Jacobsen, Evans and Osada, and Beck, that the unidirectional nature of word-class neutralization has been overlooked, and only bidirectional neutralization would be true flexibility; that a large and semantically

wide-ranging portion of a lexicon must be surveyed in order to demonstrate flexibility; and that unpredictable semantic differences on lexicalization undermine a claim of flexibility. Though this removes the much-noted cases of Wakashan and Salishan languages from the flexible class, the careful and comprehensive studies of Gil on Riau Indonesian and Peterson on Kharia mentioned above would seem to show that whole-language part-of-speech flexibility does exist.

Let us return to the question of whether lexical differences as in English *tree* (as in *apple tree* vs. *tree a raccoon*) or *table* (as in *kitchen table* vs. *table a motion*) demonstrate not flexibility but conversion—that is, separately lexicalized words. This line of argument implicitly assumes that the lexicon is produced diachronically as it is produced synchronically in generative derivations, producing words from bases according to regular rules. In fact, though, a lexicon in that sense is not the same thing as the actual word-stock of a language, in which everything is lexicalized, whether the semantic correspondences in conversions are regular or not. A word comes into existence when it is coined³ because something needs a new label, and the coining process uses the resources of the language (including any part-of-speech flexibility) to produce a reasonably easily interpretable or mnemonic word that has some semantic connection to the source word. Cases like English *tree* and *table*, with semantic differences, must be more common than cases like *rain*. These are the considerations that make criterion (3) above, on semantics of lexicalization, a red herring.

Therefore, my revised criteria for word classes and word-class flexibility are:

- (1) Ability to function referentially, predicatively, or attributively, and/or inflect as noun, verb, or adjective, without special derivational or stem-forming material. If special derivation or adaptation is required, the word is basic in the underived form. To be diagnostic, the criterion must be applied in both directions: for example, determine whether any putative noun can function as predicate without derivation or thematization, and determine whether any putative verb can function as argument without derivation or thematization. (This is criterion (2) above with some elaboration.)
- (2) The above applies to individual words (or stems), word by word (or stem by stem). To determine the language's type, determine the percentage of basic verbs and basic nouns in some representative wordlist.

Applying these criteria yields a continuum of languages with flexibility percentages ranging from very low (1 or 2%) to very high (over 80%). No language tested on the wordlist of Foley and Nichols (in prep.) has either 0 percent or 100 percent flexibility.

³ Or borrowed, but that is irrelevant here.

5 Person

Pronouns and inflectional person markers are one of the more stable systems of grammar and/or lexicon, and they generally form a strictly structured small closed class that makes a convenient self-contained diagnostic of relatedness. Two pronominal system types – north Eurasian *m/T* systems (like English objective *me*, *thee*, German accusative *mich*, *dich*, Komi (Uralic, Russia) nominative *me*, *te*), and American Pacific Rim *n/m* (e.g., Wintu (California Penutian) *ni*, *mi* ‘I, you’; for both systems see Nichols and Peterson (2013)) – form large clusters that are near-singularities and call out for better historical analysis. These same patterns of consonantism recur elsewhere and would appear to be diachronic *attractors*, forms that are more easily gained (through morphological change, borrowing, blending, etc.) than lost, an observation calling out for more crosslinguistic work. Therefore it is important to be able to specify the structural types and functions of pronouns in sufficiently fine-grained detail to make possible incremental within-family and within-area comparison.

A consensus account of recent work on types of pronouns (Kibrik 2011: 74ff., Siewierska 2004: 67–74, 2011) classifies them as follows:

5.1 Free

Free pronouns (also known as *independent pronouns*) are full words morpho-syntactically, though without lexical content. Strong and weak varieties are distinguished. *Strong* free pronouns are full phonological and prosodic words. Examples: French *moi*, *toi*; English *me*, *him*, and so on, as in *Me*, *I’d never do that* or *Who was it?* – *Me*. *Weak* free pronouns lack phrasal stress or are clitics. For example (bold) French *Moi*, *je l’ai oublié*. English *Me*, *I’d never do that*. The French weak pronouns (like those of Romance and West-South Slavic generally) are clitics; those of Germanic languages lack phrasal accent but not tonic stress, and are not clitics.⁴

5.2 Bound

Bound pronouns (or bound person markers) are affixes on the head (verb, possessed noun). Languages with bound pronouns include Navajo (two arguments), Abkhaz (three), Basque (three); also German, Russian, with one argument only (subject). In Kibrik’s terms, bound pronouns can be either *tenacious* (capable of co-occurring with overt coreferential arguments, like the verb person markers of German or Russian, and also

⁴ They have tonic stress as shown by the fact that their vowels are not reduced to schwa or another of the vowels that can occur in absolutely unstressed syllables. Another language with non-clitic weak pronouns is Russian, where in, e.g., *ja ego ne vižu* (‘I him not see’) ‘I don’t see him’, weak *ja* and *ego* have the vowel qualities /a o/ that can occur only in tonic syllables and are therefore not clitics.

Abkhaz) or *alternating* (in complementary distribution with overt co-referential arguments). (Free pronouns can also be tenacious: see Kibrik (2011: 78, 81) for Lele and Hausa examples.) Kibrik argues (2011: 76–7) that *pro-drop* as commonly used is not well defined, it includes both alternating bound and zero pronouns, and since over 90 percent of the world's languages fit into the *pro-drop* category it is not typologically very useful. Tenacious versus alternating is a more principled classification.

Ever since Boas (1911) and (explicitly and formally) Jelinek (1984), a widespread view has been that, in a head-marking language, the bound pronoun is the argument and any independent NP coreferential to it is in some kind of appositive or adjunct relation; while in other languages (including most European languages), the independent NP is an argument and the bound pronoun agrees with it. This is the distinction of **pronominal** arguments versus **agreement**. Kibrik shows that this distinction is artificial (and the European type is a small minority type worldwide), and he presents evidence that in any clause with tenacious bound pronouns both the NP and the bound pronoun are referential. In such constructions there is **distributed argumenthood**: both the NP and the bound pronoun have the status of argument. The grammatical relation between the two coreferential tokens of the argument is not apposition or adjunction but some different, as yet unnamed relation. In view of these and other difficulties with the notions of *pro-drop* and pronominal argument, in recent years it has become increasingly standard among typologists and fieldworkers to use *index* (and *indexation*) as a general term for bound pronominals rather than attempting to distinguish between pronominal arguments and agreement. This term is used here.

5.3 Zero

Unrestricted zero reference occurs in Japanese and Korean, most Southeast Asian languages, and a few languages in West Africa and Australia. (See Kibrik (2011: 106, 107) for extended Japanese examples.) Restricted zero pronouns occur in specific syntactic contexts such as coordination, as in English *He came in and Ø took off his hat*; unrestricted ones occur as default (this is the situation in Japanese, etc.). Differences between weak and bound pronouns, and (especially) tenacious versus alternating, are not always fully covered in grammars. Another frequent descriptive gap is attention to the functions of the independent pronouns. Siewierska (2004: 67–74) gives this breakdown of discourse-related functions of independent pronouns:

Non-emphatic. Ordinary independent pronouns, functioning as arguments, nominal predicates, adnominal possessors, etc. English independent pronouns are generally of this type.

Emphatic. Dedicated emphatic forms (as opposed to ordinary forms that are available for emphatic use, as in English *Hé did it*, with contrastive stress on *hé*). There are two subtypes:

- (a) *Arguments.* The emphatic pronoun is the argument itself. Presumably nominal predicates and possessors could also be included here. I would also include vocatives, as in *Hey you!* and the Acoma forms for ‘me’ and ‘you’ used only for one-word answers to questions like *Who did it? Who is it?* (Siewierska 2004: 40, following Miller 1965: 174).
- (b) *Intensifiers.* The emphatic form is not the actual argument (or predicate or possessor) but a modifier or appositive or the like, co-occurring with the argument, such as *I myself would never put it like that*.

The semantics of emphatic forms can vary, and some languages have more than one formally distinct series: “too,” “only,” contrastive focus, and others (see Siewierska (2004) for examples).

Identifying dedicated emphatics, and distinguishing between types of emphatics, are important; these forms appear to be among the sources of suppletive pronoun roots (Nichols 2013a; also Siewierska and Bakker 2013), entering the paradigm as a nominative; and nominatives have a good chance of influencing the form of the other cases, so that originally case-suppletive pronouns become regular and the entire pronoun root has been replaced. Many emphatics consist of an ordinary pronoun or person marker plus an emphatic affix or clitic, but some are etymologically unconnected to ordinary pronominals. My impression is that it is especially the vocatives and one-word-answer types that are likely to be etymologically distinct. These especially, and perhaps also emphatic intensifiers, would seem to have the kind of interpersonal and discourse pragmatics that can easily be copied from one language to another in situations of bilingualism, perhaps initially as code switching. If such forms are nativized and begin to invade existing pronoun paradigms, we have a mechanism for the spread of resemblant pronoun forms that seems more plausible than garden-variety borrowing of pronouns.⁵ Even without a whole-cloth import of an emphatic into a non-emphatic paradigm, emphatics are a possible source of attractor consonants (Nichols 2013a).

Person systems sometimes mark nothing but person, but more often also carry categories such as case, gender, and (especially frequent) number. Plurals of person categories are actually associative (Corbett 2001: 102–11; Cysouw 2003: 69ff.), so that an actual breakdown of person categories for the person space is (based on Cysouw) (1, 2, 3 = person categories):

⁵ Borrowing of whole inflectional paradigms, which can include person markers, is a different matter. For borrowing of a verb inflectional paradigm including the person-number markers see Pakendorf (2014). For more on affix borrowing as whole sets see Seifart (2012, 2013).

(1)	Singular	Plural
	1	1+3 (exclusive) 1+2 (inclusive)
	2	2+3
	3	3+3

A common crosscutting dimension in European person systems is politeness, commonly marked in second-person pronouns (Brown and Gilman 1972; Levinson 1983: 89–94; Fillmore 1997; Helmbrecht 2003, 2013; also Hanks 1990). There are two types of politeness—rank/power/prestige and social distance—and both can be considered kinds of social deixis. Politeness distinctions are not universal but form a large geographical cluster in western and southern Eurasia with scattered instances elsewhere (see the map in Helmbrecht 2013). Helmbrecht notes that even some of the scattered instances may be due to influence from colonial European languages.

6 Hierarchies and Alignment

Hierarchies, or scales—ordered sets of categories linked by transitive implicational relations or similar correlations—have been a staple of linguistic analysis since the implicational hierarchies of Greenberg (1963), the feature hierarchy determining alignment or its coding of Silverstein (1976), the accessibility hierarchy for relativization of Keenan and Comrie (1977), and others. Concern with hierarchies has now expanded beyond typology to include formal theory, cognition, and processing; a lucid summary on the current state of research into hierarchies is Bornkessel-Schlesewsky et al. (2015). Recent years have seen flourishing growth in testing and applying hierarchies in typology and describing them in much more detail, and at this writing there are two books nearing submission, one recently published (Bornkessel-Schlesewsky et al. 2015), and a special journal issue nearing submission.

Chief among the hierarchies is what is now increasingly called the (or a) **referential hierarchy**, the familiar one comprising this sort of scale: first person < > second person > third person: name > kin term > general human noun > animate > inanimate count noun > inanimate mass noun. In the literature it has also been known as **animacy hierarchy** (predominant in the 1980s–1990s), **indexability hierarchy**, and other terms. **Referential hierarchy** is a cover term for what may function as two or more separate hierarchies in individual languages; those commonly found include hierarchies of person, specificity, topicality, and singular/plural (Bickel 2011: 410, 439).

Closely connected to hierarchies is alignment. Since Silverstein (1976) alignment has been seen as potentially determined by the referential hierarchy: higher levels of the hierarchy are likely to be accusative, lower levels

non-accusative; or lower levels ergative, higher levels non-ergative. In recent work, the understanding of alignment has changed fundamentally: instead of a whole-language type, alignment is now seen as a property of the valence pattern of an individual verb or set of verbs, or of an individual morphological paradigm (e.g., a noun case paradigm, or a case paradigm in one declension class). All languages have a variety of different alignment types—that is, all are multiply split. At most one can identify the most frequent or most productive alignment pattern and typologize languages by that. Donohue and Wichmann (2008) contains contributions showing the various ways in which the treatment of the S role is split in various languages. A first systematic study of grammatical relations (including the coding of alignment) in a multivariate approach was Witzlack-Makarevich (2010), in which nearly six hundred languages were coded for their realizations of a few dozen relation-defining phenomena (case coding of different arguments, agreement, various syntactic constructions, etc.) and conclusions were drawn, among other things, on what categories and constructions are accusative in alignment, which ones ergative, and so on, for each language. The Leipzig Valence Classes Project (n.d.) has data on alignment for fifty verbs in each of several languages.

An important question concerning hierarchies and alignment is the position of inverse and hierarchical indexation patterns among alignment types. In inverse indexation, the typical situation is that transitive verbs index two arguments for person. In the basic indexation form, the higher-ranked argument occupies the subject slot and the lower-ranked one the object slot. In situations where the roles are reversed (e.g., third-person A acting on first-person O) the markers remain unchanged in the same slots but an additional inverse marker is added to reflect that fact. For example, Southern Tiwa (Kiowa-Tanoan, US; Zúñiga 2006: 180, citing Klaiman 1991: 219–20):

- (2) Seuan-ide ti-mų-ban.
 man-SG 1sg:IIA-see-PAST
 'I saw the man.'
- (3) Seuan-ide-ba te- mų-che-ban.
 man-SG-OBL 1sg:I-see-INV-PAST
 'The man saw me.'

(The third-person singular marker is zero regardless of role, so only the first-person singular argument is marked. Forms IIA and I reflect role. Also, the overt noun argument has a case suffix.)

Some languages have both direct and inverse markers, such as Plains Cree (Klaiman 1991: 230, citing Wolfart and Carroll 1981: 69)

- (4) a. ni - pēh -ā - nān -ak
 1 wait DIRECT 1PL 3PL
 'We await them.'

b. ni- pēh -iko -nān -ak

1 wait INV

'They await us.'

In hierarchical alignment, for two-argument verbs typically two arguments compete for access to a single indexation slot, and the higher-ranked one wins. Potential ambiguity is reduced in various ways, such as some indexation of role on the person affixes, additional A-sensitive or O-sensitive morphology, and others. For example Pazar Laz (Kartvelian; Georgia, Turkey; Öztürk and Pöchtrager 2011; G = the more goal-like object of a ditransitive):

(5) Pazar Laz singular person markers

		Person prefixes		Suffixes:	
				Past	Nonpast
S/A	1	v-, p-, p'-, b-	-i	-i	-Ø
	2	Ø-	-i	-i	-Ø
	3	Ø-	-u	-u	-s, (-n)
O/G	1	m-			
	2	g-, k'-, k-			
	3	Ø-			

Examples (Öztürk and Pöchtrager 2011: 46):⁶

(6) (Ma) (si) ce - **k** - č - i
 1s 2s PREVB-**2SGO**-beat-PAST.1SGA
 'I beat you'

(7) (Si) (ma) ce - **m** - č - i
 2s 1s PREVB-**1SGO**-beat-PAST.2SGA
 'You beat me'

(8) (Himu-k) (ma) ce-**m**-č-u
 3SG-ERG 1SG PREVB-**1SGO**-beat-PAST.3SGA
 'S/he beat me'

Zúñiga (2006: 20ff., 2007) and Rose (2009) argue that inverse and hierarchical are not alignment types because they do not group the basic arguments A, S, O together but add further conditions to groupings. (They do, however, interact so closely with alignment, sometimes obscuring it, that they generally need to be treated together with alignment.) Zúñiga lays out an extremely complex interaction of hierarchical indexation with various alignment types in Plains Cree. Rose shows that in Emerillon hierarchical indexation overlies a basic accusative alignment.

⁶ The full picture is more complex than what is shown here; see Öztürk and Pöchtrager (2011: 46–9). Note that overt independent pronouns are optional, and the first- and second-person ones are syncretic nominative/ergative/dative.

Different from inverse or hierarchical, yet also based on the referential hierarchy, is what has most often been known as conjunct/disjunct marking and more recently egophoricity. (The classic work is Hale (1980); later Curnow (1997, 2002), Dickinson (2000); Creissels (2008); soon to appear is Floyd et al. (2016). For more on terms see Bickel and Nichols (2007): 223.) This type codes person indirectly and the source of information directly: one and the same marker is first person (and information source) in statements and second person in questions; sometimes there is a distinct disjunct marker for non-first, non-second-person information source. The motivation is that the speaker is the source of information for statements but the hearer for questions. Other properties may also be marked, such as subject versus undergoer in Awa Pit:

(9) Awa Pit (Barbacoan; Colombia)

- a. *juan=na* (*na=wa*) *izh-ti-s*
 Juan=TOPIC *1SG=ACC* *see-PAST-CONJUNCT.UNDERGOER*
 ‘Juan SAW me’
- b. *nu=wa=na* *min=ma* *pyan-ti-s ?*
 2SG=ACC=TOP *who=Q* *hit-PAST-CONJUNCT.UNDERGOER*
 ‘Who hit you?’
- c. *pina alu ki-mati-zi*
 very rain do-PFV.PAST-DISJUNCT
 ‘It rained heavily’

Source: Bickel and Nichols (2007): 224, citing Curnow (2002)

Egophoric marking is also an alignment type, but it is not an access issue in the same way that inverse and hierarchical marking are; rather, the entire epistemic stance follows from the referential hierarchy.

Also based on the hierarchy is the proximate/obviative type, found in a number of North American languages, notably Algonquian, and also Philippine languages such as Tagalog. Here, arguments compete for a single more prominent slot, called **proximate** in North American languages and **focus** in Philippine languages; all others are obviative. Typically, the proximate argument is first or second person, or (if third person) more topical. All others are obviative. The verb tracks the proximate argument. See Bickel (2011: 408–10); for syntactic and other conditions determining proximate/obviative status in third-person arguments see Aissen (1997).

Where referential hierarchies affect alignment, they usually involve person and more generally the upper reaches of the hierarchy, and commonly there is a cutoff point between first and second person, and third person. An exception to this is noun case paradigms, where the animate/inanimate cutoff point can determine morphological alignment: for example, the Anatolian branch of Indo-European has split ergativity with neuter (inanimate) nouns inflecting ergatively and others accusatively

(Garrett 1990), and the Gorokan language family of New Guinea has a similar pattern (Garrett 1990).

Salient though person markers are to hierarchical effects on alignment, their behavior is often not straightforward. Combinations of first and second person (“I VERB you,” “you VERB me”), where two arguments are marked on the verb, are generally opaque, or overtly mark only one of the persons, or are ambiguous or otherwise non-transparent (Heath 1991, 1998). My informal observation is that this is somewhat prone to extend to any combination involving second person (including inclusive). Witzlack-Makarevich et al. (2016) show in detail, for a large cross-linguistic sample, that for two- and three-argument clauses in this upper referential range the roles are a better predictor of indexation forms than the hierarchy is.

Apart from alignment, referential hierarchy effects have generally been regarded as a primary factor in differential object marking and differential subject marking (Silverstein 1976; Comrie 1981; Aissen 1999, 2003, and others); for example, in most Turkic languages a direct object takes the accusative suffix only if it is definite or specific (exact conditions vary) and otherwise has no case suffix. Bickel and Witzlack-Makarevich (2008) and Bickel et al. (2014) find that this situation obtains only in Eurasia and Indonesia–New Guinea; elsewhere, hierarchical effects are not significant. What appears to diffuse areally is not particular role-marking splits but splits in the abstract.

There has been a good deal of attention to referential hierarchies in recent years (§6), and overall it seems safe to say that the referential hierarchy is a universal,⁷ though not all languages make use of it and its implementation can vary, as can the ranking and treatment of first and second persons.

Apart from alignment, the referential hierarchy has widespread validity, for example in predicting the distribution of number categories (Corbett 2001: 90–102): dual, paucal, and other minor numbers tend to affect only the higher range of the hierarchy, while plural can extend to all nouns, and associative rather than plural meaning is found in the highest ranges.

7 Derivation, Inflection, Other

Word formation is usually understood to include derivation (whether by concatenative means such as affixation or by nonconcatenative means such as reduplication or ablaut), compounding, and conversion. Compounding and conversion are easily identified, but drawing a clear line between derivation and inflection has proven problematic. A rule of thumb is that derivation creates new words; inflection creates word forms which respond to their syntactic context (Bickel and Nichols 2007). (A widespread but implicit

⁷ That is, a universal bias affecting diachronic changes: see §2 above.

assumption seems to be that derivation has a word as input and a word as output.) Another frequent rule of thumb is that a morpheme or process is derivation if it changes the word class or subclass, inflection if it does not. However, these are a continuum, or at least there are forms traditionally viewed as inflectional that change word class (e.g., participles, considered an inflectional form of the Indo-European verb but changing word class from verb to adjective: Haspelmath (1996)). See also Section 9 below on the difficulty of distinguishing inflection from derivation in polysynthetic languages. Inflectional morphology from a typological standpoint is covered in Bickel and Nichols (2007). Derivational morphology is covered in recent reference works (Štekauer and Lieber 2005; Lieber and Štekauer 2014).

Word formation plus inflection leaves out a large class of formatives, usually affixal, that are clearly not inflectional and also not derivational by usual criteria, in that they do not change word class and do not have a word as input and a different word as output. These are known by terms such as **thematic suffix**, **stem formative**, **inflectional class marker**, and others. They can be described as marking or indicating the (preexisting) class or category or subclass of a word (rather than creating it), and often also as enabling the word to belong to an inflectional class and inflect in that class. Examples include these Latin triads of state and endpoint state lexemes:

(10)	Latin verb	<i>timēre</i>	‘be afraid’	(citation form: infinitive)
		noun <i>timor</i>	‘fear’	(citation form:
				nominative singular)
	adj.	<i>timidus</i>	‘fearful’	(citation form:
				nominative singular)
		<i>calēre</i>	‘be warm’	
		<i>calor</i>	‘warmth’	
		<i>calidus</i>	‘warm’	
		<i>candēre</i>	‘shine white, glow’	
		<i>candor</i>	‘shining whiteness, luster; sincerity, candor’	
		<i>candidus</i>	‘shining white’	

and many more (there are 31 full unprefixal verb sets, 150+ counting prefixed ones, and a few dozen defective or irregular sets). There are no unsuffixed forms of the stems *tim-*, *cal-*, *cand-*. These suffixes do not form words from other words; they simply indicate the inflectional class and/or word class of the output word. Every verb in Latin has to belong to some conjugation class, and the *-ē-* suffix does nothing but put these verbs into a conjugational class so that they can inflect.⁸ Likewise for *-or*

⁸ Importantly, the *-ē-* does not **derive** verbs of some semantics (such as stative); it is the flexible stem that has that meaning, and the *-ē-* allows that stem to inflect as a verb.

on the nouns, which is simply the nominative singular of an inflectional subclass. In the adjectives, *-id-* is not an inflectional class marker, but neither is it a true derivational suffix: it does not change word class but rather can be said to just mark or signal it. All of this means that the stems *tim-*, *cal-*, *cand-* themselves have no word class but are flexible. Importantly, this is not word-class flexibility of *words* (as frequently in English, Samoan, etc.) but flexibility of *stems* or *bases of derivational paradigms*.

Another example comes from Slavic. The modern Slavic languages have reflexes of two verbs that took the reflexive clitic in Proto-Slavic: **bojati se* 'fear, be afraid' and **smějati se* 'laugh.' They may (or may not) have been reflexive even earlier, in Proto-Balto-Slavic. Now, the modern Slavic languages, like Romance and continental Germanic languages, make extensive use of reflexivization as a detransitivization device in both word formation and inflection (passivization, impersonals), but this is not reconstructable to Proto-Slavic; it begins to show up in the earliest Old Church Slavic documents (written in the ninth century, oldest extant copies from the tenth century) and is well under way within about a century. It is a contact phenomenon, marking the entry of Slavic into the European cultural sphere and contact with Romance and Germanic. The two Proto-Slavic reflexive verbs are not of this type, as those verbs were intransitive to begin with. What the reflexive clitic does here is not detransitivize but simply signal the fact of intransitivity, so these verbs can be considered marked for middle voice (as Kemmer (1993) defines that term; crosslinguistically it is sometimes a stem-formation device and sometimes derivational, infrequently inflectional).

The status of stem-forming devices is typologically important and bears on fixed versus flexible word classes. It is one thing if one member of the Latin triads above is set up as basic (e.g., the verb) and the other two are derived from it; then the base has a word class (e.g., verb) and derivation changes it. It is a different matter if all three are thematic suffixes; then these bases are flexible. Latin emerges as a language with a fairly high percentage of flexible bases.

As another example, for Slave (Athabaskan; Canada) Rice (1989: 161–2) treats as word-class-flexible a sizable number of simplex roots which take different stem-forming prefixes to function as nouns and as verbs. These include a large class of nouns which she describes as having a zero stem-forming prefix. But in a structurally analogous situation in Slavic, such as Russian, the Slavic grammatical tradition treats such sets as having an adjectival root and two verbs derived from it (11). However, when only verbs are at issue, traditional grammar treats athematic (suffixless or zero-suffixed) verbs as just one more conjugation class and not as the base or root, as in the Russian as in (12). It is one thing if the verb root is fundamentally punctual and the stative/durative verb is derived from it,

but another thing if this is an aktionsart-flexible root that assumes different conjugation classes in different aktionsart senses.

(11)		Root	Thematic suffix	Citation form ending	
	adjective	bel-		-yj	‘white’
	intrans. verb	bel-	-e-	-t’	‘turn white’
	trans. verb	bel-	-i-	-t’	‘whiten, bleach’
(12)	punctual	sed-		-ti	/sest’/ ‘sit down’
	static	sid-	-e-	-t’	/sidet’/ ‘be sitting’

There is no standard decision on the status of thematic or stem-forming morphology, or on technical matters such as whether the Slave zero-suffixed nouns, Russian adjectives as in the set for ‘white,’ and the punctual verb form in ‘sit’ are the bases of paradigms or zero-affixed forms among the other affixed forms in a derivational paradigm. In the latter case the language will have a number of flexible bases. Either decision has implications for the word-class type of the individual language and the frequency of word-class types crosslinguistically. Careful theoretical attention on the part of typologists is needed to resolve the issue, clarify the status of stem-forming morphology, and draw up criteria for whether and when to regard roots, stems, and derivational base as word-class flexible.

8 Canonicity

Canonical typology is a method and line of inquiry begun by Greville Corbett and developed particularly in the Surrey Morphology Group (e.g., Corbett 2004, 2007, 2010, 2013a, 2013b, 2015; Brown et al. 2013, in which the editors’ introduction gives a good overview of the field). Canonicity has to do with determining an ideal point in a theoretically defined typological space (a canonical value) and describing the possible departures from the ideal (non-canonical). For example, in inflectional paradigms, canonical values include completeness (every cell should be filled; i.e., no defectivity), distinctiveness (each form in the paradigm should be different; i.e., no syncretism), predictability of stem (i.e., no suppletion), predictability of inflections (i.e., no deponence); if there are inflectional classes they should all be discrete (i.e., no cross-paradigm sharing); if stems vary or supplete the different forms should be defined by external criteria (e.g., number suppletion, tense suppletion) and not purely morphomic (i.e., purely paradigm-internal, unconnected to semantic categories or syntactic functions; see Chapter 2, §1.3). Compare the partial noun case paradigms from Mongolian and Russian in (13).

- (13) Mongolian (Svantesson 2003: 163; Janhunen 2012: 297–8, 106–12, 66–8; Janhunen's transcription)

	'book'	'house'	'sea'	'year'
Nominative	nom	ger	dalai	or
Genitive	nom- <u>yn</u>	ger-i <u>in</u>	dalai-n	or- <u>n-<u>ŷ</u></u>
Accusative	nom- <u>ŷg</u>	ger-i <u>ig</u>	dalai-g	or- <u>ŷg</u>
Dative	nom-d	ger-t	dalai-d	oro- <u>n-d</u>

Mongolian essentially has a single paradigm of case endings, with variation due to predictable phonological and morphophonological alternation (e.g., vowel harmony, hiatus-breaking *g* in 'sea') and two stem classes, the open one as in the first three words and one with an *-n-* extension in the genitive and dative (see 'year') (this extension is also found in the ablative, not found here; its distribution is morphomic). This last class and its morphomic extension are the only real non-canonicalities in the singular declension system.

- (14) Russian

	'brother'	'house'	'book'	'window'	'net'	'time'
<i>Gender:</i>	<i>M.anim.</i>	<i>M.inan.</i>	<i>F</i>	<i>N</i>	<i>F2</i>	<i>N-n-</i>
Nominative	brat	dom	knig-a	okn-o	set'	vremja
Genitive	brat-a	dom-a	knig-i	okn-a	set-i	vrem-en-i
Accusative	brat-a	dom	knig-u	okn-o	set'	vremja
Dative	brat-u	dom-u	knig-e	okn-u	set-i	vrem-en-i

Russian has four major declension classes, labeled M, F, N, and F2, with an animacy-based distinction of two variants of M. The N-n- class (that is not the traditional term) is a closed class of about a dozen neuter nouns with an *-en* extension in the oblique cases and plural. The declension classes partly coincide with gender. Non-canonical patterns in the forms above include nominative-accusative syncretism in M.inan., N, F2, and N-n-; genitive-accusative syncretism in M.anim.; a split of the accusative in the M paradigms, based on animacy; identical genitive and dative endings in the M classes and N; genitive-dative syncretism in F2 and N2; and the fact that the ending *-a* is nominative for F but genitive for M and N (and also accusative for M.anim.), and *-u-* is dative for M and N but accusative for F. Not shown here are oblique stem extensions other than that of N-n- nouns, and stem changes involving fixed versus mobile stress. These are all departures from a one-form-one-function ideal.

Dimensions of canonicity themselves can have internal canonicity ranges: for example, though suppletion is less canonical than an invariant root, one can identify canonical suppletion as involving a maximally regular semantic correlation and maximally irregular formal correlation (Bond 2013: 23). The theoretical space – here, the notion of inflectional paradigm – is made up of a number of dimensions (completeness, distinctiveness, predictability, etc.), and the systems of individual languages are more canonical to the extent that they converge on the ideal point.

Canonical typology is important to typological theory and comparative theory more generally because it makes it possible to set up cross-linguistically comparable features and values and to measure the extent to which individual systems approximate the canonical value. (Setting up comparable variables is essential to crosslinguistic comparison—this is what Corbett calls the **correspondence problem**—yet in most domains of grammar comparison has proceeded long in advance of defining such variables.) Canonical values are defined logically and theoretically, not empirically, and, importantly, need not coincide with frequency, favored outcomes in diachrony, ease of acquisition, prototypicality, and so forth. In general they are not empirically testable. For morphological paradigms, canonicity essentially amounts to codification of a one-form-one-function ideal for which an item and arrangement model would suffice (Corbett 2004: 34). For syntax, only the one-form-one-function ideal but not necessarily the Item-and-Arrangement model obtains; see contributions in Brown et al. (2013).

In some respects canonicity coincides with the Prague School notion of markedness (that is, canonicity is reminiscent of unmarkedness and non-canonicity of markedness). Though as an ideal point in a logical space a canonical value is not expected to be empirically testable, it is notable that canonicity does have implications for complexity theory and tracking the empirical consequences of complexity. Non-canonicity of all kinds increases the amount of information required to describe a grammatical subsystem, a good definition of grammatical complexity (see §9 below). Compare the length of the descriptions required for the noun case declension patterns of Latin or Russian versus those for Turkish or Mongolian. Latin and Russian have several different morphologically defined declension classes, unpredictable except for the limited extent to which gender and declension class correlate; each class has its own patterns of syncretism; some endings are shared across classes. Turkish and Mongolian have a single declension class with the same set of endings (*modulo* phonological and morphophonological processes, all quite transparent and many of them general across all morphology rather than needing separate statements specifically for noun declension), minimal or no syncretism, no cross-class sharing of endings by definition, and no interaction with gender as neither language has gender. Describing Turkish or Mongolian declension essentially amounts to listing a single set of inflectional suffixes (plus an account of phonological alternations, mostly via cross-reference). Describing Latin or Russian declension requires display of more paradigms and discussion of their predictability, the interaction with gender, and discussion of the syncretisms, sharings, and so forth that occur. Since description length captures complexity, (non-)canonicity can serve as a convenient guide to complexity, ready to use off the shelf, while a satisfactory understanding of linguistic complexity will probably require at least a decade of theoretical and computational work.

9 Complexity

Language is a complex adaptive system: complex because it involves emergent levels, and adaptive because the various components interact and the history of that interaction affects future interactions and behavior (via what is known as a feedback loop; in languages, of course, the feedback and interaction involve speakers and learning). An emergent level (of organization within a system) is composed of smaller units whose structure and/or behavior do not predict that of the higher level. (Another term for the presence of emergent levels is *hierarchical structure*, a different sense of *hierarchical* from that which is familiar from syntactic phrase structure or from the discussion of hierarchies above.) A linguistic example of an emergent level, from Dahl (2004: 38–9), is the set of strong verbs in Germanic languages. The set itself, and some of the subclasses in it, has greater stability than do the individual verbs in it: not all verbs of the same subclasses are cognate from language to language, yet the subclasses and the overall set have lasted for the entire history of Germanic.

What, then, is complexity and how is it measured? Important general references are Kusters (2003), Dahl (2004), Miestamo et al. (2008), Sampson et al. (2009), Sinnemäki (2011), Newmeyer and Preston (2014), and the journal issue *Poznań Studies in Contemporary Linguistics* 50:2 (2014). The main concern of typological work on linguistic complexity, and still a wide-open question, is how to measure and compare linguistic complexity, chiefly grammatical complexity. The main approaches that have been used in typology are:

- (1) The number of elements in the system; for example, for phonological complexity, the number of phonemes. Numbers of elements are easy to count for cross-linguistic surveys (examples: Nichols 2009; Atkinson 2011; Plank 2011), but this is a crude measure of complexity and at best a proxy for a better measure.
- (2) Length of description; in other words, the amount of information required to describe a system (or generate a string). (This is also known as Kolmogorov complexity, descriptive complexity, and other terms. For discussion and an application see Juola (2008).) See above on Mongolian or Turkish versus Latin or Russian declension. There are major difficulties associated with applying this complexity metric for actual quantification of complexity and for anything as large and complex as the entire morphology of a language, but it is useful when applied informally and to small paradigms or parts of paradigms (as with the comparison of Mongolian-Turkish-Latin-Russian noun inflection, above). As noted above, the one-meaning-one-form ideal that underlies canonical typology amounts to a length-of-description criterion: either a one-to-many or a many-to-one correspondence requires a lengthier description than a one-to-one correspondence, which is

maximally simple (Kusters 2003; Dahl 2004; Miestamo 2008; Sinnemäki 2011: 30–1, 39–40 and *passim*).

- (3) Transparency (less complex) versus opacity (complex). For example, the three-gender system of Avar (Nakh-Daghestanian, Caucasus) is highly transparent both semantically (the three genders are masculine (human), feminine (human), and other, all entirely semantically predictable) and formally (no allomorphy, always marked in the same position, root-initially). The four-gender system of Tsakhur (also Nakh-Daghestanian) is opaque: semantically unpredictable, considerable allomorphy among gender markers, and also some allopositionality. Transparency co-varies with length of description, and is also well captured by canonicity.
- (4) Processing cost, ease of learning, and so on. These cognitive and psycholinguistic considerations are relevant but not covered here.

Stump and Finkel 2013 present a method that computes the principal parts for the paradigms of an inflectional-class system, and from that allows one to calculate a precise measure of complexity based on such factors as number of principal parts, predictability of each cell in the paradigm, predictiveness of each cell, number of minor classes, and others. It promises to make possible very consistent crosslinguistic comparison of inflectional-class complexity. For a theoretical perspective on predictiveness in paradigms see Chapter 12 here; the notion of conditional entropy described there amounts to a definition of complexity based on predictiveness within and across paradigms. It differs from the measures mentioned above in that predictiveness also depends on the lexical frequencies of paradigm types.

In the absence of a theoretically sound and crosslinguistically applicable measure of overall complexity, two theoretical issues have been conspicuous in the literature. One is the **equi-complexity** hypothesis (or assumption, or article of faith, as it has often been): are all languages equally complex overall? A “yes” answer was a textbook truism in the mid-twentieth century but has been near-unanimously rejected in recent years. The other is **complexity tradeoffs**: the idea that individual subsystems balance out in complexity, so that negative correlations between the complexity of different variables can be taken to support equi-complexity. Though there is some evidence in favor of tradeoffs, for the most part they are not supported (e.g., Shosted 2006; Sinnemäki 2011, 2014).

For both of these issues see Sinnemäki (2014), who shows that simulated random variables, variables from simulated equi-complex systems, and actual variables from the *World Atlas of Language Structures* (Dryer and Haspelmath 2013; henceforth *WALS*) behave very differently: the random ones display a slight bias toward negative correlations, those from equi-complex systems display a very significantly greater but still small bias in the same direction, and the *WALS* variables display a strong bias toward positive correlations. This in itself is enough to suggest strongly that testing

individual correlations for complexity tradeoffs can never prove or disprove equi-complexity, and that equi-complexity and complexity trade-offs are two separate things neither of which supports or weakens the other (much less proves or disproves). Sinnemäki also observes that entire real languages involve enormous numbers of variables, orders of magnitude more than simulated systems or collections of WALS variables, and that the overall complexity of a language might be built up from many very small correlations, so that even a good number of them (as typological comparisons go) would be unable to demonstrate anything about the contribution of either positive or negative correlations to the whole.

A historical and evolutionary question is how complexity increases or decreases over time in languages. An answer is proposed by Dahl (2004) and Trudgill (2011). Natural changes such as assimilations, conditioned splits, grammaticalization, and so on, gradually add conditions, alloforms, and units (phonemes, morphemes, etc.) to grammars, increasing complexity; loanwords and other contact phenomena also make additions. There is nothing to hinder, as children are capable of learning languages (or their subsystems) of any degree of complexity. Loss of complexity, on the other hand, is an occasional, punctuating, contingent event, the only well-studied exemplar being decomplexification when an expanding language absorbs adult L2 learners in large enough numbers that their version of the language—necessarily simplified, as adults usually fail to master all the intricacies of a late-learned language—eventually has impact on the entire speech community.⁹ This is the finding of Trudgill (2011), where the known researchable positive cases are expertly studied.

Another question is what, outside of grammar, complexity is correlated with. Correlations have been proposed for population size, with larger population implying lower complexity (pro: Sinnemäki (2009) for core argument marking, but see Sinnemäki (2011: 143–6); con: several papers in Plank ed. (2011) on phoneme inventories, Nichols (2009) for general inventory size); and for sociolinguistics (Trudgill 2011 (see just above); Nichols 2013b).

Related to complexity is polysynthesis, the extremely complex development of verbal morphology that is relatively common in the Pacific Rim linguistic population and the larger Trans-Pacific region but has outliers in East Africa. The typological literature has found it easier to agree on which languages are polysynthetic than on how to define polysynthesis. Head marking is a necessary criterion, as all polysynthetic languages are largely to entirely head marking in their clause structure; but it is not a sufficient

⁹ Another factor is surely geographically influenced extinction. Language spreads tend to move poleward and, in mountain areas, uphill. It is the languages far from the centers of spread that experience sociolinguistic isolation (as defined by Trudgill (2011); no intake of substantial adult L2 learners) and are prone to display greater complexity (supported for parts of the northern hemisphere by Nichols 2011, 2013b). They are also prone to go extinct by shift as more centrally located languages spread polewards or uphill. If more generally confirmed, these patterns would mean that no language has survived long enough in sociolinguistic isolation to reach unlearnable levels of complexity.

condition, as there are a good many languages that are head-marking but not polysynthetic (the Mayan languages, for instance). Fortescue (in press) gives a good consensus definition: polysynthesis is holophrasis (verb forms can stand alone as independent clauses, with no external lexical arguments and with at least two core arguments indexed by bound pronominals) plus at least one lexically heavy morpheme in addition to the verb stem.¹⁰ He also includes a list of the languages that count as polysynthetic by this definition. Denny (1989) argues that polysynthesis is a distinct type of morphological composition, neither inflection nor derivation, and that the defining property is combination of morphemes from the major word classes (verb, noun, adverb, adjective), with no reference to syntactic roles such as subject and object, and with all incorporanda figuring as predicates and not as arguments (hence they cannot co-occur with overt external arguments or introduce arguments into discourse). Polysynthetically combined classifier nouns (generic nouns that can and often do co-occur with more specific overt external arguments), in contrast, are arguments (sorted noun arguments), and because they refer to individuals they cannot be used with non-referential verbs like “seek.”

Whereas in non-polysynthetic languages the usual organization of verb morphology is that derivational affixes are closer to the root than inflectional affixes (Bybee 1985), in many polysynthetic languages the two types of affixes are intermingled, and it can be difficult to distinguish derivation from inflection. This is more or less unique to polysynthetic languages and can almost be regarded as definitional (see Arkad'ev et al. 2009). Fortescue (2013: 245) sees it as marking an evolutionary threshold after which a language can no longer simplify back to the analytic type, and as useful in discriminating between long-polysynthetic and recently polysynthetized languages and therefore a guide to the age and embeddedness of polysynthesis in a language population. And indeed, two of the least complex polysynthetic languages, Ainu (isolate; Japan, formerly also Sakhalin Island in Russia) and Aleut (Eskimo-Aleut; Aleutian Island chain of Russia and Alaska) appear to have undergone large spreads and absorbed other populations (Janhunen 2002; Berge 2015), histories that should have decomplexified them considerably but have not made them non-polysynthetic.

The outline of an evolutionary history for polysynthesis would then be this. Polysynthesis arises in an already head-marking language, when by some means the language adds some incorporation, or indexation of additional arguments or non-arguments, or the like to its morphological

¹⁰ Nichols (in press) has a non-consensus definition: Polysynthesis is open head marking — in other words, at least one bound morpheme slot admits open fillers (rather than a closed set) and/or at least one additional slot can be added. In fact the two definitions overlap almost completely in extension; only Nuuchahnulth, morphologically complex with noun incorporation (open fillers) but bound pronominals only for subjects, is polysynthetic by this definition but not by Fortescue's.

inventory. Eventually, through reanalysis, renewal, or replacement of inflectional morphology, changes in affix order, and so on, it comes to have an affix string in which derivational elements are interspersed among inflectional elements. Once it reaches this point it is likely to remain polysynthetic even if it undergoes fairly drastic decomplexification by absorbing L2 learners. With Ainu moribund and Aleut endangered, we will probably never know how they might have evolved further, and certainly we will never see either language continue expanding by language shift – nor probably any polysynthetic language undergoing a large spread. If Fortescue is right that intermingled inflection and derivation mark a point of no return in polysynthesis, then in a language population containing any polysynthetic languages and with little or no linguistic immigration to swamp the existing population, polysynthesis should gradually increase over time. How long it would take to stabilize at anything close to 100 percent depends on the size of the population, the birth rate of polysynthesis (low, and requiring something other than routine contact, to judge from the fact that most language families have either all polysynthetic daughters or none), and whether and under what conditions polysynthesis can be lost. These are questions that morphological typology combined with historical linguistics and language-family expertise can answer, using simulation, research on language attrition and language death in polysynthetic languages, and historical-comparative work on the ages of the various polysynthetic elements in language families.¹¹

10 Templates, Affix Order, and so on

Typology has contributed to and drawn from work on affix ordering in the same ways and to the same extent as other subfields of linguistics have. For affix order in general see Chapter 7 here, and also Rice (2011), a longer survey with many examples. Templatic morphology (fixed arbitrary ordering of elements, regardless of semantic scope, phonology, etc.) has sometimes been treated as important to defining polysynthesis, and the frequent intermingling of inflectional and derivational affixes that is a natural concomitant of templatic morphology is also prototypical of polysynthesis (see §9 just above). Importantly for what's-where-why typology, particular template patterns characterize language families and can help define families: see Rice (2000) for Athabaskan. Vajda et al. (2012) present several case studies showing that complex templatic morphology can be remarkably stable in language families. Good (2016) gives a full descriptive and theoretical account of template structure, with terminology, definitions, and many examples, so that typology may now be

¹¹ For polysynthesis see also Chapter 7 here.

poised to undertake in-depth crosslinguistic analysis of template-structure variables and their evolution.

11 Conclusions

In the age of Big Data, all depends on the quality, quantity, consistency, and theoretical sophistication of every individual datapoint in the grammars and historical works we all depend on. What's-where-why typology is Big Data typology, but the theoretical and descriptive underpinnings that make it possible are what mediates between fieldworkers, historical linguists, and language-family specialists and computational, formal, experimental, and applied linguistics. Grammars necessarily lag behind the development of typological theory, but recently the lag is commendably small. This chapter has attempted to lay out the main points of convergence between descriptive and historical practice and typological theory, and to identify some remaining gaps.

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Morphological Change

Brian D. Joseph

1 Introduction: What Is Morphology?

The various chapters in this work make it clear what morphology is and what is encompassed by the notion of “morphology”; nonetheless, it is probably good to start this chapter with a sense of what morphology is from my point of view, in order to be clear about what change in the morphology means. After that, various dimensions relevant to the matter of morphological change are explored, and during the course of the discussion of these dimensions, rich exemplification of morphological change of various types is offered.

I start with a general statement about the goal of a grammar—a grammatical account—as conceived of by linguists: the grammar that is licensed by (i.e., developed within the framework of) a linguistic theory should be a reflection of a speaker’s knowledge of and competence in his or her language. “Knowledge” and “competence” here do not mean a practical command of the language, but rather the set of combinatorics and related adjustments that are necessary for speakers to produce meaningful utterances. Moreover, I make the assumption that there are different components of a grammar, each with its own aspects but with principles of interaction between them as well.

Within such a conceptualization of the purpose and general architecture of a grammar, we can start with the obvious as to what *morphology* is and where it fits in: it is about the forms (cf. Greek *μορφός* ([*morp^hós*]) ‘form, shape’) of a language. The most obvious manifestation of form is the word, so, clearly, morphology is (somehow) related to words. Speakers for the most part know what the words of their language are, and we can call a speaker’s catalogue of words his/her **lexicon**. It is safe to say that any given speaker’s lexicon overlaps considerably with the lexicon of any other given speaker in the relevant speech community without any two speakers’ lexicons necessarily being identical.

If words are involved in morphology, then so also are the elements that make up words, not so much the sounds, though those are not irrelevant (Inkelas, Chapter 19), but rather the “chunks” — the distinct and recognizable pieces — that make up the word and give it some internal structure. Traditionally, such word-formative pieces have been called **morphemes** (Bauer, Chapter 13). Speakers seem to be aware of such pieces, though perhaps not always in as clear a manner as linguists might think (Clahsen, Chapter 28), so that the existence in the grammar of a catalogue of morphemes, including all such word-formational elements, can be justified (but see Blevins, Chapter 3). Moreover, principles by which words are formed and regularities of word-formation fall within the domain of morphology.

Words have meaning, and as a result, it is reasonable to recognize a distinct component of grammar that deals with at least certain aspects of combinatorial meaning — that is, a semantic component. However, it is difficult, at some level of analysis at least,¹ to separate meaning from the pieces to which meanings ultimately are attached. This means that at least lexical meaning and, further, under certain assumptions (see below), morphemic meaning must be registered somewhere in the grammar. The lexicon is the obvious such place.

It is fair to ask then what information is to be included in the entries in the lexicon. The traditional (American Structuralist) view of lexicon was that it is a repository of all of the idiosyncratic information about words, such as the nonpredictable aspects of their pronunciation and alternations in their form (morphophonemics), their meaning, their combinatorics, and the like. Such information, however, proves not to be all that cataloguing idiosyncrasies entails. Once one realizes that idiosyncrasies involving lexical items can include the obligatory occurrence in certain syntactic structures (e.g., the English idiom *What gives?* occurs only in direct and indirect questions, and the verb *rumor* occurs only in the passive, as in *John is rumored to be a member of the Vegetarian Party*) as well as highly restricted phonological information (e.g., the English indefinite article has a largely phonologically determined allomorphy, *a* ~ *an*, that shows a unique alternation in form that is unparalleled elsewhere in the language), it becomes clear that aspects of syntax (e.g., question formation) and phonology (*n* ~ $\emptyset$ roughly prevocalic ~ preconsonantal)² must be built into the lexicon. In this way, the lexicon becomes a much more vital part of the overall grammar than American Structuralists envisioned.

Thus, we have not so much a lexicon and a morphology as a *morpho-lexicon*, enriched with syntax and phonology, and necessarily touching base with semantics. With regard to change, this means that changes in all

¹ By stating things this way, I am leaving open the possibility that one could describe and analyze form in itself, without reference to meaning, as in the “Separation Hypothesis” (Beard 1995); for the purposes of describing morphological change, it seems not to matter whether form is separated from meaning at some level of analysis, as long as there is a level at which form and meaning are linked (as there surely must be, given that forms ultimately express meaning). See Bonami and Stump, Chapter 17.

² I say “roughly” because of variation for some speakers (or across speakers) before #h- (cf. *a/an historian*).

aspects that go into a lexical entry in principle are a type of morphological change—in other words, a change in the form of words and word-pieces, in morphemes that is, and all that is associated with them. This view is elaborated on below in Sections 2 and 3.

Further, there are several issues in the analysis of morphemes that need to be mentioned here. First, in order to talk coherently about change in morphemes and change in morphology, one has to be able to identify the pieces that figure in morphological change. For the sake of having some point of reference for being able to talk coherently about change, I adopt the American Structuralist discovery procedure by which one matches recurrent forms with recurrent meanings in order to segment words into morphemic pieces and gives each word an exhaustive analysis, so that no piece is left unidentified. While this procedure most evidently is based on a notion that morphemes are “things”—concrete pieces such as roots and affixes, that is, that are generally concatenated together³—it does not rule out the identification of processes such as ablaut or consonant gradations—as well as affixation, of course—that become evident as finer and finer comparisons are made between and among related forms and related meanings. The distinction between morphemes as things and morphemes as processes figures in important ways in the discussion below of morphological change, since processes can arise sometimes through the reinterpretation of the effects of the concatenation of morphemes as “things.”

I therefore lay my cards on the table in the following way regarding morphology as a necessary prelude to understanding morphological change. For me, morphology, in the form of the enriched morpho-lexicon described above, is central to the organization of grammar and covers a large amount of “space” within the overall architecture of grammar. Given its centrality and considerable scope, changes involving morphology are (therefore) quite widespread and frequent. Moreover, evidence from language change suggests that speakers generally opt for morphological solutions to matters of linguistic analysis wherever possible, say over syntactic solutions or phonological solutions, where by “solution” I mean which traditional component of the grammar (phonology, morphology, syntax, etc.)⁴ is the locus for the statements in the grammar regarding the analysis of a particular linguistic phenomenon.

2 What Can Change?

In short, the answer to what can change in the morphology is the same as the answer to what can change in language in general; that is, anything can

³ Or intercalated, as the case may be, as in the folding in of vocalic patterns into consonantal shells, such as is found in the Semitic languages.

⁴ I say “etc.” here so as not to preclude the possibility that phonetics or semantics or something else might form its own component of grammar.

change that is not part of the basic rock-bottom set of principles that define a communication system as a human language.

Moreover, given the broad conceptualization of morphology in terms of a morpho-lexicon in Section 1, one dimension of morphological change is any change in the material in individual lexical entries or the creation of new lexical entries themselves. Thus, changes in the meaning, or range of meanings, associated with a given lexical item, largely through processes of metaphorical extension or metonymic transfer, can in this view be construed as morphological changes since they entail a change in one dimension of a morpheme, and thus a change in the overall morpheme. Similarly, changes in the phonetic realization of a morpheme, through the operation of regular sound change or other means (e.g., analogy) by which a morpheme's shape can be altered, can be construed as a type of morphological change, a trivial one perhaps but a change nonetheless.

With regard to the effects of sound changes, a subsidiary issue arises: with the accumulation of sound changes, basically the lexical representations on the sound side stay the same only at the expense of abstractness – in other words, a greater distance between underlying forms and surface forms. At some point, all phonological theories recognize the need for relexicalization, so that no phonologist, with the exception of Ted Lightner, as seen in Lightner (1975, 1983), starts an analysis of English with underlying representations (or the equivalent in a constraint-based grammar, such as GEN forms that would be ruled out immediately) that look like reconstructed Proto-Indo-European (PIE), with phonological rules (or constraints) that recapitulate the sound changes that occurred between PIE and various Indo-European languages that fed into the modern English lexicon. For instance, one might relate the forms *cycle*, *pole*, *tele-* (as in *telephone*), and *wheel* – as Lightner overtly does (see 1983: 167 regarding the last three and 1983: 218 regarding *cycle*) – by positing a basic root $/k^w(e)l-/$ for them that occurs with different vocalism (and other slight differences) for the different forms and shows synchronic phonological developments in particular environments such as $/k^w/ \Rightarrow p / \_\_o$, $/k^w/ \Rightarrow t / \_\_e$, or $/k^w/ \Rightarrow h^w (= w \text{ in most dialects})$ so as to give the various attested forms; the respective etymologies of these words – *wheel* as a native Germanic outcome of a reduplicated $*k^wek^wlo-$, *cycle* as a borrowing from the Greek outcome of this reduplicated form, *tele-* as a borrowing from a Greek form with *e*-vocalism in the root (actually, *ē*), $*k^wel-/k^wēl-$, and *pole* as a borrowing from a Latin form that is based on a borrowing from a Greek form with *o*-vocalism, $*k^wol-(o)-$ – reveal exactly such proto-forms and sound change developments. One has to wonder about the learnability of representations and the ability of speakers to make the lexical connections that could lead to an underlying $/k^wel-/$ for these words,⁵ so that there is surely a need to

⁵ Lightner's strategy here is to talk in terms of a grammar of a speaker with "perfect knowledge of a language" (1975: 634); such obscure lexical connections are part of that "perfect knowledge."

constrain such representations and thus for speakers periodically to “update” the lexical forms of words after the operation of sound changes.

This type of morphological change—change in the lexical representations and the nonphonetically⁶ based generalizations that mediate between lexical forms and surface forms—is highly theory-bound: there is less such change in theories that tolerate high degrees of abstractness, because the effects of sound changes can (typically) be modeled as an increase in the number of phonological rules while the lexical representations can stay the same. Since most approaches to modeling phonology have some at least implicit limits on the amount of abstractness allowed, such relexicalizing change is presumably quite common. And in a theory that has no rules or constraints *per se* but rather builds different allomorphs into lexical entries, this type of morphological change consists of the addition of new allomorphs into the entry for a given morpheme.

The nature of the mediation between underlying forms and surface forms can change, and this constitutes another type of morphological change, in a certain way. That is, if one assumes that sound changes start with a phonetic basis,⁷ so that their effects can be thought of as automatic exceptionless phonological adjustments at first that only later gain exceptions due to the operation of other sound changes that alter the environments or the outcomes of the first change, or to the workings of analogy (see §3.2 below, especially if an original segment is restored analogically based on alternations it is involved in), or to borrowings, it can end up that a once-phonetic adjustment becomes morphologized, tied only to specific morphological or morpholexical categories. Such adjustments, such once-phonological rules, can then be recast in the grammar as morphologically determined and thereby become part of the morphological component of grammar.

An example from the history of German should make this point clear. Umlaut in German—and, for that matter, in most of Germanic—refers to changes in a vowel of a root that originally were triggered by a vocoid—vowel or glide—in the next syllable, typically a derivational or inflectional suffix. For instance, some noun plurals were marked by a suffix containing *-i* and by concomitant fronting of the root vowel in anticipation of the suffixal vowel. Thus Proto-Germanic *lūs ‘louse,’ modern German *Laus*, originally had a plural *lūs-iz; the root vowel *ū was fronted to [y:] due to the *-i* in the suffix, and that fronted root vowel is the source of the vowel in the modern German

⁶ “Nonphonetically” is important, as I assume that if an allomorph arises synchronically entirely through the workings of purely phonetically determined processes, such as devoicing of a voiced stop adjacent to a voiceless stop, with no reference to morphological conditions, it would not have to be listed in a lexical entry under any theory.

⁷ I assume here essentially the neogrammarian view of sound change as being entirely phonetically determined; see Janda and Joseph (2003a) for a model of sound change—the “Big Bang” model—in which sound changes start as neogrammarian-like “events” but then go off in different directions, including a greater degree of morphological conditioning.

plural *Läuse* [lojzə] (cf. also English *louse/lice*, with a parallel history). What is significant from our standpoint here is that while the root alternation between the singular and the plural started as a phonetically determined fronting of a vowel in one syllable due to the high front vowel (i) in the immediately following syllable, in modern German, the suffixal vowel is no longer a high front vowel but rather is the mid-central vowel [ə]. There is thus no phonetic motivation for the vowel change, which, incidentally, in this word is not even fully a matter of fronting, except as to the glide, being [aw] in the singular versus [oj] in the plural; some plurals, though, do show fronting *vis-à-vis* the singular, as with *Buch* ‘book’ ([bux]) / *Bücher* ‘books’ ([byçər]). Given that the vowel change has come to be removed from having a phonetic basis, it seems now to be more a morphological phenomenon, associated with the marking of plurality (among other categories)⁸ and not a matter of a(n automatic) phonological adjustment that a particular suffixal shape requires. In fact, in some nouns, the vowel change is not even accompanied by any sort of triggering suffix: *Bruder* ([brudər]) ‘brother,’ for instance, has a plural *Brüder* ([brydər]). Thus, for the modern language, only a fairly abstract analysis, in which there is a plural-marking suffix that has an *-i-* in it underlyingly and surfaces as a [ə] or Ø depending on the noun involved, could treat umlaut as having no morphological involvement, and even then, the ə/Ø outcome could be viewed as morpholexically determined inasmuch as some underlying /i/ vowels do not surface as ə or Ø. For *Brüder*, one could justifiably say that plural is realized only by a morphological process of fronting the root vowel, without any overt affixation; even an analysis with an underlying plural suffix with *-i-* would have to have umlaut realized on a syllable two away from the abstract triggering element. Similar misgivings can be expressed for other categories marked by umlaut (see footnote 8).

Thus some changes in the phonemic shape of morphemes (“morphophonemic alternations”) undoubtedly do have a phonetic origin and maintain that phonetic aspect, as in the Latin *b ~ p* alternations such as *scrib-ō* ‘I write’ versus *scrip-tus* ‘having been written’ or *urb-is* ‘of a city’ versus *urb-s* ([urp-s]) ‘city’ (nominative). Many others, however, lose their phonetic motivation and are simply tied to particular morphological categories, as with German umlaut, or Celtic initial mutations,⁹ or, most likely, PIE vowel gradation (also known as ablaut or apophony), to give an example involving the use of inferencing in what amounts therefore to

⁸ For instance, it appears in the derivation of certain nominalized forms of adjectives, as in *Länge* ([lɛŋə]) ‘length’ from *lang* ([laŋ]) ‘long,’ in comparatives, as in *älter* ‘older’ from *alt* ‘old,’ and so forth.

⁹ See Thurneysen (1946), for instance, on Old Irish, where words that originally ended in a vowel trigger lenition changes (weakenings) on the initial segment of a following word, and those originally ending in a nasal trigger certain nasalization effects. The historical loss of final syllables eliminated the original triggering elements but the lenition and nasalization effects remain, generally tied to the realization of particular morphosyntactic categories and constructs, such as marking of direct objects, occurrence of object-centered relative clauses, and the like.

morphological reconstruction.¹⁰ Thus the morphological component of the grammar can change if new morphophonemic variants emerge via phonetic adjustments or if the triggering mechanism itself undergoes a change, leading to a change in the nature of the source of the variant.

In a similar vein to treating changes in lexical representations as falling within the ambit of morphological change, we can say that really any addition to the lexicon constitutes a type of morphological change. Such a broad conceptualization of morphological change would thus include any new words that are borrowed from another language (e.g., *taco* from Mexican Spanish), or any new coinages (e.g., *googol* '10¹⁰⁰,' coined in 1940 by mathematicians Edward Kasner and James R. Newman), or any forms that move from a highly specific domain into more general use, as when the brand-name *Xerox*, itself a coinage dating to 1952 and based on the name of the relevant photocopying process (*xerography*, from Greek elements *xero-* 'dry' and *graph-* 'write') expanded into use as a generic term for any xerographically produced photocopy, even if not made with Xerox corporation machines; the shift in domain of use essentially created a new lexical item, hence a new morphological element, a new root.¹¹

Such creation is not restricted to lexical forms; grammatical markers can also arise, in many instances from lexical forms, typically adverbs or prepositions but other elements can be involved too, that come to be univerbated onto the forms they modify or co-occur with. The similarity between the ending *-aśśāl* of Tocharian A comitative forms, such as *yukaś-śāl* 'with the horse' and the particle *śla* meaning 'with,' makes it an easy etymological inference to assume that the case ending derives from an original phrasal combination of 'horse' with a postposition 'with.' Similar phrase-to-inflected-word developments are seen in the Oscan locative (e.g., *húrtín* 'in the garden,' apparently from *húrti-* 'garden' with the adpositional element **en* 'in') and the Spanish adverbial suffix *-mente* from an ablative case form of Latin *ment-* 'mind' (thus *obstinadamente* 'obstinately' was originally 'with an obstinate mind' (Latin *obstinātā mente*)), to mention just a few well-known such cases.¹² And periphrastic

¹⁰ And it is certainly the case that ablaut in all of the attested Indo-European languages is morphological in nature; consider English *sing/sang/sung/song*, reflexes of PIE *e*-grade, *o*-grade, zero-grade, and lengthened *o*-grade, respectively, where the vowel changes signal morphological categories of present tense, past tense, past participle, and nominalization, respectively.

¹¹ And, as a noun in English, it could be the basis for a derived verb, inflected just as a verb should be. Thus to *xerox*, with present tense *xeroxes* and past tense *xeroxed*, entered English some time after the noun (first attested as a verb in 1965).

¹² There is more to say about each of these: the Oscan ending is also used with adjectives modifying a locative noun, suggesting that the *-n* is truly a case ending and fully part of the morphology of the nominal system; in Tocharian, however, one finds so-called *Gruppenflexion* 'group inflection' with comitatives and other such formations, in which the ending occurs on only the last element in the noun phrase (e.g., with *adj + n* or with coordinated nouns), suggesting that it is not a case ending proper but rather a phrasal affix (or the like); and in Spanish, *-mente* behaves like the *Gruppenflexion* of Tocharian (*rápida y claramente* 'rapidly and clearly') and shows evidence of having been reintroduced from Latin at some point as a learned borrowing. Still, these examples make the point of lexical sources for grammatical — derivational and inflectional — material.

combinations in the verbal system are a rich source of verbal inflexion; the Romance future tense, as in French *finir-ai* ‘I will finish,’ from a late Latin periphrasis of an infinitive plus ‘have’ (thus, *finire habeō* ‘I have (i.e., am obliged in the future) to finish’). In most of these cases, there are semantic shifts and prosodic adjustments involved as well, so that the changes actually reflect the contributions of a complex of several developments. Other sources of grammatical material and other changes involving grammatical material are discussed in Section 3.2 below.

3 What Are the Conditions for Change?

The small number of examples presented already offer some insight into two key sets of factors that need to be addressed in a consideration of the conditions that lead to morphological change. These are the same that analysts must confront for any change: conditions internal to a given linguistic system, such as the sound changes that alter the shapes of morphemes or that bring about shifts in the nature of the triggering mechanism for morphophonemic alternations, and conditions external to a given linguistic system, such as the introduction of loanwords into a language from a different language.

3.1 Internal Causation versus External Causation

It must be borne in mind that in a certain sense, all change involves external factors in some way, at least insofar as the spread of an innovation is concerned. That is, innovations often go through a speech community from speaker to speaker, by contact between speakers and the adoption by one speaker of another speaker’s use of a particular word or pronunciation or turn of phrase.¹³ It is also the case that the recognition on the part of one speaker of what constitutes an innovation may come through contact with at least some other speaker (or set of speakers). Thus there is always an external dimension in the recognition and adoption of an innovation.

Still, ultimately the innovation must come from somewhere and it is vain to think that the introduction of an innovation into a system can only be a matter of contact; after all, where did the speakers of the donor language get that innovative form in the first place? Even if they got it by contact with speakers of some other language, at some point a reduction sort of argument says that there must have some speaker(s) somewhere for whom the innovation originated through system-internal factors. Thus for a full accounting of causation in language change, one must look both to internal and to external causes.

¹³ Not all spread of an innovation is due to contact as it is possible for different (sets of) speakers in different parts of a speech community to independently come up with the same innovation; see Janda and Joseph (2003b: 83) on this notion.

3.2 System-Internal Causes

Of the system-internal factors in morphological change, some are rather trivial. As noted in Section 1, once one allows for relexicalizations—reformulations of lexical entries—any sound change can potentially affect the shape of lexical entries, and thus affect the morphology through the morpho-lexicon. And if sound change is driven by the working of the system of phonetic production and perception, as is widely believed, then sound change counts as a system-internal cause of some morphological change. The same can be said for semantic change in terms of an effect on the content of lexical entries, and, if the semantic shifts are severe enough, as when *prove* ‘demonstrate, establish as true’ came to mean in nineteenth-century British usage ‘of bread or dough: to become aerated by the fermentation of yeast prior to baking,’ one can envision a sort of “mitosis,” leading to the creation of a new lexical entry altogether.

But the system-internal mechanism of language change most associated with morphological change is analogy, which essentially involves the establishing of associations between and among linguistic forms (morphs) and changes due to those associations. It is best to operate with a broad sense of analogy by which any influence of one form, or piece of a form, over another constitutes an analogical linkage and if that linkage leads to a change, that change can be called an analogical change or an analogy.¹⁴

These associations and influences are largely cognitive in their basis and in a certain sense are inevitable, given the networks of relations among morphemes that speakers seem to be aware of, along all sorts of dimensions—for instance, phonic, formal, and/or semantic (Ackerman and Malouf, Chapter 12). They are system-internal because the structure of the lexicon depends on the existence of linkages among morphemes and lexemes, and the evidence both diachronically of analogical change and synchronically of psycholinguistic effects, such as the tip-of-the-tongue phenomenon or semantic or phonic priming effects, points to a lexicon with all sorts of connections among entries.

As far as analogical change is concerned, such associations mean that the influences that lead to morphological change can come from a number of different directions. By far the most studied sort of analogy is that involving grammatical forms, but one can see analogical influences outside of grammar in blends (e.g., *laxadaisical* as a variant of *lackadaisical*, affected by a phonic and semantic connection with *lax*), in folk etymologies (e.g., *sparrow grass* for *asparagus*, due to the sound and the meaning, or *mushroom* for *macaroon*, based on the sound of the words and the shape of the cookie), and in renewals and recompositions (e.g., *forehead* as [forhEd] replacing [forId]), among others.

¹⁴ It is perhaps unfortunate that there is no universally agreed upon terminology distinguishing the mechanism of analogy from the result of analogy.

As for grammatical analogy, it is seen in the leveling out of allomorphy within paradigms (e.g., Latin nominative *honōs* ‘honor’ becoming *honor* due to influence from the oblique stem *honor-*, as in accusative *honorem* or genitive *honoris*, or *wharves* as the plural of *wharf* being replaced by *wharfs* in American English, eliminating the *wharf-/wharv-* allomorphy), and in the encroachment of one realization of an inflectional category into the domain of another (e.g., earlier English *holp* as the past tense of *help* marked by vowel change (ablaut) giving way to *helped*, with the more prevalent dental suffix realization of past tense; so also *climbed* for *clomb*, *writhed* for *wrothe*, among many others). But the grammatical effects of analogical changes can be somewhat more subtle, almost like blends. For example, at one stage in early Modern Greek, the first-person plural (1pl) nonactive (mediopassive) ending was *-meste* (from an Ancient Greek variant ending *-mest^ha*). For many speakers, this ending changed to *-maste*, with a different vocalism in the first syllable, due, it seems, to a perceived connection with (i.e., influence from) the pronominal form for 1pl oblique (accusative/genitive) *mas*. Interestingly, Greek speakers also changed the second plural (2pl) ending in the same paradigm, *-este* (from Ancient Greek *-est^he*), to *-osaste* through a perceived connection with, and thus influence from, the innovative 1pl ending, aided by the form of the 2pl oblique pronoun *sas* and the pattern of apparent pronominal incorporation that the 1pl form gave. And analogy can affect periphrastic combinations: early Modern English used *be* as the auxiliary with the perfect of *become*, as in the King James version of Exodus 15:2, *He is become my salvation*; in present-day English, by analogy to other perfects, it would seem, *have* is now used: *he has become*.

These are but a few examples of the innumerable analogical changes that have shaped morphemes across scores of languages over centuries and centuries. As noted above, analogical change is almost inevitable, since speakers know and draw on so many connections among forms. But it is fair to ask what motivates the connections and the resulting analogical changes.

One principle that seems to cover many cases of analogy is the semiotically based principle of “one form to one meaning,” and indeed, in analogical change, speakers often seem to be striving towards that semiotic ideal, even if it is never fully achieved across the language as a whole. That is, leveling out the *s ~ r* allomorphy in the paradigm of Latin *honor-* eliminates an irregularity, an extra bit of information that needs to be accounted for somehow, even if it is a fairly regular alternation statable in purely phonological terms (*s* => *r* /V__V). Eliminating the unmotivated voicing in the plural of *wharf* makes that noun more regular, though until all such morphophonemic plural voicing is leveled out (*wifel/wives*, *knifel/knives*, and others remain), the one-form-to-one-meaning dictum does not hold in general for all English plurals. The same can be said for extending the dental preterite suffix into use with verbs it did not occur with before,

for the *-ed* ~ ablaut past “allomorphy”¹⁵ is being leveled out but ablaut preterites still remain. The extension of *have* over *be* in the perfect, however, now approaches a fully general situation, though there is perhaps some variation still with *go* (*She is gone* remains, with a slightly different nuance of meaning as opposed to *She has gone*).

In general, it can be said that speakers seem to opt for overt and concrete marking of categories, so that forms that become opaque for some reason are subject to change. The plural of *child* once was just with an *r*-suffix, *cildru*, reflecting a pluralization marking that occurred with a half-dozen or so nouns in earlier English, such as *lamb* / *lambru* ‘lamb / lambs,’ *cealf* / *cealfu* ‘calf / calves,’ and so forth. However, as those other nouns changed their pluralization pattern to a more prevalent type with *-s*, *cildru* was isolated and thus opaque, not looking much like a plural; the addition of *-en*, at the time a more widely occurring plural marker, recharacterized the plural of *child* as an overt plural, albeit one that ended up once again isolated in later stages of English.

A somewhat more complicated case of making an opaque form more transparently marked is the case of the Latin third-person singular (3sg) ‘eats.’ The Latin outcome of a Proto-Indo-European underlying form */*H₁ēd-ti* ‘he eats,’¹⁶ with a surface realization **H₁ēt^sti* (with **t^st* from */*dt/* or */*tt/*) would be expected to have been *ēs**, a form that is unattested but presumed because PIE **t^st* regularly yields Latin *ss*,¹⁷ which would have been simplified in final position. How is the actually occurring form, *ēst*, to be explained? Once one notices that the *-t* is the 3sg present ending throughout the whole of the Latin verbal system, the answer becomes clear: the form *ēs** was anomalous as a Latin 3sg present verb, lacking the usual marking that such a verb should have. It was thus opaque as a 3sg form so that analogically regularizing it, renewing the 3sg marking that was lost by regular sound change, made it more transparent as a 3sg form. Another way of viewing this change is semiotic in nature: the more transparent form *ēst* shows a better fit between form and meaning: each element of meaning, ‘eat’ and ‘3sg.present,’ has an overt element of form corresponding to it.

Since paradigms, whether defined strictly in terms of related cells of inflection or more loosely in terms of patterns present in the language (e.g., across different realizations of inflection or involving derivational

¹⁵ The scare quotes here are to signal that there are linguists who would say that *-ed* and ablaut are not truly allomorphs because they represent different forms, even if their function and meaning are the same; in such a view, which I personally see as an entirely reasonable position to take, *-ed* would have allomorphs [t], [d], and [əd] and ablaut’s allomorphs would presumably be defined by variant patterns of alternation such as [aj]/[o] (*drive/drove*), [aj]/[aw] (*find/found*), [l]/[ə] (*dig/dug*), and so on.

¹⁶ This is actually a morphologically based reconstruction — root **H₁ed-* with 3sg present tense ending **-ti* — that can be taken to represent the underlying representation of the PIE form that would on the surface have been something like **H₁ēt^sti*. (The symbol < *H₁* > stands for one of the so-called “laryngeal” consonants, the exact phonetics of which are somewhat uncertain, and irrelevant for the point at hand.)

¹⁷ As in *sessus* ‘having sat,’ from **sed-to-*.

relationships), figure prominently in analogically driven morphological change, it is worth considering where paradigms come from in the first place. It turns out that despite the regularity and uniformity that paradigms typically present (e.g., a novel verb created recently in Greek, *klikaro* ‘to click on a link on the internet’ has a full panoply of personal forms in all the moods and tenses (*klikaro* ‘I click,’ *klikarume* ‘we click,’ *klikara* ‘I was clicking,’ *klikare* ‘click!,’ *exo klikari* ‘I have clicked,’ etc.), there is evidence that they are, or can be, built up form by form. The Ancient Greek verb *ēmi* ‘I say’ occurs in only four forms:

1sg.pres	ēmi	1sg.past	ēn
3sg.pres	ēsí	3sg.past	ē

but it was innovatively built up, with regular personal endings, from the 3sg.past form *ē*, as it is the only form in the (defective) paradigm that derives directly from a PIE proto-form, **ēg-t*.¹⁸ Clearly, a full paradigm was not constituted because only three additional forms were created with *ē* as the basis. Third-person forms are often the basis for the (re)constitution of a paradigm, an observation made, and exploited, by Calvert Watkins in his 1962 account of the origin of a form of the Old Irish preterite. For Watkins, the third-person singular was a useful starting point for a (new) paradigm as it could be interpreted as formally unmarked (with zero-marking), matching its status as functionally unmarked.¹⁹

These examples are meant to suggest that analogy is pervasive, permeating and shaping the entire morphological system, as speakers make connections among forms and act on those connections, apparently driven semiotically to match form and meaning as best as possible. In many instances, the matching is only local, as with *wharf/wharfs* (but not, yet, *wife/*wives* or *knif/*knifes*). But this accords with the view of Joseph and Janda (1988), who, following the lead of Jespersen and others, argue that analogy is always a matter of *local generalization*—that is, of speakers acting on the limited set of forms available to them or, more realistically, within their immediate scope of awareness.

3.3 System-External Causes

Talking about system-external causes for morphological change actually means talking about morphology in language contact situations. Contact with different languages, or different dialects of one’s own language, for

¹⁸ The root here is that seen in Latin *ad-ag-ium* ‘saying’ and *aiiō* ‘I say’ (< **āg-jō*), with zero-grade forms versus the Greek full-grade. The three novel forms in Greek must be innovations since a 1sg present form **ēg-mi* would have given Greek *ēgmi**, not *ēmi*, past **ēg-m* would have given *ēga**, and 3sg present **ēg-ti* would have given *ēksi**.

¹⁹ This path of development has come to be called “Watkins’ Law” in the literature, though Watkins himself disavowed any “law-like” regularity to it, seeing it only as an interesting way in which several languages dealt with the problem of developing paradigms. The functional unmarkedness of the 3sg form comes from it being the form that is the “other,” nonpersonal (as opposed to first and second person, which necessarily reflect persons) and nonsubjective (like second person, but as opposed to first person, which is necessarily subjective).

that matter, opens up the possibility for new material—new words, new morphemes—to enter the language. And, while it is generally believed that morphology, especially inflectional morphology, is hard to borrow, there are numerous cases to cite of just that occurring. I give a few select examples here by way of illustration.

- Various local dialects of Greek—for example, that spoken in Megara (Attica), due to contact with speakers of the southern Albanian (Tosk) dialect known as Arvanitika, which has been spoken in Greece for some six hundred years—use the Albanian diminutive suffix *-za* on Greek roots, as in *liyaza* ‘a little,’ formed from Greek *liya* ‘a little’ plus the Arvanitika diminutive.
- In virtually all of the languages of the Balkans, due to intense contact with Turkish speakers in the period of the Ottoman Empire, the Turkish agentive/occupational suffix *-çI/-ci*²⁰ can be found: for example, Greek *taksi-dzis* ‘taxi-driver,’ Macedonian *lov-džija* ‘hunter.’
- The Turkish plural suffix *-lar/-ler* has been borrowed into several Balkan languages, used mostly with Turkish nouns (for males of high standing), but in some instances with non-Turkish stems; Albanian, for instance, has *baballarë* ‘fathers’ (cf. Turkish *babalar*), and *dervishlerë* ‘dervishes’ (cf. Turkish *dervişler*), among others, and dialectally has *mbretler* ‘kings’ (with *mbret* from Latin *imperator* ‘emperor’), while Macedonian has *kardašlar* ‘brothers,’ and *efendiler* ‘gentlemen,’ among several others, and Bulgarian has *agalar* ‘Turkish noblemen,’ along with numerous others (as documented by Grannes (1977)).
- Cappadocian Greek, under heavy influence from Turkish, has incorporated the Turkish first-person plural past ending *-k* onto the native Greek ending *-misti* for the first-person plural forms of the past nonactive, giving an ending *-misti-k* (cf. Janse 2009).

It may be that in at least some of these cases of suffixal borrowing, the suffix first entered the language as part of a whole word and was then extracted from that word and given a “life” apart from the lexeme through which it came into the language. That would explain its use with non-source language material, as with *mbretler* or *lov-džija* above. Such an account, however, does not work so well for the Cappadocian Greek example; Janse argues that it is the phonic similarity of the Greek ending *-misti* to a Turkish pluperfect formation with suffixes *-miş-* and *-ti-* that triggers the addition of the Turkish ending to the Greek.

It should be noted that just as opacity plays a role in system-internal morphological change (see §3.2), it also figures in externally driven change. A form entering a system from the outside, as a borrowing, is almost by

²⁰ I use a capital letter, here *-I*, for the high vowel that shows harmonic alternations in the features of frontness and rounding, based on the features of the final vowel of the stem the suffix attaches to. The suffix itself is subject to some phonological adaptation as it is borrowed.

definition opaque within the borrowing system. It starts out as an “alien” element. It is not surprising, therefore, that borrowed items can take on a value in the recipient language that is different from that in the donor language. For instance, the inflectional suffix *-dl-* for past tense in Turkish has been borrowed into Greek in a number of Turkish verbs, but serves only as a derivational element, creating a verbal stem, as far as Greek is concerned; thus the noun *boya-* ‘paint’ is the basis for a verb *boya-d-iz-* ‘to paint,’ where *-iz-* is a widespread (native Greek) verbalizing suffix and the *-d-* creates the stem to which the verbalizer attaches – the Turkish root is *boya-* and the basis for the Greek verb, *boyadı*, is an inflected form in Turkish meaning ‘(s)he painted.’ Similarly, the Turkish plural marker *-lar* that entered various Balkan languages in some instances was treated as opaque as far as marking plurality was concerned, and was augmented by a native plural suffix, such as the *-ë* in Albanian *baballarë* ‘fathers’ or *-i* in Serbian *hodžalari* ‘Muslim clerics.’

4 More on Analogy-Conflicting Tendencies

In the same way that internal and external factors present differing paths of causality for morphological change, so too are there differing tendencies, sometimes seemingly at odds with one another, in other aspects of morphological change through analogy. In particular, analogy can be seen as involving simplification, but at the same time, there are ways in which analogy can lead to complication in the grammar.

The simplifying aspect of analogy, already touched on in Section 3.2, has to do with a reduction of arbitrary elements, such as the *-s/-r-* stem alternation in Latin *honōs/honor-is*. A paradigm with *-r-* throughout is less exceptional, so that, in a real sense, the paradigm is simpler. Similarly, if personal pronouns and verb endings are connected by speakers in some way, then a set consisting of Modern Greek 1pl pronoun *mas* and 1pl ending *-omaste* offers a more straightforward, hence simpler, connection than *mas* and *-omeste*. And if personal endings form a network of related elements, then the set with 1pl *-omaste* and 2pl *-osaste* forms a more coherent and rational network than *-omaste* and *-este* would; further, when 3pl *-ondusan* became *-ondustan*, as it has in some dialects, the plural endings are united in that they all have *-st-* as an element linking them.²¹ Even the Latin marking of ‘eats’ with 3sg *-t* (*ēs** ==> *ēs-t*) is a simplification, as it removes the lone exception to the otherwise 100 percent true generalization that the Latin 3sg is marked by *-t*.

Admittedly, the simplification may be illusory and only locally valid, as noted in Section 3.2, but there are clear cases where the outcome of analogy

²¹ As it happens, 3pl *-ondus(t)an* is analyzable as also incorporating a pronoun, as the 3pl oblique pronoun is *tus* and *-t-* would automatically voice to *-d-* after a nasal (thus */-on-tus-(t)an/* with pronominal *tus* giving *-ondus(t)an*).

is a complication of the grammar. Hogg (1980) draws attention to the fate of the *-m* in *eom* ‘am’ in Old English (OE), where this final consonant, while once an overt marker of first-person singular (cf. Latin *su-m* ‘I am,’ *era-m* ‘I was’; (Aeolic) Greek *em-mi* ‘I am,’ *didō-mi* ‘I give’; Sanskrit *as-mi* ‘I am,’ *dadā-mi* ‘I give’), was isolated within OE and thus simply part of an unanalyzable form.²² For some dialects of OE, the 1sg subjunctive form *bēo* ‘(that) I be,’ was influenced by the unanalyzable *eom* and became *bēom*. This analogical extension of *-m* into subjunctive form, whether induced by rhyming or by a grammatical connection, or both, meant that, under the principles of morphological analysis enunciated in Section 1, the indicative and the subjunctive could be segmented, as *eo-m* and *beo-m* respectively.²³ This constitutes a complication in the grammar because it introduces a new 1sg ending of very limited distribution whose exceptional occurrence must be learned as isolated facts that are not subject to particularly significant generalizing; its further spread on an occasional basis to *fleo-m* ‘I flee,’ while giving the ending a bit more “heft” and “life” in the grammar, does not further the quest for a meaningful generalization as to its use.

The key to understanding these conflicting effects—simplification and complication—of analogy is recognizing the essentially localized scope of an analogical change, and at the same time of the connections underlying the change that speakers are able to make among forms. Thus, simplification occurs on a local scale but there can be concomitant complication on a more global scale in the grammar as a whole.

5 Some (Unintended) Consequences of Morphological Change

The examples seen in previous sections offer a view of morphological change that is more centered on changes in morphemes themselves than anything else. But some of these changes have consequences for the overall grammar of the language in question that are worth considering. For instance, the borrowing into Albanian of the two allomorphs of the Turkish plural suffix, both back harmonic *-lar* and front harmonic *-ler*, means that for a small part of the grammar of Albanian, namely plural marking for a subset of nouns (e.g., *baballarë* versus *dervishlerë*), vowel harmony must be encoded somehow; a phonological solution is unlikely given the restricted nature of the distribution of the allomorphs, so apparatus like lexical listing of allomorphs which are then linked by a redundancy rule would probably be needed.

²² Note that other forms of the present of ‘be’ in OE, such as second singular *eart*, third singular *is*, and plural *sindon*, give no basis for analyzing *eom* in a way that would segment off the *m* due to the exhaustiveness principle (see Section 1), unless one adopts a highly abstract analysis (see §2).

²³ I suggest this segmentation because *bēo-* as a stem occurs in other forms of the paradigm, such as plural *bēoð* ‘that we/you/they be.’

But the general point of a structural addition to the morphophonology of the language should be clear.

The same can be said about the emergence of a structural pattern with pronoun incorporation in Greek verb endings; once forms like *mas* and *sas* can be seen as playing a role in the shape of personal endings, then essentially a new pattern has been created, with the localized analogies giving the basis for such an analysis.²⁴

And, the opacity that led to forms like *cildru* or *baballar* being augmented by, or recast with, more transparently plural endings, giving *children* and *baballarë* respectively, has the effect of leading to double marking, at least from an etymological standpoint, of in this case plurality, just like the double marking for 1pl in the Cappadocian Greek form. It is important to stress that the multiple occurrences of inflectional material do not necessarily constitute double marking synchronically, but to the extent that in some of the Balkan languages Turkish plurals can occur without native endings (e.g., Bulgarian *agalar* ‘Turkish noblemen’), the augmented form *agalari*, with the native plural suffix, might well be considered synchronic double marking.

These sorts of higher-level consequences—higher-level in that they have a more abstract effect in the grammar as a whole beyond the effect on the morpheme itself—are almost like accidental side-effects that the principles of morphological analysis lead one to. They can be thought of as “unintended consequences” because they emerge in the aftermath of a change and are not the goal of the change itself; thus the goal of borrowing Turkish plurals was not to introduce vowel harmony into a language but rather to have a way of characterizing these otherwise alien nouns as plurals—vowel harmony is just what one gets when allomorphic alternants are borrowed as such.²⁵ Still, unintended or not, they represent further ways in which the morphology of the language changes, system-internally but on occasion with external material serving as the basis.

6 Directionality in Morphological Change

In Section 4, conflicting tendencies in analogical change towards simplification in some circumstances and complication in others are shown to be resolvable by viewing analogy as involving generalizations at a localized level, thus simplification locally versus complication more globally.

²⁴ The potential role of the singular forms should not be overlooked. The first-person singular (1sg) nonactive past ending is *-(o)mun*, which derives by regular sound change from earlier Greek *-omên*; a connection with the 1sg oblique pronoun *mu* can be surmised as a plausible influence, all the more so since the second-person singular (2sg) ending is *-osun*, from earlier *-ou* with the involvement of a variant 2sg ending *-so* but conceivably also the 1sg *-omun* and the 2sg genitive pronoun *su*. So the singular forms offer a possible model as well for pronoun incorporation in the endings.

²⁵ There may well be an ideological dimension to be recognized here as well, in that borrowing speakers could well have overlooked the vowel harmony (as they seem to have done for the most part with the *-ç/-d* occupational suffix); keeping *-lar* and *-ler* may reflect a desire on the part of some speakers to sound more Turkish or to show solidarity with Turkish, or the like.

This means that an apparent directionality in morphological change, with analogical change always moving in a particular direction, is not exactly wrong but not exactly right either. Such an outcome suggests that other instances where directionality might be an issue in morphological change might benefit from more careful scrutiny.

For instance, regarding the examples cited in Section 3.2 and Section 4 of verb endings being affected by pronouns, it is fair to ask if the influence can go in the other direction here. If pronouns affect verb endings because they are ways in which the same categories of person and number are realized, then it stands to reason that a verb ending should be able in principle to affect a pronoun, and sure enough, there are attested cases. In the Italic branch of Indo-European, and into the modern Romance languages, the 1pl verb ending begins with *-m-* (e.g., Latin *-mus*, Spanish *-mos*) and the 1pl pronoun begins with *n-* (e.g., Latin *nos*, Spanish *nos(otros)*). That mismatch was actually resolved in a manner like the Greek cases in New Mexican Spanish where the 1pl ending has come to be *-nos* in some forms, such as *hablabanos* ‘we were speaking’ (Janda 1985). It is thus particularly interesting that there are varieties of Spanish (e.g., Judeo-Spanish) that have the 1pl pronoun with initial *m-* (*mosotros*), due to the influence of the personal ending.

In the case of paradigm-internal analogy, in the Latin change of *honos* to *honor* discussed in Sections 3.2 and 4, the nominative case was leveled out in favor of the stem occurring in oblique cases. The directionality here may have been driven by type frequency, since the obliques outnumber the nominative in the paradigm overall or even by token frequency, but as it happens, the other direction of leveling also occurs. Ancient Greek ‘one’ was originally **hem* (from PIE **sem*, cognate with English *same*) in the neuter nominative/accusative, with a genitive **hem-os* and a dative **hem-ei*. A sound change of word-final *m* > *n* occurred, giving the following paradigm (the dative is attested in Mycenaean Greek) with allomorphs *hen-/hem-*:

NOM/ACC	hen
GEN	hem-os*
DAT	hem-ei

In Classical Greek, the allomorphy was resolved in favor of the nominative allomorph, giving:

NOM/ACC	hen
GEN	hen-os
DAT	hen-i

Other factors may have been at work here, such as the functional basicness of nominative as opposed to oblique, which of course conflicts with the frequency-based account of the *honos*-to-*honor* leveling. But that is exactly the point: different factors can yield different results, and thus different directionalities in analogy.²⁶ And, while some historical linguists have attempted to

²⁶ Note also that just as *wharves* is giving way to *wharfs*, the innovative form *dwarves* with voicing in the plural seems to be gaining on the older *dwarfs* (itself an analogical formation).

lay out principles for directions of analogical change, most notably Kuryłowicz (1945–9) and Mańczak (1957), these have generally yielded recurring tendencies that sometimes are in conflict with one another.²⁷

On a somewhat grander scale, looking at movement between components of grammar, cases such as umlaut in German (and Germanic more generally) discussed in Section 2 or Irish mutations discussed in footnote 8 show that phonologically determined phenomena can become morphologized and thus best handled in the morphological component of the grammar. But under the right conditions, movement in the other direction, from a morphologically determined phenomenon to a phonological determined one can occur. Joseph and Janda (1988) highlight the case of the past tense prefix *e-* (the “augment”) in the passage from Ancient Greek to Modern Greek: in Classical Greek the augment was an obligatory part of the past tense, and thus was part of the morphological structure of all such forms; in some varieties of Modern Greek, especially the standard language, the augment appears only when it is stressed. Thus the classical forms on the left have given way to the modern forms on the right:²⁸

égraph ^h on	‘I was writing’	=>	éyrafa
egráphomen	‘we were writing’	=>	yráfame

Given that accent in such past tense forms is predictably on the antepenultimate syllable, the appearance of the augment is phonologically determined, so that the once-morphological phenomenon is now a matter of phonology.

Finally, just as the developments with the Tocharian comitative and especially the Oscan locative show the movement from a phrasal, and thus syntactic, combination to a word-level, and thus morphological, combination, there are counter-directional cases whereby an affixal element that was part of a word-level combination takes on free word status, with thus a degree of syntactic freedom that the earlier affix did not have. Méndez Dosuna (1997), for instance, documents the development of the Modern Greek free adverb *ksaná* ‘again’ out of the combination of two bound prefixes, *eks-ana-*, that occurred obligatorily attached to verbs. Thus earlier *eks-ana-blépo* ‘I see again’ yielded not only a prefixed verb *ksana-vlépo* ‘I see again’ but also a phrasal combination – note the stress on *ksaná* and its mobility, indicating that it is an independent word – *ksaná vlépo*, also *vlépo ksaná*, ‘I see again.’

As this last example suggests, these cases of movement between components can also be interpreted in terms of changes in the morphological status of particular elements, such as word or affix; and, in theories that recognize a separate morphological “atom” of “clitic,”²⁹ changes from word to clitic

²⁷ Hock 1991: Chapter 10 offers a concise but illuminating presentation of these two works, with an overt comparison of the different claims they make. See Winters (1995) for a translation of the Kuryłowicz piece, with some discussion. Anttila (1977) is an extremely useful and thorough overview of the state-of-the-art regarding theorizing about analogy.

²⁸ With other changes evident as well, of course; especially decisive here was the loss of unstressed initial vowels.

²⁹ I myself do not recognize “clitic” as a basic morphological building block, choosing to follow Zwicky (1994) in theorizing that there are no clitics *per se*, and that the elements that some linguists might call “clitics” are in fact either

to affix. The not-fully-affix-like behavior of the Tocharian *-aśśāl* discussed in footnote 12 could lead some linguists to treat it as a clitic. However, if the positioning of words and clitics is a matter of syntax, as some would have it, and the appearance of affixes a matter of morphology, then it is reasonable to view such changes in status as movement between components.

Up to this point, I have not mentioned the term “grammaticalization” *per se* but many of the changes could be brought under the umbrella of this term, especially if “grammaticalization” is viewed simply as the emergence of grammatical forms and grammatical processes. I adopt this characterization here, recognizing though that many linguists make much more of the notion, seeing it as the movement from lexical elements to grammatical ones and from less grammatical elements to more grammatical ones, and claiming, further (see, e.g., Hopper and Traugott 2003), that grammaticalization is unidirectional. By “unidirectionality” here is meant that only movement in the direction of greater grammatical status is allowed. Thus changes of grammatical to lexical or from more grammatical to less grammatical are claimed to be impossible. Counter-directional cases such as Greek *ksaná* are counterexamples to such a “Unidirectionality Principle,” and it is not clear how the interesting multi-directionality of analogy or the movement between components would be treated.

Moreover, other instances of “counter-directional” movement can be found, so counterexamples are not just an isolated case like *ksaná*, as compelling as it is. For instance, unidirectionality would predict that a change by which an inflectional morpheme becomes a derivational morpheme would not occur, inasmuch as derivation is less grammatical than inflection; that is, derivation is tied to the lexicon and is involved in the creation of new lexical stems, whereas inflection serves a purely grammatical purpose.

Nonetheless, there are documentable instances of inflection turning into derivation. Testing such a claim demands careful morphological analysis as one cannot know the analysis of a diachronic development without understanding the proper analysis of the starting point and the endpoint; accordingly, I follow here the tenets of morpheme identification outlined in Section 1, matching recurring form with recurring meaning. As it happens, taking these tenets seriously leads to an interesting novel counterexample to unidirectionality, not previously discussed in the literature.³⁰

atypical words or atypical affixes. See Joseph (2001) for an application of this thinking to the analysis of Greek so-called “clitics.”

³⁰ Not all claims about grammaticalization have followed rigorous principles of morphemic identification, leading to claims that are empty or simply wrong. For instance, Hopper (1994), in talking about “phonogenesis,” his label for once-meaningful morphemic pieces losing morphemic value and taking on a role of simply adding to the phonological “bulk” of a morpheme, gives the *-i-* of *handiwork* as an example, inasmuch as it comes from an earlier English *-ge-* with a collectivizing sense (*hand-geweorc* ‘(collection of) things worked on by hand’) but now, he says, only adds phonological material to the word and is no longer a morpheme. However, *hand* is a morpheme, and *work* is a morpheme, so that the principle of exhaustive analysis (see §1) demands that *-i-* be recognized as a morpheme; it no longer contributes to the meaning of the form and so can be said to have (been) desemanticized, but it does serve a function as a compositional element, “gluing” together *hand* and *work* in this particular compound. It may well be, as

In particular, in Old English (OE), the 3sg neuter pronoun showed the following forms:

NOM	hit	‘it’
ACC	hit	‘it’
GEN	his	‘its’

These forms are analyzable morphemically as *hi-t* and *hi-s*, in that *hi-* recurs, matching the meaning ‘it,’ and the principle of exhaustive parsing identifies *-t* as a grammatical ending, and thus an inflectional marker, for nominative/accusative neuter, a segmentation that is verified by the recurrence of *-t* with the same value in *hwæt* ‘what?’ and *þæt* ‘that.’ As for the segmentation *hi-s*, that is verified by other pronominal genitives such as *hwæs* ‘of-what?’ and *þæs* ‘of-that.’ In later English (e.g., by the early modern period), the neuter pronominal forms have changed to:

NOM	it
ACC	it
GEN	its

through the irregular loss of *h-*, a change which is irrelevant here, and the reshaping of the genitive form by the addition of the regular genitive/possessive ending *-s* (as in *stone’s*) to the stem *it*. What is significant for claims about unidirectionality in grammatical change is that the stem *it* is analyzable into *i-t*, with the *-t* found also in the pronouns *what* and *that*, seemingly as in OE. The difference between OE and NE in this regard though is that in OE, *-t* has a grammatical value, whereas in NE it serves a stem-forming function only. This means that in OE, *-t* was an inflectional marker whereas in NE, it serves a derivational purpose. Thus the change seen here represents a move in which a morpheme goes from being more grammatical to being less grammatical, contrary to the hypothesis of unidirectionality of grammaticalization.³¹ Unidirectionality cannot be an absolute constraint on grammatical change, even if it might be a robust tendency.³²

7 Conclusion

In this survey of morphological change, it has been argued that a broad view of what constitutes morphology is illuminating for understanding the pervasiveness of morphological change. Moreover, an argument can be

Gregory Stump has pointed out to me, that many speakers have folk-etymologized (i.e., reanalyzed) *handiwork* as a compound of *handy* and *work* (compare *handyman*, *Handi Wipes* (name of a brand of paper towels), and uses such as *handy with a wrench*); such a combination would be noncompositional in meaning, but folk-etymologies are not necessarily semantically impeccable anyway (as the examples in §3.2 suggest). Still, a relation between *hand* and *handi/y* would make segmentation of *handiwork* into *hand-i-work* a possible analysis.

³¹ See Joseph (2011, 2014) for other examples of this sort, some involving “Watkins’ Law” (see §3.2 and footnote 19). In general the literature on unidirectionality is huge, too much so to survey here; Norde (2009) has a useful summary with insightful discussion of the general debate over this principle — see also Joseph (2004) and Haspelmath (2004).

³² But see Joseph (2014) on the difficulty of enumerating grammaticalization and counter-grammaticalization cases so as to compare the numbers of directional changes in a meaningful way.

made from diachrony as to the role that morphology plays in language overall. Given how many different strands of linguistic behavior interact in morphological change, and how morphology is an apparent “destination” for many changes—a necessary one if the Unidirectionality Principle is right, a preferred one if it holds in even a weakened form—then on diachronic grounds, one would be justified to consider morphology as occupying a central position in the architecture of grammar. And especially if we view diachrony as the transition through successive synchronic states, the historical facts argue for the centrality of morphology in synchrony as well.

Hamlet, when asked by Polonius “What do you read, my lord?,” responds “Words, words, words”; interestingly, he does not say “Sentences, sentences, sentences” or “Meanings, meanings, meanings,” or “Sounds, sounds, sounds,” or even “Letters, letters, letters”! It seems as if Shakespeare himself understood the relevance and importance—what we can interpret as the centrality—of morphology to speakers, a centrality that the evidence of morphological change itself supports.

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Morphology and Language Acquisition

Constantine Lignos and Charles Yang

1 Introduction

Morphology is language specific and must be acquired on the basis of particular linguistic data. This chapter addresses three central issues for the understanding of morphological acquisition: the distributional properties of morphology, the mechanisms of learning from data, and the developmental patterns and trajectories in child language. First, corpus studies of child-directed language reveal a systematic pattern of data sparsity: in general, only a (small) fraction of possible morphological forms will be attested in the acquisition data. The child learner, then, must be able to form wide-ranging generalizations from early on, and on very partial corners of the morphological paradigm. Second, we review evidence from morphological development, especially the study of English past tense, and draw two broad conclusions: (a) morphologically complex forms appear not to be memorized by association but learned in relation to their morphophonological classes, lexicalized or otherwise, and (b) as far as child language is concerned, morphological productivity appears categorical, where children often overuse productive processes but almost never commit analogical errors. Third, we situate morphological learning models in the context of language acquisition, where psychological considerations pose additional challenges and constraints. The child must proceed in an incremental and unsupervised fashion, which deprives them of assumptions (such as stem and derived pairs) that are taken for granted in theoretical analysis. Along the way, we discuss how language acquisition may provide useful insight for the theoretical study of morphology.

2 Distributions

One of the greatest challenges that a child learning morphology faces is the sparsity of morphological combination in the target language. We might

imagine in the ideal case that a child would be presented with full paradigms when attempting to learn the morphology of a language, much like in a foreign-language course. For example, imagine that a learner trying to learn a verbal system with four different inflectional categories (1–4) is exposed to four verbs (A–D). In optimal conditions, they would be exposed to every inflectional variant of every verb, seeing sixteen forms in total: A1–4, B1–4, C1–4, D1–4.

Morphological learning is relatively simple in this case. If the child were to receive every form for every lemma—a *dense* input where no evidence is absent—and is also told what features each form carries—*supervised* learning—rote memorization would result in perfect performance and any errors might be attributed to failures of memory or inference of incorrect generalizations. However, as we discuss in this section, neither of these assumptions are met and the process of morphological learning proceeds in an *unsupervised* fashion and on *sparse* input.

Because the input is sparse and distributed in a *Zipfian* fashion, a more realistic version of the learner’s input would contain a sparse set of unique forms—for example, only A1, A3, A4, B1, B2, C1, and D2, with all other combinations unseen. Additionally, children are not provided with pairs (e.g., *sing/sang*, *walk/walked*) that specify the morphological relations; while they must be able to eventually infer these pairs from the input, we cannot assume that they can do so perfectly and before they have identified the phonological relationship between items of the pair. Indeed, as we review in Section 4, the vast majority of the proposed models in the study of morphological acquisition provide paired input to the learner, which is tasked with identifying the mapping between these forms—by no means a trivial problem in its own right. The more formidable and less-studied problem is that in many cases of morphological learning, the learner will not observe anything close to a complete paradigm as discussed above: many entries are missing and related forms are not grouped together in the input.

2.1 Morphology in a Zipfian World

It turns out that the statistical properties of morphology are quite similar to the statistical properties of words (Zipf 1949); see Chapter 24 for background on corpus research. According to Zipf’s Law, relatively few words are used frequently—very frequently—while most words occur rarely, with many occurring only once in even large samples of texts. For instance, in the Brown Corpus (Kučera and Francis 1967), about 43 percent of words occur only once, about 58 percent of words occur 1–2 times, 68 percent of words occur 1–3 times, and so on. The frequencies of combinatorially formed units tail off even more precipitously. For instance, approximately 78 percent of Brown Corpus bigrams appear only once and 90 percent of them appear only once or twice. For trigrams, the singletons and the doubles make up 91 percent and 96 percent of the unique trigrams.

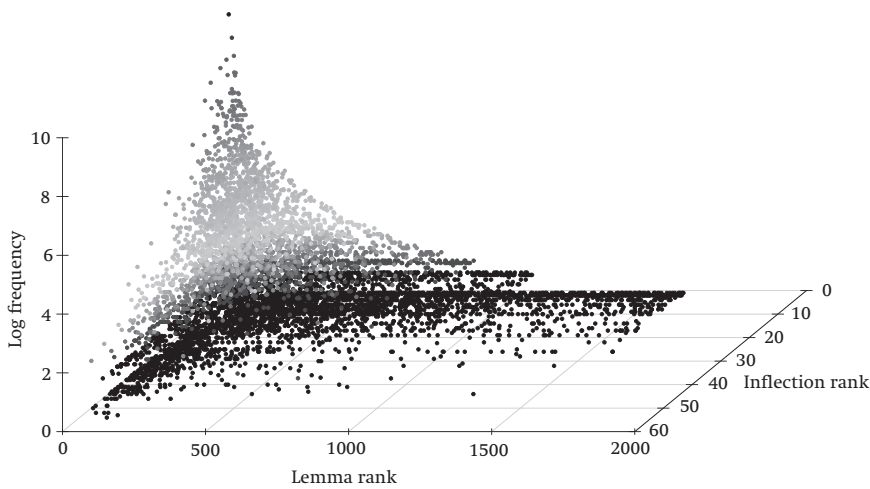


Figure 27.1. Frequencies of CHILDES Spanish lemmas across inflection categories

Morphological word formation, which can be viewed as the composition of morphological primitives such as morphemes,¹ show very similar statistical properties. In Figure 27.1, we present the distribution of verbal inflectional morphology in a 985,262 token Spanish corpus of child-directed speech assembled from CHILDES Spanish (MacWhinney 2000).

The Spanish data has been analyzed using a part of speech tagger (Freeling; Atserias et al. 2006) which is especially suitable for the processing of Romance languages. There are 1,584 verbal lemmas, which altogether appear in 54 inflectional categories, the most frequent being the third-person singular present indicative.² Lemmas are shown in order of increasing rank across the X axis, inflections show in order of decreasing rank across the Y axis, and $\log_{10}$ frequency of an individual form is represented by the Z axis.

First, consider the pattern visible across lemmas. As described by Zipf, the most frequent lemmas are greatly more frequent than all others; the most frequent lemma *ver* is almost twice as frequent as the second-most frequent lemma *mirar*, and 521 lemmas—32.9 percent of all observed lemmas—only appear once. The ten most frequent lemmas account for 42.1 percent of all occurrences of verbs in the corpus.

A similar pattern is visible across inflectional categories; some appear with almost every lemma, but many more appear with only a few lemmas. The most common inflectional category (third-person singular present indicative) appears 37,573 times, while two inflectional categories appear only

¹ We use terms such as morpheme, paradigm, lemma, and rule informally and descriptively to express the combinatorial nature of morphology, without making any specific commitment to their theoretical status.

² The copular and light verbs *estar*, *haber*, *hacer*, *ir*, *ser*, and *tener* are excluded from these counts and from Figure 27.1. An inflectional category is considered a unique combination of person, number, tense, mood, and aspect. Only active voice verbs are included.

once each: the first- and second-person imperfect subjunctive. Thus we come to identify another Zipfian pattern; in addition to Zipf's law applying across lemmas, it also applies across inflectional categories. Looking across the inflections within each lemma, we observe that while the most frequent lemmas appear in many inflectional categories, the least frequent lemmas appear in a few scattered inflectional categories. Visually, if the combination of lemmas and inflectional categories was dense and not sparse, there would be no trend in the Y axis and few gaps in the plot.

2.2 Quantifying Sparsity

As a means of formalizing this sparsity, we can report the metric of inflectional *saturation* (Chan 2008). Saturation is computed per-lemma by dividing the total number of inflectional categories observed in the corpus by the number of inflectional categories observed within that lemma. A lemma with 100 percent saturation is seen in every inflectional category that appears in the corpus; it provides a complete paradigm for that verb. However, any verb with a lower saturation is missing forms, providing an incomplete paradigm full of accidental gaps.

The naive expectation is that many verbs will show a high level of saturation, providing useful examples for a learner to use to infer the best candidates for the many unobserved lemma-inflectional category combinations. However, as shown in Figure 27.2, in the CHILDES Spanish data under examination, even the most frequent lemmas show relatively low saturation. The most saturated lemma is *decir*, with a saturation of 72.2 percent. The mean saturation across all lemmas is just 7.9 percent; thus the average verb appears in about one of every thirteen inflectional categories observed in the corpus. A particular combination of lemma and inflectional category is far more likely to be missing than observed.

The phenomenon of low saturation is not specific to Spanish; Table 27.1 presents the analysis of the inflectional morphologies of several languages and genres as computed by Chan (2008).³ However, excluding English corpora, regardless of corpus size the max saturation does not approach 100 percent; the common case is that the learner does not see a complete paradigm for any verb even with relatively large amounts of input.

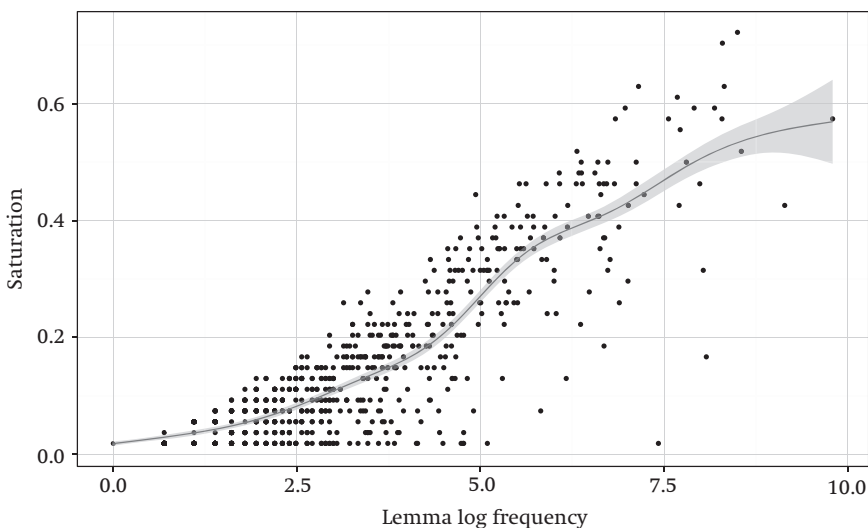
2.3 Implications for Learning

These simple statistical investigations of morphology have direct implications for the acquisition of morphology. First, it is unrealistic to expect the full paradigm of any particular stem to be available to the child learner

³ Chan finds higher numbers for saturation than in the CHILDES Spanish example that we give in this section because his study does not exclude functional verbs. While functional verbs appear in many inflectional variants, they are generally irregular and do not provide much value as exemplar paradigms.

Table 27.1. *Saturation in a variety of languages, adapted from Chan 2008*

Corpus	Tokens (millions)	Inflectional categories	Maximum inflectional categories per lemma	Maximum saturation
Brown Corpus	1.2	6	6	100.0
Wall Street Journal Corpus	1.3	6	6	100.0
Basque	0.6	22	16	72.7
Czech	2.0	72	41	56.9
Finnish	2.1	365	147	40.3
Greek	2.8	83	45	54.2
Hungarian	1.2	76	48	63.2
Hebrew	2.5	33	23	69.7
Slovene	2.4	32	24	75.0
Spanish	2.6	51	34	66.7
Catalan	1.7	45	33	73.3
Italian	1.4	55	47	85.5
CHILDES Spanish	1.4	55	46	83.6
CHILDES Catalan	0.3	39	27	69.2
CHILDES Italian	0.3	49	31	63.3

**Figure 27.2.** Saturation of CHILDES Spanish lemmas across lemma frequencies, with a GAM-derived fit line and standard error estimate

(e.g., Albright 2005). Language acquisition takes a finite, and in fact quite modest, amount of input (Hart and Risley 2003) which, true to Zipf's Law, contains numerous instances of few linguistic types: the learner must be able to generalize fairly aggressively to "fill in" the paradigm table for unattested forms. Second, the sparsity of morphological distribution must be taken into account when we assess the empirical properties of children's morphology.

As we shall see in Section 3, children's inflectional morphology is in general quite good. The errors tends to be those of omission (bare or infinitive when a tensed form is required) or overuse of a general form (e.g., the over-

regularization of irregular verbs), and the rates of errors are generally low. But it has been pointed out that low rates of morphological errors do not necessarily imply children's mastery of morphology, especially its combinational aspects. In an influential line of research in child language, *usage*-based theorists such as Tomasello note that children's morphology may well result from the storage of lexically specific morphological forms in the input: if the retrieval mechanism is generally reliable, children will also make few morphological errors. Indeed, the combinatorial *diversity* in child morphology appears quite low, which seems to support lexically specific morphological learning. For instance, Pizzuto and Caselli (1994) found that in a corpus of child Italian speech, 47 percent of all verbs used by three young children (1;6 to 3;0) were used in one person-number agreement form, and an additional 40 percent were used with two or three forms, where six forms are possible (3 person $\times$ 2 number). Only 13 percent of all verbs appeared in four or more forms. The low level of combinatorial diversity has been a major source of evidence for an item-based theory of language learning (Tomasello 2000).

Here the sparsity of child morphology must be viewed in the context of morphological sparsity in general. Table 27.2 summarizes the results from a large-scale corpus analysis of child and child-directed data in Italian, Spanish, and Catalan that are currently available in the CHILDES database (MacWhinney 2000). The morphological data is again analyzed with the Freeling tagger, and only tensed forms are counted. Each cell represents the percentage of verb stems that are used in 1, 2, 3, 4, 5, and 6 person and number forms.

As can be observed in Table 27.2, Spanish and Catalan children and adults show very similar, and very sparse, agreement usage diversity. Italian children use somewhat more stems in only one form than Italian adults (81.8% vs. 63.9%), but this can be attributed to the measure in the last column, which is the ratio between the total number of inflected forms (S) over the total number of stems (N). This ratio provides the average number of opportunities for a stem to be inflected: when the ratios are comparable between children and adults as in the case of Spanish and Catalan, we observe similar diversities of agreement morphology. In the case of Italian, the adults had roughly two-thirds more opportunities to use a stem

Table 27.2. *Verb agreement distributions in child and adult Italian, Spanish, and Catalan*

Subjects	1 form	2 forms	3 forms	4 forms	5 forms	6 forms	S/N
Italian children	81.8	7.7	4.0	2.5	1.7	0.3	1.53
Italian adults	63.9	11.0	7.3	5.5	3.6	2.3	2.54
Spanish children	80.1	5.8	3.9	3.2	3.0	1.9	2.23
Spanish adults	76.6	5.8	4.6	3.6	3.3	3.2	2.61
Catalan children	69.2	8.1	7.6	4.6	3.8	2.0	2.10
Catalan adults	72.5	7.0	3.9	4.6	4.9	3.3	2.34

than the children, which would account for the modest discrepancy in the frequency of one-form verbs.

Of course, these comparisons do not conclusively show that children's grasp of agreement morphology is identical to adults. To do so, one must calculate the statistically predicted morphological diversity under the assumption of an adult-like morphological system, while taking the Zipf-Law distribution of stems and inflectional categories into account (Figure 27.1 and Table 27.1), and compare it against the empirically attested usage diversity. (For an assessment of syntactic combination in early child language, see Yang 2013.) Likewise, an item-based approach also needs to be precisely formalized with quantitative predictions to be verified against the empirical patterns in child and adult language. Nevertheless, it is premature to conclude that low usage diversity necessarily implicates an underdeveloped morphological system: *all* morphological systems are sparsely represented. In what follows, we review how children's morphological systems develop (Section 3) and how children may overcome these statistical challenges in morphological acquisition (Section 4).

3 Development

It is impossible to review the acquisition of morphology without an extended discussion of the English past tense, one of the most extensively studied topics in all of linguistics and cognitive science (Pinker 1999). The generally impoverished morphology of English may not seem like a representative case for the complexity in the world's languages, but the theoretical issues it raises have important and general ramifications for the methodology and theories of morphology. So we begin.

3.1 English Past Tense: Words versus Rules

In the traditional linguistics literature, the past tense of English is treated as a computational system that takes the stem (e.g., *walk* and *think*) as the input and produces the past tense (e.g., *walked* and *thought*). Bloch (1947), for instance, divides the verbs into inflectional categories: the verb *think* falls into a category that adds the *-t* (his category B3, p.413) and follows the morphophonemic alternation (his Type II, p.415) that changes the vowel to /ɔ/. According to this view, both regulars and irregulars are generated with input-output systems: it is just that the latter requires special instructions since their categories and alternations are not predictable. Generative grammar has largely preserved this tradition from *The Sound Pattern of English* (Chomsky and Halle 1968) onward: the main difference can be found in the formulations that are more abstract than those found in Bloch's treatment, whose classification generally pertains to the surface pattern. In the present discussion, we will use the term "rule" to describe

the computational process that maps an input to its morphological derived form (cf. *schema* used by Bybee and Slobin (1982)). Crucially, when we speak of rules for irregular verbs, we are, à la Bloch (1947), referring to the lexicalized rules that apply to a fixed list of verbs but do not extend beyond them.

The major point of contention in the past tense debate (see Clahsen 1999; Pinker 1999; Pinker and Ullman 2002; McClelland and Patterson 2002 for general overviews) concerns the treatment of the regular verbs: the two sides are in general agreement that the irregular verbs are acquired as paired associations between the stem and the past form. The connectionist position, starting with Rumelhart and McClelland (1986), holds that the regulars are stored and learned as associative pairs similarly to the irregulars, whereas the Words and Rules model, starting with Pinker and Prince (1988), holds that the regular verbs are handled by a symbolic rule (“add -d”) in a decidedly non-associative fashion. This debate has spilled into the morphological processing literature; see Chapter 28 for discussion. Hence, our review highlights a third approach (Yang 2002; Albright and Hayes 2003), briefly considered but not pursued by Pinker and Prince (1988), one which may be of more interest to the linguistic theorists: irregular verbs are also handled by rules albeit lexicalized ones, and they are not learned by direct word association.

What kind of evidence would bear on the nature of irregular past tense learning by word association or rules? The strongest evidence for associative storage comes from frequency effects in child language acquisition: in general, irregular past tense forms that are more frequently used in the input tend to be acquired more accurately by children.⁴

Logically, children may make three kinds of errors regarding the use of past tense.⁵

- (1) a. Over-regularization: an irregular verb is inflected with the -ed rule (e.g., *hold-helded*).
- b. Over-irregularization:
 - i. Regulars: a regular verb is inflected with an irregular form (e.g., *heal-helt* along the lines of *feel-felt*).
 - ii. Irregulars: an irregular verb is inflected with an incorrect, non-target, irregular form (e.g., *sting-stang* along the lines of *sing-sang*).

⁴ The measurement of learning accuracy is by no means a simple matter. On the one hand, young children under the age of 4 often omit tense marking altogether, characteristic of their general syntactic development (Phillips 1995; Legate and Yang 2007). On the other hand, there are methodological issues concerning the inclusion and exclusion of verbal forms, which has resulted in quite different reports in the literature; see Maratsos (2000) for discussion.

⁵ By errors, we mean forms that deviate from the “standard” adult usage form: unfortunately, the acquisition data presently available does not offer any opportunity to systematically study the acquisition of dialectal variation in past tense formation (Anderwald 2009).

Over-regularization is extremely well known and has become the focus of virtually all empirical studies of past tense acquisition. By contrast, over-irregularization errors, which are sometimes referred to as analogical errors, are frequently alluded to (e.g., Pinker 1999) but rarely studied systematically. These turn out to be virtually absent; we return to this matter in Section 3.2 when we discuss the role of productivity and analogy in child morphology. Earlier studies of past tense find an over-regularization rate of 4.2 percent (Marcus et al. 1992; Pinker 1995), but later studies have found somewhat higher rates. For instance, Yang (2002) reports 10 percent out of approximately 7,000 tokens on the basis of four large longitudinal corpora in the public domain, Maslen et al. (2004) reports 7.8 percent out of approximately 1,300 tokens from a single child. In general, however, a frequency effect has been found in the rate of over-regularization: irregular verbs that appear in past tense more frequently in adult speech tend to have lower rates of over-regularization errors. Marcus et al. (1992) report that across all irregular verbs, children's rates of over-regularization for irregulars and the (log) frequencies of their past tense forms in child-directed input show a coefficient of correlation of -0.33 . Most of the evidence provided for the associative account of irregular verbs draws on various forms of frequency effects (e.g., Pinker 1995).

However, -0.33 is a fairly weak correlation as far as statistical analyses go. Partly motivated by this, Yang (2002) explores the plausibility of the traditional rule-based approach to irregular past tense. According to this view, the learning of irregular verbs consists of several components:

- (2) a. The learner must construct rules for the irregular verbs such as those found in Bloch (1947).
- b. The learner must associate, or lexicalize, each irregular stem with the corresponding irregular rule.
- c. To inflect an irregular past tense, the learner needs to locate the associated irregular rule and then apply it.
- d. The failure to either retrieve the irregular rule or to apply the irregular rule results in the use of the default rule of "add *-d*" and thus over-regularization.

It is important to note that the rule-based approach does not dispense with the role of associative memory altogether. The irregular verbs are unpredictable and have always been treated with some type of lexicalization. However, the rule-based approach makes significantly different predictions from the word-based approach. For instance, the learner receives evidence for the "ought" rule, which applies to *bring*, *buy*, *catch*, *seek*, *teach*, and *think*, whenever any of the six verbs appears in past tense. This leads to the notion of a *rule frequency*, which is the sum of the frequencies of the words that follow the rule. The word-rule association, of course, can only be established upon exposure to the specific words: *brought* will contribute to the lexicalized association between *bring*, and only *bring*, and the "ought" rule.

The bipartite nature of the rule-based approach contrasts with the word-based associative approach. Consider two irregulars that are comparable in their word frequency but one belongs to a very frequent irregular rule and the other belongs to a relatively infrequent irregular rule. For the word-based theory, the two verbs are expected to be learned at a comparable level of accuracy. For the rule-based theory, the verb belonging to the more frequent rule will be expected to be learned better because the rule, being more abundantly attested in the input, will be used more reliably. The irregular verbs *taught* and *flew* are two such examples. They are comparable in frequency (81 and 117 in 3.6 million words of English spoken by the mothers in the CHILDES database), but children produced the overregularized *flied* 26 percent of the time (23/89) but *taached* only 12 percent of the time (3/25). (Many additional examples can be found in Yang (2002).) This performance disparity is hard to reconcile with the word-based theory but is straightforward under the rule-based theory: *teach* belongs to the “ought” rule which counts far more frequent verbs such as *thought*, *brought*, *bought*, and *caught* (with frequencies of 1516, 416, 367, and 288 in the same corpus). By contrast, the most frequent member of the rule that applies to *fly* is *knew*, which only appears 390 times. This sort of free rider effects goes a long way to ameliorate the weak statistical correlation between input frequencies and overregularization rates.

Yang (2002) has identified another pattern that further suggests that past tense acquisition is not a matter of building word associations. A subset of English irregular verbs has long been recognized as following more general morphophonological patterns. For instance, verbs such as *hide-hid*, *feel-felt*, and *say-said* have been analyzed as instances of the vowel shortening process triggered by the suffix (null, *-t*, and *-d* respectively), similar to alternations in derivational word formation such as *deep-depth* and *divine-divinity* (Halle and Mohanan 1985; Myers 1987). Intriguingly, all vowel shortening verbs, including those with very low input frequencies, are used very well by child learners, with an overall over-regularization rate of only 2 percent (Yang 2002). The learning mechanisms for and the representation of these vowel shortening verbs are by no means clearly understood but it is plausible that vowel shortening, being a fairly general process in English morphophonology, will be supported by data beyond the realm of past tense, which in turn benefits the acquisition of the irregular verbs that make use of the same process.

Needless to say, these investigations of English past tense acquisition are only beginning to unravel the underlying complexity of this very small corner of English morphology. But we believe that morphological theories have much to offer to the psychological studies of language learning and processing. Indeed, the rule-governed nature of irregular verbs reviewed here goes hand in hand with recent findings in behavioral and neurological studies that the irregular past tense is compositionally formed (see, e.g., Allen and Badecker 2002; Stockall and Marantz 2006; Morris and Stockall

2012); abstract morphological postulates seem to have observable psychological correlates; see Chapter 28 for a review of morphological processing literature.

The present discussion also raises some important questions. How are rules such as “add *-d*” as well as the lexicalized irregular rules acquired? Some of the existing work is reviewed in Section 4, but much remains unclear. Additionally, how does the learner know that lexicalized rules are lexicalized and do not extend to novel items while the “add *-d*” rule is general and open-ended? Notice that this issue also needs to be resolved by the Words and Rules model: without knowing what the default rule is, the learner does not know whether to commit a verb to associative storage or to apply a rule without needing to commit any additional memory. In other words, how does the child distinguish the regular rules in her language from the lexicalized ones?

3.2 Productivity and Analogy in Child Morphology

The acquisition of morphological productivity can be summarized very succinctly: children draw a sharp, nearly categorical, distinction between productive and unproductive processes. These findings should be integrated into the study of productivity, a central topic in morphological research (Chapter 4).

3.2.1 The Wug Test

The simplest and most direct assessment of productivity is the celebrated Wug test. In a landmark study, Berko (1958) introduced young children to a wide range of novel words including nouns, verbs, and other categories:

- (3) This is a wug.
Here is another one.
These are two ____.

The Wug test is now extensively used in a wide range of studies (see, e.g., Bybee and Slobin 1982; Bybee and Moder 1983; Marcus et al. 1992; Clahsen 1999; Hahn and Nakisa 2000; Albright and Hayes 2003; Hayes et al. 2009; Zhang and Lai 2010; Becker et al. 2011) which subsequently have had considerable influence in linguistic theorizing (Pinker 1989; Taylor 2003; Tomasello 2003; Hay and Baayen 2005). Yet the Wug test by no means provides a direct window into morphology. It turns out that children are far from perfect on their Wug tests (Berko 1958: 160). For instance, in the inflection of regular past tense, first graders’ (ages 6–7) success rate for novel (regular) past tense ranges from 25 percent to 85 percent, producing responses such as *rick-ricked* and *spow-spowed*. Yet most if not all English-learning children have acquired the “add *-ed*” rule by the age of three (Marcus et al. 1992), as indicated by their spontaneous use of over-regularized forms. Thus a gap of a minimum of three to four years exists

between the knowledge of regular past tense and the appropriate use of it in a specific experimental design that involves learning a novel word; failure at the Wug test does not entail the language user's morphological deficiency.

When children do produce a response in the Wug test, their behavior points to a categorical distinction between regular and irregular processes. For instance, when children fail to produce *spowed* for *spow*, they produced no response at all rather than, say, *spew*, which would follow the analogy of *know-knew*. The role of analogy was systematically investigated by Berko, who also created novel verbs such as *bing* and *gling* that bear great similarity to existing irregular verbs, corresponding to the *i-a/u* class that seems to have the greatest potential for analogical extension:

- (4) This is a man who knows how to GLING.
 He's GLINGING.
 (Picture of a man exercising.)
 He did the same thing yesterday.
 What do he do yesterday?
 Yesterday he ____.

Children, however, are overwhelmingly conservative in their response: only 1 of the 86 children in Berko's study supplied the analogical form *bang* and *glang*; the rest all produced the *-ed* forms. It is possible that adults treat the Wug test differently, and Berko did notice that adult subjects are far more likely to use the irregular form with at least half of the subjects supplying *ba/ung* and *gla/ung*. But given the task complexity with the Wug test (see Schütze (2005) for extensive discussion), results obtained from adult performance, while interesting and potentially informative about the organization of morphology, cannot be directly used as evidence for the acquisition of morphology.⁶

3.2.2 Regularization versus Irregularization in English

The use of naturalistic data, which is now abundantly available in the public domain, sidesteps the methodological issues inherent in behavioral tasks such as the Wug test and provides very clear evidence for how children deal with morphological productivity. This is made possible because inflected forms are highly frequent and an enormous amount of data have been accumulated in the public domain (MacWhinney 2000). As reviewed above, children frequently attach *-ed* to irregular verbs. Likewise, when new words such as *google* were

⁶ We do not discuss the use of rating tasks in assessing morphological productivity (e.g., Albright and Hayes 2003).

Rating, by definition a gradient task on a scale, guarantees a gradient outcome. It is useful to gain a refined understanding of phenomena that are independently shown to be gradient but is not suitable for determining whether a process or class is categorical or gradient in the first place (Armstrong et al. 1983).

introduced into the English language, its (regularly inflected) past tense (*googled*) was instantly available.

The lexicalized irregular rules, by contrast, are almost never overgeneralized by children beyond the lexicalized lists, despite frequent anecdotal references to these forms in child language, such as *bite-bote*, *wipe-wope*, *think-thunk*, and so on (Bowerman 1982; Bybee 1985; Pinker and Prince 1988; Pinker 1999). But the empirical evidence for irregularization is very slim: there is not a single attested example of these in the entire CHILDES database of about 5 million words of child English. The most comprehensive empirical study of analogical errors (Xu and Pinker 1995) in fact refers to analogical errors as “weird past tense errors” on the basis of their rarity. Xu and Pinker examined all the past tense forms produced by nine children in the CHILDES database, about 20,500 in all. Only forty over-irregularization errors (0.02%) were identified, which is at least an order of magnitude lower than the rate of over-regularization. A closer examination of the irregularization errors, exhaustively listed in the Xu and Pinker study, suggests an even lower rate of irregularization. Of the forty attested examples, at least ten are very likely speech errors (e.g., “fit-feet,” “say-set,” “fight-fooed,” “bite-bet”) or potentially transcription errors. For instance, “slep” is included as an analogical error of “sleep” but is more likely due to the word final t/d deletion process in spoken English (Labov 1989). The only systematic pattern is *ing*→*a/ung* pattern, and the verb *bring* is the only item that is frequently over-irregularized. It is possible that children form a productive rule that changes /t/ to /æ/ before ŋ: for children’s small vocabulary, this pattern is consistent with two out of the three verbs that fit this structural description (*ring*, *sing*, and *bring*). But it is also possible that *brang* is present in the input as a matter of dialect variation (Herman and Herman 2014): in fact, *brang* can be found in the child-directed speech collected in CHILDES (MacWhinney 2000). Nevertheless, the drastically different rates of over-regularization and over-irregularization suggest that there is a (near) categorical distinction with respect to productivity between the regular rule and the irregular rules.

3.2.3 Productivity across Languages

The productivity/analogy asymmetry has been observed in many case studies of children’s language, mostly in the arena of morphological acquisition but can be found in syntax as well. When children make mistakes, they almost always employ a default or productive form (e.g., *thinked*) or omit the appropriate form altogether: they almost never substitute with an inappropriate form. Of course, the very notion of a default raises complex theoretical questions (see Chapter 11 in this volume) and we will also briefly address the acquisition of what appears to be defective, or default-less morphological systems (Section 3.3). But first, an overview of previous findings on productivity from the crosslinguistic research of child morphology.

In a study that targets the agreement affixes *-st* (2nd singular) and *-t* (3rd singular), Clahsen and Penke (1992) find that while a child ("Simone") supplied an agreement affix in obligatory context only 83 percent of time, the rest are errors of agreement omission. When an agreement affix is on offer, it is almost always the appropriate one (over 98% of the time); inappropriate use (e.g., substituting a *-t* for *-st*) is thus virtually absent. Similar patterns can be observed in the acquisition of Italian. In a cross-sectional study (Caprin and Guasti 2009: 31), children in all age groups use a diverse and consistent range of tensed forms. Furthermore, the use of person and number agreement is essentially error free throughout, reaching an overall correct percentage of 97.5 percent, consistent with previous reports (Guasti 1993; Pizzuto and Caselli 1994). Children's impressive command of agreement is best demonstrated in the acquisition of languages with considerable morphological complexity. In a study of morphosyntactic acquisition in Xhosa (Gxilishe et al. 2007), children gradually expand the use of subject agreement across both verbs and noun classes between 24 and 36 months. The rate of marking in obligatory contexts as well as the diversity of the morphological contexts themselves steadily increased. In a process best described as probabilistic, the children often alternate between marking a verb root in one instance and leaving it bare in another, very much like the use/omission alternation pattern reviewed earlier. Crucially, however, virtually all agreement errors are those of omission: 139 out of 143 or 97.2 percent to be precise. Substitution errors are again very rare, confirming previous research on similar languages (Demuth 2003; Deen 2005).

We now turn to several case studies that focus more specifically on the contrast between regular and irregular morphologies in children's naturalistic speech. This type of evidence has been accumulating from research on the Words and Rules model of morphology (Pinker 1999; Clahsen 1999), for which a categorical distinction between regular and irregular processes is of central importance. The evidence is unequivocal.

The German participle system consists of a productive default *-t* suffix (*fragen-gefragt* 'ask-asked'), as well as an unpredictable set of irregulars taking *-n* (*stehlen-gestohlen* 'steal-stolen') (Wiese 1996). In a series of studies, Clahsen and colleagues (Clahsen and Rothweiler 1993; Weyerts and Clahsen 1994; Clahsen 1999) find that children across all age groups overapply the *-t* suffix to the irregulars, where the reverse usage is virtually absent. Their longitudinal data contains 116 incorrect participle endings, out of which 93 percent are *-t* errors (**gekommt* instead of *gekommen* 'come'). The rest are irregularization errors such as **geschneien* for *geschneit* ('snowed'). According to the authors, the overall rate of *-t* regularization is 10 percent of all usage, which results in the *-n* irregularization rate of 0.75 percent. The acquisition of German past participles, therefore, is quite analogous to that of English past tense

reviewed earlier, as both point to the productive asymmetry between regulars and irregulars.

The inflection of Spanish verbs provides a complex but revealing case for exploring productivity in child language. In Spanish, stems generally consist of theme vowels and roots, which are then combined with affixes for inflection. For instance, a finite form of the verb *hablar* 'to talk' is *habl-á-ba-ais*, which represents the root (*habl* 'speak'), the theme vowel (*á*), the past tense (*ba*) and the second-person plural (*ais*). The theme vowels form three conjugations, with the first (*a*) being the numerically most dominant class which has 9,706 members, followed by the second (712) and third (730), according to Real Academia Española (1992, cited in Clahsen et al. 2002). The irregularity in Spanish inflection comes in two broad classes concerning the stem and the suffix respectively. There are some thirty verbs that are highly irregular with the insertion of a velar stop in certain inflections. These examples include *tener* 'to have,' *poner* 'put,' and *salir* 'go out,' whose first-person singular forms are *tengo*, *pongo*, and *salgo*, respectively. The majority of irregulars undergo a well-known morphophonemic alternation known as diphthongization, a process which is not limited to verbal morphology *per se* (Harris 1969; Eddington 1996). For these verbs, the mid vowel is diphthongized in stressed syllables. (5) shows the pattern for the present indicative of the verbs *comenzar* 'begin' and *contar* 'count,' where the graphic accent indicates phonological stress:

- (5) *comiénto comiéntas comiénta comenzámos comenzáis comiéntan*
cuénto cuéntas cuénta contámos contáis cuéntan

While it has been suggested that the *form* of diphthongization is predictable (Harris 1969), the identity of the verbs that undergo diphthongization is arbitrary and must be lexicalized. It is possible to find minimal pairs such as *contar-montar* where the former contains the diphthong (*cuento*) but the latter does not (*monto*). And there are a few common verbs that show both diphthongization and velar insertion in some forms. For instance, *tener* 'to have' and *venir* 'to come' show velar insertion in the present subjunctive and first-person singular of the present indicative and [ie] diphthongization in second singular and third person of the present indicative. While inflectional irregularities in Spanish mostly affect the stem, the suffixes are affected as well. For the stem *querer* 'to want,' for instance, the first-person past tense is *quise*, which involves the stem change noted earlier while taking the irregular suffix rather than the regular suffix, which would have resulted in **quisí*. The suffix in the third-person past tense *puso* 's/he/it put' is *-o* and the regular suffix would have formed **pusió*.

Clahsen et al. (2002) analyzed the verbal inflections of the fifteen Spanish-speaking children and found strong evidence for the categorical distinction between regular and irregular suffixes as well as stem alternations.

- (6) a. The irregulars: children produced a total of 3,614 irregular verb tokens, out of which 168 (4.6%) are incorrect either in stem formation or suffixation.
 - i. Of the 120 stem formation errors (see below), 116 are over-regularizations and only one is analogical irregularization.
 - ii. Of the 133 suffixation errors, 132 are over-regularizations with no occurrence of irregularization.
- b. The regulars: children produced 2,073 regular verb tokens, only 2 of which are the inappropriate use of irregular suffixes.

Clahsen et al.'s study did not include errors regarding diphthongs; all the stem formation errors are failures to use a diphthong when required, and no instance of diphthongization when unnecessary is found. Although this broadly supports the notion of diphthongization as a lexicalized process, it does not consider the possibility of *inappropriate* use of diphthongization, such as when the child produces [ie] alternation when the correct diphthong is [ue]. To address this issue, Mayol (2007) provides a finer-grained investigation of inflectional errors focusing more specifically on the types of stem formation errors and their underlying causes. The naturalistic speech transcripts of six Spanish-speaking children revealed a total of 345 stem formation errors out of a total 1,782 tokens, but importantly, not a single case of inappropriate form was found.

Much more data, both in volume and also in linguistic variety, are needed to refine our understanding of morphological acquisition. Unfortunately, there is little research on the acquisition of derivational morphology which should provide a fertile ground for investigations of productivity. The primary reason for this is that derivational morphology is acquired quite late and much of the vocabulary is introduced in a school setting (see, e.g., Jarmulowicz 2002). Nevertheless, the best available evidence from child morphology suggests that children are capable of drawing a categorical distinction between regular and irregular morphologies, as part of their excellent grasp of the structural properties of morphological alternations across the languages.

3.3 When Productivity Fails

We would be remiss if we didn't address some perennial challenges in the study of morphology. As children quickly and accurately grasp the productive aspects of morphology, it becomes especially puzzling that there are corners of the grammar where productivity unexpectedly fails. In a classic paper, Halle (1973) draws attention to the existence of paradigmatic gaps; for instance, there are around seventy-five Russian verbs, all belonging to the second conjugation, that lack a first-person singular (1sg) non-past form, a fact which cannot be predicted on frequency or phonotactic grounds alone (see Sims (2006) for additional discussion of the Russian data

and Baerman et al. (2010) for a recent general survey). Although we are not aware of any acquisition study of these classic cases of paradigmatic gaps, the issue of non-productivity has turned up in the child morphology literature and we briefly review a prominent case.

According to the Words and Rules model, there is a default rule for every morphological context; see Pinker (1999) for a discussion of how the learner may identify that rule on the basis of statistical and distributional properties of words. In Polish, however, masculine nouns in the genitive singular (gen.sg) either take an *-a* or *-u* suffix, but neither is productive when evaluated against the standard suite of tests for productivity (Dąbrowska 2001). The distribution of these two suffixes is widely studied but has stubbornly resisted systematic classification (e.g., Westfal 1956). In contrast, the genitive plural (gen.pl) for masculines is unproblematic: the default suffix is *-ow* with a small number of exceptional nouns taking *-i/-y*. Previous studies of Polish acquisition (Dąbrowska 2001: Tables 8 and 12) have found that children make very few errors in the gen.sg (mean rate 1% for three children), and frequently overextend *-ow* in the gen.pl (mean rate 11.3%). The significant difference in error rates suggests that, similar to the many cases reviewed earlier, the marking of the singular is lexicalized and does not generally extend beyond the lists of fixed words whereas the plurals contain a productive rule that triggers over-regularization.

The case of Polish masculine genitives, especially the singulars, is of considerable theoretical interest. It suggests that the child learner should not presuppose the existence of a default rule. Likewise, the absence of a default poses challenges to competition-based theoretical frameworks such as Distributed Morphology (Halle and Marantz 1993; Chapter 15 in this volume) and Optimality Theory (Prince and Smolensky 2004; Chapter 20 in this volume) under which a winning form generally emerges; see the collections of articles in Baerman et al. (2010). Furthermore, the default rule cannot be established on the basis of statistical dominance (*pace* Pinker 1995). According to a word list based on child-directed Polish and made available in CHILDES, *-a* and *-u* consume 62 percent and 38 percent of the stems (837 and 516) but this does not give rise to the default status for *-a*, as the child-acquisition data as well as traditional descriptions clearly indicate.⁷

At the same time, it is useful to recall that statistical minority does not entail the absence of productivity. Despite considerable disagreement over the characterization of the German noun plural system (Clahsen 1999; Wiese 1999; Wunderlich 1999), the productivity of the *-s* suffix, which applies to the smallest number of noun stems, is not controversial and indeed can be observed in children's over-regularization (Marcus et al. 1995). A computational theory of how children assess the structural and statistical factors in the calibration of productivity can be found in Young (2016).

⁷ We thank Margaret Borowczyk for the corpus analysis.

4 Learning Mechanisms

Ideally, the modeling of morphological learning would be faithful to the process of language acquisition, featuring the development of models that predict the type of learning behaviors shown by child learners and models that operate on the type of input children receive. As discussed in this section, there is much progress to be made to develop linguistically and psychologically faithful models. The majority of existing models make the assumption that the input is both dense and supervised, contrary to the evidence given in Section 2, and those that do attempt to model properties of child language acquisition struggle to balance the mechanisms required for learning of irregular forms with those required for categorical productivity.

4.1 English Past Tense Learning Models

As with studies of development, the creation of computational models of morphological learning has focused heavily on the English past tense. Rumelhart and McClelland (1986) provide the first well-known computational model that attempted to learn morphology in a manner aligned with research in child development. At a high level, this connectionist model exhibits the same over-regularization phase (e.g., Ervin and Miller 1963; Marcus et al. 1992) during training as children learning the English past tense.

But while it replicates a salient development pattern, the Rumelhart and McClelland model makes unpredictable errors that are unattested in child learning when trying to handle regular forms, such as *membled* for the past tense of *mail* (see Pinker and Prince (1988) for details). While the specifics of these problems have been addressed with further improvements to this class of models (Plunkett and Juola 1999), the core tension between capturing the minimal generalizations required for correct handling of both irregular and regular forms remains.

As discussed in Section 3, rule-only theoretical models such as the Rules over Words model (Yang 2002; see also the computational work of Mooney and Califf 1995; Yip and Sussman 1997) address this problem by expressing both regulars and irregulars as rules, with irregular rules only applying to memorized lexical entries without further generalization. The Words and Rules model (Pinker 1999) presents a mixture of rule-based and associative models, for handling default rules and classes of irregular forms, respectively, but does not provide a validated mechanism for assigning individual forms to the correct model. Albright and Hayes (2002) present a model that induces rules by identifying minimal generalizations and goes beyond many previous studies by learning full paradigms and attempting to align the output of their model with (adult) speaker intuitions.

Finally, to provide an accurate account of English past tense acquisition, a model should occasionally over-regularize the irregular verbs but should almost never over-irregularize at all, mirroring the developmental

asymmetry reviewed earlier. Unfortunately, the absence of analogical errors is almost never addressed in the computational modeling work, perhaps because this finding has been overshadowed by the attention devoted to over-regularization.

For instance, a recent study (O'Donnell 2011) tests a variety of models for past tense, by examining the models' output when presented with both existing and novel words. Most of the models are reasonably successful at passing the Wug test for regular verbs, but they frequently generate analogical forms from the existing irregulars. The best model overall (O'Donnell 2011), a Bayesian model that attempts to provide a balance between lexicalized storage and rule-based computation (Johnson et al. 2007b), produces 10 percent of over-irregularization patterns on novel items, which is on a par with children's *over-regularization* rate and two orders of magnitude higher than the over-irregularization rate. In other words, it is as if this model treats every novel instance as a regular verb. In general, the problem of productivity has not been systematically studied in the modeling work; how to bridge this gap between the computational and empirical studies of morphological learning deserves fuller attention in future research (see Yang 2005, 2016 for a general principle of productivity).

4.2 The Distributional Learning of Morphology

While the past tense learning models vary in their specificity – for example, Rumelhart and McClelland (1986) and Albright and Hayes (2002) test actual implementations, while Pinker (1999) provides only a description of a plausible model – they uniformly make the assumption that the input to the learner is neatly organized into pairs of forms representing a single inflectional change. The input to these models consists of entries like *go/went*, *make/made*, *bake/baked*. The closest thing to these pairs that may be observed in natural input are situations like this one from the Adam data in CHILDES (Brown 1973):

- (7) Adam: Mary. Mary go? Mary go, mommy?
Mother: Who?
A: Where Mary go?
M: Mary?
A: Yeah.
M: She's gone home. She went home in July.
A: Mary gone.

To use a word-pair-based approach in acquisition, a child learner would need to discover these words pairs from input, a process that is largely unexplored in psycholinguistics. As the above dialog shows, such a process would also be non-trivial, especially in cases of suppletion. While there is evidence that automatic approaches can identify sets of morphologically related words (e.g., Parkes et al. 1998; Wicentowski 2002), little work has

been done to attempt to extract the high-accuracy word pairs required by supervised single-inflection learners. Thus while cognitively motivated models have had success in replicating phenomena related to language acquisition, they have thus far not done so in an unsupervised setting.

Unsupervised learning of morphology is well studied in engineering-oriented models; however, these models generally make no attempt to align themselves with developmental studies. One approach is using sequences of characters to identify morpheme boundaries—an idea first presented by Harris (1955)—either by an algorithmic approach (Hafer and Weiss 1974; Keshava and Pitler 2006) or developing n-gram-based statistical models (e.g., Spiegler et al. 2009). Often segmentation-based approaches rely on minimum description length to guide the appropriate amount of segmentation (Brent et al. 1995; Creutz and Lagus 2005), or organize the segmentations learned into paradigms (Goldsmith 2001; Monson 2008). While the use of paradigms creates what appears to be a useful organization of the learned rules, recent work questions the learnability of paradigms or item-based representations from realistic input due to the quantitative sparseness of data available to learners (Chan 2008). Bayesian approaches (e.g., Goldwater et al. 2006; Naradowsky and Goldwater 2009; Johnson et al. 2007a) use a prior distribution to guide the learner toward a desirable target, often explicitly taking into account information regarding the frequency distributions of stems and affixes. Lignos et al. (2009) use heuristic approaches to incrementally learn affixes and the stems they can be applied to, directly taking advantage of the statistical properties of morphology discussed in Section 2.

A major benefit of studies that evaluate models using corpus input—a requirement in modern computational linguistics venues, but often optional elsewhere—is that their performance on naturalistic and sparse data can be directly evaluated. As discussed in Section 2, learning models that assume the input contains full paradigms will fail to find them in the input.

Chan (2008: Chapter 3) provides a clear demonstration of the effects of sparsity on models that require full paradigms to infer a reasonable representation of the morphology of the language. When the *Wall Street Journal* portion of the Penn Treebank (Marcus et al. 1999) is provided as input to the *Linguistica* system (Goldsmith 2006), a minimum description length (MDL) morphology learning system that attempts to derive the most compact characterization of the data, it learns a set of signatures, structures which contain a set of stems and the suffixes they take. For example, it identifies 604 stems (e.g., *alarm*) that take the set of suffixes $\{-\emptyset, -ed, -ing, -s\}$.⁸ This is a rather good representation of English verbal morphology. But what else is learned? One signature of 285 stems takes the suffixes $\{-\emptyset, -ed, -ing\}$, one of

⁸ Many computational models are evaluated using orthographic input. While this provides a relatively poor analog to the input a child learner receives, the properties of sparsity under discussion here are the same regardless of the representation of the input.

242 stems takes the suffixes $\{-\emptyset, -ed\}$, and one of 2,624 stems, the largest signature of all, takes the suffixes $\{-\emptyset, -s\}$.

These partial paradigms are a symptom of the Zipfian distributions described in Section 2. Despite the fact that all regular verbs in English should be members of the $\{-\emptyset, -ed, -ing, -s\}$ signature—modulo any orthographic oddities—most stems are only seen with some of the possible inflections. A minimum description length learner whose goal is to provide a compression of the input cannot infer the common pattern when the majority of relevant data points are missing.⁹ A useful morphological learning model must be able to look beyond the sparsity of the input, much like the child learner must look beyond the poverty of the stimulus. In this sense, productivity is at the heart of all morphological learning models (Yang 2016): the child must know where to generalize and when to lexicalize.

It is clear that children excel at drawing useful generalization from distributional information. In addition to their generally excellent command of morphology which we reviewed earlier, there is now some suggestive evidence on how they can carry out distributional learning. For instance, Gerken et al. (2005) find that infants of age 1;5 succeed in learning syntactic category generalizations from distributional cues, one finding in a constantly growing set of studies that demonstrate that infants and young children possess powerful associative and statistical learning capabilities; see also Gómez and Lakusta (2004). Yet it still remains an open question whether distributional learning mechanisms demonstrated in a laboratory setting can scale up to actual languages with realistic complexity (Yang 2004). A most fruitful direction in the computational modeling of morphological learning will likely see close engagement with the experimental study of child language acquisition, while taking the full range of crosslinguistic developmental findings into account.

5 Conclusion

To summarize, children's acquisition of morphology provides a wealth of empirical data to bear on the theoretical issues in morphology. The fact that their morphological knowledge is generally secure is especially impressive when considered in a psychological setting of language learning. Linguists have access to a wide range of evidence when studying the morphological system of a language. For instance, theorists can make use of a large lexical corpus that far exceeds the quantity of data available to the child learner. Native speakers may provide judgment involving ungrammatical examples, which are not available in language acquisition (Brown and Hanlon 1970;

⁹ The specific issue with Goldsmith's model is partially addressed by Monson (2008) using a more complex search strategy, but the core problem of inducing a full paradigm when one is not present in the input still remains.

Marcus 1993). Behavioral experiments such as the Wug test and rating can also prove informative despite their limitations. The child learner, by contrast, has none of these tools available. To understand the mechanisms of morphological acquisition will require collaborative efforts among theoretical linguists, developmental psychologists, and computer scientists in the years to come.

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Experimental Studies of Morphology and Morphological Processing

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1 Introduction

The linguistic study of morphologically complex words pursues theoretical goals (by specifying the categories and operations of morphological systems), descriptive goals (by analyzing morphological systems in particular languages), and typological goals (by characterizing what is universal and particular in morphology). The psycholinguistic and neurocognitive study of morphology addresses the question of how knowledge of morphology is employed in the production and comprehension of language in real time, along with other (linguistic and non-linguistic) sources of information. To study the processes involved in production and comprehension as they occur, psycholinguists use a range of experimental measures, including not only elicited production and (grammaticality and acceptability) judgment tasks but also time-sensitive, so-called online measures of language processing.

The questions of how morphologically complex words are to be represented and of the kinds of rules or operations required to derive them are controversial among both morphologists and psycholinguists. One view holds that there are no distinct operations or representations for morphologically complex words, that morphologically structured representations and processes operating on morphological categories might be dispensable, and that inflected or derived words can in principle be handled within the same (possibly associative) lexical system or network that is required for simplex word-forms that do not have any internal morphological structure (e.g., Bybee and Hopper 2001; Gonnerman et al. 2007; Baayen et al. 2011;

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Plaut 2011; Feldman and Weber 2012; Westermann and Ruh 2012). Others have argued that complex words are derived syntagmatically from roots by concatenative operations (e.g. affixation), in addition to phonological readjustment and spell-out rules to capture stem changes and other irregularities (e.g., Halle and Marantz 1993; Matushansky and Marantz 2013). A third view is represented by various inferential word-based models of morphology (Matthews 1972; Aronoff 1994; Stump 2001) which posit uniquely morphological operations and rules (both concatenative and non-concatenative ones) that are distinct from both syntactic and phonological principles. In addition, dual-route accounts of morphology (e.g., Pinker 1999) have also sought to confirm the existence of morphological rules or operations that can be distinguished from associatively based storage of (irregular or otherwise idiosyncratic) inflected and derived word-forms; see Clahsen (2006) for a review. While there is indeed a large body of research in this domain, the question of whether morphological structure is required as a distinct organizing element of linguistic representation and processing remains unresolved.

Experimental research on morphologically complex words has led to a number of consistent and replicable effects, which have been interpreted with respect to different models of morphological processing. To take an example, consider frequency effects. One of the most robust experimental results is that in the lexical decision task, response times (RTs) are typically shorter for high than for low-frequency words. In this task, participants are instructed to decide as quickly and accurately as possible whether a visually or auditorily presented stimulus is an existing word or a non-word. The advantage for high-frequency words in lexical decision is thought to result from memory storage, in that memory traces are assumed to become stronger with repeated exposure and use. Morphologically complex words have also been examined with respect to frequency effects. In this line of research, frequency effects in lexical decision experiments are thought to provide a diagnostic for determining whether an inflected or a derived word-form is recognized through a decompositional process that segments a word into its morphological constituents or through direct look-up of a whole-word representation stored in lexical memory. If, for example, RTs for morphologically complex words in lexical decision vary as a function of a word-form's respective surface frequency—that is, the total number of tokens of that word-form in a given language—while controlling for its base (stem or root) frequency, then this is taken as evidence against morphological decomposition and an indication of direct look-up and lexical storage. Applying this logic to the study of Dutch plurals, Baayen et al. (2003: 382) argued, for example, that “surface frequency effects . . . challenge full-parsing models.” Bybee and Hopper (2001: 16), referring to experiments showing shorter lexical decision times for high- than for low-frequency *-ed* forms in English, interpreted frequency effects from a linguistic perspective, arguing that “if regular morphologically complex words can be stored

in memory . . . , then there is no reason to suppose that lexicon and grammar are separate from one another.” In this way, frequency effects in lexical decision experiments have been argued to be a diagnostic of morphological processing and representation.

Other researchers have questioned these assumptions and cast doubt on the primacy of frequency contrasts in the lexical decision task (Marslen-Wilson 2007; Clahsen and Neubauer 2010). Lexical decision experiments on inflected words have indeed produced a mixed set of results. While surface frequency effects were consistently obtained for irregularly inflected word-forms, for regularly inflected words several studies found them to be limited to high-frequency words (Alegre and Gordon 1999; Soveri et al. 2007); but see Baayen et al. (2007) for opposing findings. Furthermore, lexical decision times for morphologically complex words were found to be more affected by properties of the affixes involved – for example, affix homonymy (i.e., the same affix encoding different sets of features) and affix allomorphy (i.e., changes in the surface form of an affix in different environments) than by frequency contrasts (Järvikivi et al. 2006). In addition, frequency effects in lexical decision have been shown to be explainable by opposing psycholinguistic models (Davis et al. 2003; Taft 2004) and have been argued to provide a less direct diagnostic of morphological processing and representation than previously thought.

Controversies such as those surrounding the interpretation of frequency effects from lexical decision experiments are common in psycholinguistic research. Consequently, the theoretical implications from processing experiments for the nature of morphological concepts are not always straightforward and direct; alternative explanations, task effects, and other factors influencing experimental findings have to be considered before using them as evidence in favor of or against any theory of morphological representation. In this chapter, we will pursue this approach showing how the morphologist may benefit from psycholinguistic and neurocognitive experimentation and how theoretical concepts and descriptive findings from linguistic morphology may help to better understand experimental results.

2 Experimental Methods for Studying Morphology

Experimental methods that are useful for examining morphology include familiar paper-and-pencil tasks, such as elicit production and grammaticality and acceptability judgment tasks. These techniques provide information on the outputs of morphological decoding or encoding processes, for example, with respect to productive versus unproductive bits of morphology. To gain insight into the temporal sequencing of morphological processing, online, time-sensitive experimental measures are required. Here, we can distinguish between (i) behavioral measures, such as lexical decision times and other response time measures, and (ii) physiological

measures, such as brain responses and eye-movements. Event-related brain potentials (ERPs), for example, provide a detailed—millisecond-based—record of language processing and a rough indication of the brain areas involved. The ERP technique is based on the fact that active neurons in the brain produce electrical activity which can be measured by electrodes placed on the scalp. In the ERP record, the brain activity associated with a specific linguistic task is separated from background noise. Previous ERP research on language has, for example, led to the identification of distinct ERP components involved in lexical-semantic and grammatical (combinatorial) processing. Lexical-semantic processing has been found to elicit modulations of the N400 component, a negative waveform that peaks at around 400ms after stimulus onset (Kutas and Federmeier 2011). Grammatical processing of different kinds of morphosyntactic and syntactic phenomena has produced modulations of the P600 component, a positive late waveform (sometimes preceded by an early left-anterior negativity, LAN) which shows an increased amplitude in response to grammatical violations, such as agreement violations, verb-inflection errors, and case-inflection violations (van Herten et al. 2006). The advantages of using online experimental techniques such as ERPs are that they allow us to tap into automatic unconscious processes involved in language comprehension and production and that they minimize participants' reliance on explicit or metalinguistic knowledge. On the other hand, like other kinds of linguistic data, performance in psycholinguistic or neurocognitive experiments is likely to be affected by a range of participant-level factors such as participants' reading and listening ability, working memory capacity, speed of processing, and general cognitive resources. It is possible that such factors are responsible for a particular experimental result. The role of such factors therefore needs to be assessed before any finding is taken as evidence for or against a particular linguistic analysis or account. Furthermore, any data set or experiment is in danger of producing artefacts—for example, due to an experiment's specific task demands, weaknesses of individual techniques, or gaps in particular data sets. This holds not only for the standard techniques employed by linguists but also for all kinds of psycholinguistic studies. One way around this problem is to look for converging evidence from different sources. Thus, in the same way in which linguists do not, for example, rely on just one test for determining constituent-hood, psycholinguistic findings should only be used as evidence if they are replicable, ideally across different experimental techniques and data sources.

Experimental studies may provide insight into a number of questions relevant to the morphologist. Here we focus on two such topics, first morphological productivity and the search for defaults, and second the internal structure of morphologically complex words and the quest for the units of morpholexical representation.

One crucial property of inflectional and other morphological processes is that they can be easily applied to novel or unusual words under appropriate

circumstances. Generalization properties provide a crucial diagnostic for determining productivity in morphology. Morphological generalization properties can be studied using elicited production and acceptability judgment tasks. In such experiments, participants are presented with one or two forms of an existing or a nonce word (*This is a wug*) for which they have to produce a morphologically complex word-form for a nonce word they have not seen before (*These are two ...*). Such experiments have been used to study the generalizability of a range of morphological phenomena (e.g., Berko 1958; Bybee and Pardo 1981; Clahsen 1997; van der Lely and Ullman 2001). Another method for experimentally testing morphological productivity is acceptability judgment tasks. In such tasks, the critical morphologically complex words are often embedded in sentence contexts presented for reading or listening. Participants are instructed to rate the well-formedness of the critical word they see and hear using a graded scale consisting, for example, of five points with two degrees of unacceptability, a mid-point, and two degrees of acceptable ratings. Elicitation and judgment tasks have advantages and disadvantages. While from an elicited production task the researcher only gets one response per item and subject, such as a singular or a plural form, a judgment task generates continuous graded responses to degrees of acceptability, which may better reflect the more subtle aspects of grammatical intuitions. On the other hand, while producing an inflected or derived form for a given item seems a perfectly natural task, it is not quite clear what judgments of acceptability mean for linguistic interpretation as these decisions involve subtle and noisy processes, requiring conscious, metalinguistic access to a phenomenon (i.e., morphological knowledge and processing), that is in fact more tacit in nature (see also Fanselow and Frisch 2006; Sampson 2007). Consequently, both techniques should ideally be used to study the productivity of a particular morphological phenomenon.

The second set of experimental findings from which the morphologist may benefit concerns the nature of morpholexical representations, including questions such as: What is the internal structure of morphologically complex words? How are they segmented into smaller component parts? Should outputs of morphological processes be represented combinatorially (e.g., as stem + affix) or as wholes? To take an example, products of inflectional and derivational processes such as *fruits* and *fruitless* may both have internal morphological structure ([fruit]-s, [fruit]-less) but derived forms such as *fruitless* may be more likely to (also) have a word-level representation (to capture, for example, their specific meaning) than an inflected form such as *fruits*. To gain insight into these questions from experimental research, spoken and written word-recognition experiments with and without primes are potentially insightful.

One important source of evidence for tapping into a morphologically complex form's whole-word properties are results from unprimed lexical decision experiments. Lexical decision is a task which encourages subjects

to rely on their lexical memory, in order to determine whether or not they have encountered a stimulus word before. Due to its task demands, lexical decision is likely to be affected by word-level properties of inflected and derived forms, such as their word-form frequency. By contrast, unprimed lexical decision tasks are less sensitive to the internal structure of a morphologically complex word-form.

Results from priming experiments are better suited for this purpose; see Marslen-Wilson (2007) for a review. In morphological priming tasks, participants are presented with a morphologically complex prime word before a different word-form with the same stem as a target word: for example, *walked* as a prime for the target *walk*. For the target word, they have to perform a lexical decision task, or they have to read the target word aloud. A robust finding from priming experiments is that response latencies to target words are shorter when they are preceded by morphologically related than by unrelated prime words. In some cases, even the same amount of facilitation on target recognition times can be found for a derived or an inflected prime word as for an identity prime (i.e., no reliable difference between pairs such as *walked-walk* and *walk-walk*), a pattern referred to as full priming. Full-priming effects for morphologically related word-forms have first been reported by Stanners et al. (1979) and have since been replicated in many priming experiments. Stanners et al. (1979: 403) explained full-priming effects as follows: "... the base verb and suffix are partitioned prior to memory access and the base verb is then directly accessed." In other words, a word-form such as *walked*—presented as a prime—is decomposed during recognition according to its morphological structure ([walk]-ed), thereby isolating the base stem which then directly facilitates recognition of the target word *walk*. Different priming techniques are available. Primes and targets may be presented in the same modality or cross-modally: for example, primes auditorily and targets visually. Primes may be presented long enough to allow for overt recognition or in a visual mask for a very short period of time which only allows for partial recognition. Targets may be presented immediately at the offsets of the prime word or with a delay. Tasks assigned to participants may be to perform a lexical (word/non-word) decision on the target word, to name it, or to read it aloud. Among these different techniques, the cross-modal immediate repetition priming paradigm (which Stanners et al. (1979) used) is of particular interest for the morphologist, because it most directly taps into abstract lexical representations and due to being cross-modal is less likely to be affected by surface-form (orthographic and phonological) properties than unimodal priming experiments; see Marslen-Wilson et al. (1994).

In the following, we will report sets of experimental findings that provide insight into morphological productivity and morpholexical representation. Our specific focus will be on three long-standing controversies, (i) morphological types, (ii) the contrast between derivation and inflection, and (iii) the representation of morphosyntactic information.

3 Morphological Types and Their Generalization Properties: The Case of Stems

In addition to words, roots, and affixes, some morphologists have argued that stems represent an independent morpho-lexical type (e.g., Anderson 1992; Aronoff 1994; Stump 2001); but see Embick and Halle (2005) and Blevins (2006) for alternative views. While roots are morphologically unanalyzable and are defined with respect to lemmas, stems may be morphologically complex and represent recurrent parts of a series of inflected and/or derived forms. Stems are widespread – perhaps even universal (Berent et al. 2007) – across human languages. Stem formation can be combinatorial, yielding, for example, combinations of a root plus a stem-formation affix (e.g., Italian: [[cant]-a] in *cantare* ‘to sing’) or can involve phonological changes – for example, vowel alternants (e.g., German: *werfen* – *warf* – ‘to throw – throw-past’) – or even suppletion as, for example, in past-tense forms of *sein* ‘to be’ in German (e.g., *war-st* ‘be-2nd sg past,’ *war-en* ‘be-1st/3rd pl past’). Some stem-formation processes encode morphosyntactic features such as tense, person, number, and so on; others are non-morphemic without any specific meaning or morphosyntactic feature content defining, for example, conjugational or declensional classes. German verb stems such as *warf*- and *war*- are of the former, Italian verb stems such as [[cant]-a] of the latter type.

The question of whether the mental representation of stems encodes morphological structure is also controversial among psycholinguists. Three proposals have been made. Firstly, stems may not have any separate mental representation from the word-forms they are embedded in, and instead reflect correlations between form and meaning-level representations, possibly constituting associative patterns or schemas; see, for example, Colombo et al. (2006) and Eddington (2002) for Italian, and Bittner and Köpcke (2007) and Smolka et al. (2007) for German. Secondly, stems may be products of rule-based operations – for example, a rule to form Italian *canta*- from the root *cant*- and the stem-formation affix -a- (e.g., Vogel 1993) – or a morphophonological rule such as Lowering Ablaut to derive stem changes such as those in English or German (e.g., Stockall and Marantz 2006 for English; Beedham 1994 for German). A third possibility is a dual-mechanism account of stem representation by which some stem forms, for example, those belonging to the productive 1st conjugation in Romance languages, are the output of morphological rules while other stem forms are stored as units in the mental lexicon, which may form part of larger morpho-lexical templates; see Say and Clahsen (2002) for Italian, Clahsen et al. (2002) and Trompelt et al. (2013) for German, and Veríssimo and Clahsen (2014) for Portuguese.

The generalization properties of inflectional and other morphological processes provide a crucial diagnostic for how they are mentally represented. Some morphological processes may be freely applied to novel or

unusual words, others only under appropriate circumstances. Morphological productivity has previously mainly been investigated with respect to inflectional processes such as the English past-tense (e.g., Bybee and Moder 1983; Prasada and Pinker 1993). This research has led to a distinction between two fundamentally different kinds of generalization mechanism, symbolic versus associative generalization. The first mechanism can be understood as an operation, rule or constraint over a variable—for example, a category variable such as [+V] that stands for every instance of this category irrespective of the idiosyncratic phonological or semantic properties of any particular token in the lexicon; this mechanism allows for free and unbounded generalization to novel instances. The second mechanism is primarily determined by similarity to existing items, yielding graded generalization patterns in which the likelihood of generalization is determined by the degree of overlap between a novel item and a set of previously learned items. Some inflectional patterns, such as *-ed* affixation, seem to be productively extendable in an unbounded fashion (i.e., even to novel items that are very dissimilar to existing forms in the language), effectively behaving as a default, whereas other patterns, such as irregular past-tense formation in English, generalize only to novel items that resemble clusters of existing verbs. Examining the generalization properties of different types of stem will also be insightful. Like inflectional affixes, some stem-formation processes may generalize by analogy, driven by similarity-based associations between the particular form of a novel word and existing stem forms, others may generalize by default independently of the particular properties of individual items. In the following, a number of experimental findings will be reported that examined the generalization properties of different kinds of stem forms from this perspective.

Consider first the generalization properties of marked verbal stems compared to those of unmarked stems. One case from German that has been experimentally studied is the subclass of strong verbs some of which have up to six different stem allomorphs. The stem variants of the German equivalent of the verb ‘to throw,’ for example, are *werf-*, *wirf-*, *warf-*, *-wurf-*, *würf-*, *wurf-*. The base stem *werf-* occurs when “all else fails” and is a candidate for default-based generalizations, whereas all other stem variants occur under more specific circumstances and for a lexically restricted subclass of items (e.g., *wirf-* for second- and third-person singular present tense forms and in imperatives or *warf-* in preterite forms). Clahsen et al. (2002) tested this contrast in an elicited production experiment in which participants were presented with novel verbs, in three steps. Step 1 introduced the novel verb in its infinitive form (e.g., *quelmen*) and its corresponding second- or third-person singular present tense or imperative form either with unmarked stems (= *quelm-*) or with marked *-i-* stems (= *quilm-*). In step 2, participants were asked to employ the unmarked/marked stem presented in step 1 in a related context. Finally, in step 3 they had to produce a different

inflectional form of the novel verb which they had not seen before. The results showed that the unmarked base stem significantly more often generalized to novel verbs (e.g., *quelm-t*) than marked *-i-* stems. Even for nonce verbs that were presented (in step 1) and repeated (in step 2) with *-i-* stems, 20 percent of the step 3 responses had unmarked stems. The reverse response, *-i-* stems produced for nonce verbs that were introduced with *-e-* stems, was significantly less common (= 8%). These results indicate that unmarked stems generalize more freely to novel verbs than marked stems.

Linares et al. (2006) employed the same type of experiment to examine the generalization properties of marked relative to unmarked stems in Spanish focusing on novel verbs similar to existing third-conjugation verbs such as *ped-ir* 'to ask for' that have a marked *-i-* stem in various finite verb forms (e.g., *pid-en* 3rd pl, *pides* 2nd sg). Note that the *e~i* alternation pattern affects some thirty-five verbs—that is, nearly half of all third-conjugation verbs that exhibit an unstressed mid-vowel in their stems. In Linares et al.'s (2006) experiment, participants read inflected forms of novel verbs (all of which rhymed with existing third-conjugation verbs) in sentence contexts, in two experimental versions, one in which the novel verbs were introduced with *-e-* stems only (version 1), and the other one with both *-e-* and *-i-* stems, the latter for a first-person singular form of the novel verb (version 2). For both versions, participants were asked to fill in a third-person singular form of the novel verb (e.g., *Los campesinos acostumbran pervir el borpo. Yo pirvo el borpo moderadamente bien. Algunos_____ el borpo con gran agilidad* 'The peasants are used to pervir the borpo. I pirvo the borpo moderately well. Some of them_____ the borpo with great skill'). The results showed a clear contrast between the two experimental versions. In version 2, participants commonly extended *-i-* stems to third-person plural forms of novel verbs (= 78.5%), whereas this was not the case in version 1 (= 18.5%); instead *-e-* stems were significantly preferred over *-i-* stem forms ($Z = 11.25$, $p < 0.01$). These findings fit in with the observation that the *e~i* alternation is not fully predictable in Spanish; *agredir* 'to attack' and *transgredir* 'to breach,' for example, do not change to *-i-*. Linares et al.'s (2006) results are indicative of the restricted productivity of the marked *-i-* stem which is only extended to nonce words if a given item can be assigned to the lexical template for existing third-conjugation verbs. Otherwise, participants fall back on the unmarked *-e-* stem.

The limited productivity of marked stems suggests that they are not derived by rule-based operations from a single underlying base (as proposed, e.g., by Distributed Morphology), but instead, that these kinds of stem alternants are lexically listed. One possible way of formalizing the relations between lexicalized stems is through default inheritance hierarchies (e.g., Corbett and Fraser 1993). For example, in the Minimalist Morphology framework (Wunderlich 1996), lexical entries are structured and can comprise sub-entries which encode marked stems. Such sub-entries are assumed to be underspecified and inherit all information from higher

nodes, except for the features that they add or replace (i.e., their idiosyncratic phonological aspects, as well as specific morphosyntactic features). In this way, structured lexical entries can capture the distinction between an unmarked base stem, which is generalized by default, and a set of marked stems, which apply in restricted morphosyntactic contexts, and are generalized to novel forms only when they conform to the same lexical template.

Consider next the mental representations of combinatorial, unmarked stems such as those found in Italian and other Romance languages, which consist of a verb root and a theme vowel in one of three conjugation classes, *-a* for first conjugation, *-e* for second, and *-i* for third conjugation. The question here is whether some (or perhaps even all) conjugational stems have internal structure (i.e., [root + tv]) or whether some (or perhaps even all) stem variants are associatively stored in lexical memory (along with other morphologically complex word-forms). This question has been addressed by examining the generalization properties of different kinds of conjugational stems. For illustration, I will report some experimental findings on Italian and Portuguese.

Say and Clahsen (2002) used an elicited production task in Italian in which participants were asked to complete sentences with a participle form of a previously introduced novel verb. The novel verbs were constructed such that they rhymed almost exclusively with either regular or irregular forms of verbs of the second or the third conjugations. The rhyme *-end*, for example, is not only highly frequent in irregular second-conjugation verbs (e.g., *prend-ere* 'to take,' *attend-ere* 'to wait for,' *difend-ere* 'to defend,' etc.), it is also almost entirely absent from regular second-conjugation verbs and from both first- and third-conjugation verbs. In addition, a "No similarity" condition contained nonce forms that did not rhyme with any Italian verbs, but were phonologically legal. The novel verbs were presented in sentences in either a first singular (e.g., *cendo*), second singular (e.g., *cendi*) or first plural (*cendiamo*) present-tense form. These are forms in which the theme vowel is not present, giving no clue to class membership. Participants were asked to fill in participle forms of these novel verbs (e.g., *cend-a/-i/-u/-to*), thereby having to choose a theme vowel and assigning each verb to a conjugation class. The results showed that participles belonging to the second and the third conjugations were frequently produced in their expected high similarity contexts (~20% to 40% of responses), but almost never outside their corresponding similarity clusters. In contrast, first-conjugation participles were the preferred response in every condition, but especially so in the condition where nonce forms did not resemble Italian verbs (which elicited 90% of first-conjugation responses). Say and Clahsen argued that the results reflected the operation of two distinct mechanisms: an analogical mechanism, which applies to the non-default classes and is based on associations between stored stems of the second and third conjugations and their roots, and a default stem formation operation for the generalization of the first conjugation.

Other studies (Albright 2002; Eddington 2002; Colombo et al. 2006) proposed single-system accounts of conjugation assignment in Italian, using different kinds of computational implementations. What is common to these accounts is that novel verbs are assigned to conjugation classes through a single mechanism, on the basis of phonological similarity to existing verbs in the language. Although this mechanism produces human-like generalization patterns for second and third conjugation, the default behavior of the first conjugation is difficult to implement with these systems. In Colombo et al.'s (2006) connectionist network, for example, proportions of first-conjugation participles produced in response to forms similar to second- or third-conjugation verbs were much smaller than for human participants, indicating an oversensitivity of the network to phonological similarity. Likewise, while Eddington's (2002) model disprefers first-conjugation responses for nonce forms rhyming with high-frequency second-conjugation regular participles, the human participants tested by Say and Clahsen (2002) produced a majority of first-conjugation responses in such cases.

A weakness of many earlier generalization studies is that they adopted intuitive notions of similarity. Say and Clahsen (2002), for example, used "rhyme" as the criterion for establishing similarity, noting that rhymes were chosen to be exclusive to each conjugation class as far as possible. While previous analogical and connectionist models of conjugation class assignment have incorporated precisely defined similarity metrics (e.g., Eddington 2002; Colombo et al. 2006), these systems fail to account for the human data; see Clahsen and Veríssimo (2015) for a detailed discussion. A major step forward in this research comes from Albright's (2002) proposal of an algorithm for calculating phonological similarity, which also includes an evaluation metric for determining the success (or "reliability," in Albright's terms) of a given phonological pattern. This so-called Minimal Generalization Learner (MGL) algorithm has been applied to the English past tense (Albright and Hayes 2003) and to conjugation class assignment in Italian (Albright 2002), French (Bonami et al. 2008), and Portuguese (Veríssimo and Clahsen 2014). Bonami et al. (2008) tested conjugational stems in French in a judgment task in which participants were asked to rate whether second plural and infinitive forms of novel verbs presented next to each other "correspond." Unlike Say and Clahsen (2002) for Italian, they did not find a clear distinction between default-based and similarity-based generalization patterns; instead, participants' responses, even for the first conjugation, could best be accounted for by a novel verb's MGL reliability scores – in other words, by phonological similarity to existing verb forms. It is conceivable that the overt word-matching task Bonami et al. (2008) used may (at least partially) be responsible for their findings in that it engages participants in (metalinguistic) direct comparisons of the word pair's surface forms.

For Portuguese, Veríssimo and Clahsen (2014) assigned a (more natural) elicited production task to their participants in which they were presented with novel verbs in first-person singular present tense indicative forms

(which do not provide any clues to conjugation class) and had to produce infinitives (by necessarily assigning the root to one of the three verbal conjugations). Novel verb forms were constructed on the basis of the reliability scores of an MGL implementation of the Portuguese verb lexicon. The results revealed a dissociation between conjugation classes. Proportions of second and third conjugation responses were solely determined by similarity – in other words, their corresponding MGL reliability values. In contrast, the MGL reliabilities for the first conjugation did not reliably predict first-conjugation responses. Instead, the likelihood of a first-conjugation response was predicted by phonological similarity to the second and third conjugations, such that the higher the reliabilities for these classes, the lower the proportion of participants producing first-conjugation infinitives. Veríssimo and Clahsen (2014) also compared human performance on conjugational class assignment to the MGL model's predictions for the novel items under study. The results showed that the MGL model consistently underestimated first-conjugation responses and overestimated proportions of second- and third-conjugation responses. For example, for novel verbs that were more similar to the second conjugation, participants still produced a majority of first-conjugation responses (51% vs. 44%), whereas the MGL model predicted the inverse pattern: a majority of second-, rather than first-conjugation responses (35% vs. 57%), indicating the shortcomings of a purely similarity-driven model of morphological generalization.

At a more general level, the results of the experimental studies reported in this section are indicative of two mechanisms of linguistic generalization, a similarity-driven mechanism that is sensitive to phonological overlap and a variable-based mechanism that generalizes by default to all members of a given grammatical category.

4 Dissociating Inflection and Derivation

The question of whether derivation and inflection differ in any substantial way is controversial among morphologists. Distributed Morphology, for example, does not explicitly distinguish between derivational and inflectional processes, but instead attributes the construction of complex words to a single generative component, the syntax; see Matushansky and Marantz (2013) for reviews. Various inferential word-based theories of morphology, by contrast, assume distinct morpholexical representations for derived words that distinguish them from the products of inflectional or paradigmatic processes. In Anderson's (1992) theory of morphology, for example, derivational processes "constitute sources for lexical stems," whereas inflectional processes "introduce inflectional material into the surface forms of words" (Anderson 1992: 184-5). Other word-based approaches, such as Matthews (1972) and Stump (2001), establish a similar split between processes that define derivational stem entries and those that

define inflected forms. Hence, the outputs of derivational processes are words (i.e., entries stored in the lexicon), whereas the output of an inflectional rule is a feature-form pairing, not an entry. It should be noted, however, that even within word-based morphology, the question of whether there is a sharp split between derivation and inflection is controversial; see Spencer (2013) for relevant discussion.

What does experimental work on morphology have to say to this controversy? If there is one single generative component for deriving complex words (Matushansky and Marantz 2013) and no need for a principled distinction between inflection and derivation, we would expect to find parallel experimental effects, at least for productive inflectional and derivational processes. If on the other hand there is a split between entry-defining derivation and form-defining inflection (Anderson 1992), we would expect corresponding experimental contrasts between these morphological processes. Due to the fact that derivational (but not inflectional) morphology serves to form new lexemes, derived word-forms should demonstrate stronger lexicality effects than inflected word-forms in processing experiments. Response times for derived word-forms in the word/non-word lexical decision task should, for example, be particularly sensitive to whole-word (surface) frequencies. Furthermore, experimental techniques such as eye-movement monitoring in which the processing of morphologically complex words can be examined in sentence contexts should show semantic context effects, which should be stronger for derived than for inflected word-forms. Finally, neurocognitive experiments using brain measures—for example, electrophysiological techniques such as ERPs and brain-imaging techniques (e.g., functional Magnetic Resonance Imaging, fMRI)—should elicit more pronounced lexical-semantic ERP signatures and corresponding brain network activations for derived than for inflected word-forms.

Although much experimental research on morphological processing has focused on inflection, there are also many experimental studies investigating derivational morphology and some that have directly compared inflection and derivation. For English, Raveh and Rueckl (2000: experiment 2) found a full priming effect for inflected forms, and a reduced one for derivational primes. Raveh (2002) found the morphological priming effects to be modulated by frequency, with low-frequency inflections and derivations showing equivalent priming effects, and high-frequency inflections producing more priming than derivations. For German, a series of behavioral studies has produced an interesting pattern of similarities and differences between derivation and inflection. Regularly inflected word-forms such as *-t* participles and *-s* plurals were found to produce **full priming** and **no surface frequency** effects in unprimed lexical decision (Sonnenstuhl et al. 1999; Sonnenstuhl and Huth 2002; Neubauer and Clahsen 2009; Jacob et al. 2013). That is, in a priming experiment a plural form such as *Waggons* ‘coaches’ facilitated recognition of the corresponding base form *Waggon* as effectively as an identity prime, whereas in an

unprimed lexical decision task, a high-frequency form such as *Autos* ‘cars’ did not produce shorter lexical decision times than a low-frequency one (e.g., *Waggons*). Parallel to these experiments on inflection, a number of productive derived word-forms (-*ung* nominalizations, -*chen* and -*lein* diminutives, and *un-* adjective formations) were examined, each in both priming and unprimed lexical decision experiments (Clahsen et al. 2003; Clahsen and Neubauer 2010; Neubauer 2010). The pattern of results for these derived word-forms was parallel. Like regularly inflected word-forms, the outputs of productive derivational processes showed efficient stem-priming effects; the prime-target pair *Kindchen*–*Kind* ‘child-DIM-child’, for example, did not significantly differ from repetition priming (*Kind*–*Kind*), but unlike for inflected word-forms, high-frequency derived words yielded shorter response times in unprimed lexical decision than low-frequency ones. These results are hard to explain without positing a principled distinction between inflection and derivation and are more in line with the kinds of morpholexical representations for inflected and derived word-forms proposed by inferential word-based models of morphology (e.g., Anderson 1992; Stump 2001; Aronoff 2012). From this perspective, outputs of regular inflection such as -*t* participles and -*s* plurals are pure combinatorial forms (e.g., [*Waggon*]-*s*) which do not necessarily form lexical entries. Consequently these forms are more likely to produce decomposition than lexicality effects. Derivational processes, on the other hand, yield lexemes but maintain their internal morphological structure. Hence they produce both lexicality and decomposition effects.

Another source of experimental evidence for contrasting inflection and derivation comes from neurocognitive studies measuring brain activity for morphologically complex words, using both brain-imaging techniques (e.g., Božić and Marslen-Wilson 2010) and electro-physiological measures (e.g., Álvarez et al. 2011; Kielar and Joanisse 2011). In an fMRI study, Tyler et al. (2005) showed that -*ed* forms (compared to irregular past-tense forms) particularly engage both Broca’s and Wernicke’s areas, namely area 44 in the left inferior frontal gyrus and areas 21/22 in the temporal lobe. In contrast, derived word-forms showed increased neural activation in a distributed *bilateral* frontotemporal subsystem (which is responsible for whole-word lexical-semantic processing) without selectively activating the left-lateralized subsystem. The latter was even the case for fully productive and semantically transparent forms such as *bravely*; see also Božić et al. (2013) for additional evidence. These results provide *prima facie* evidence for the theoretical distinction between entry-defining derivational and form-defining inflectional processes. One problem with some of these brain-imaging studies is, however, that while special care is usually taken to match the materials for frequency, length, orthographic neighbourhood, and the like, materials used in experimental studies may be surprisingly diverse in linguistic terms, yielding uncontrolled possibly confounding factors. Kielar and Joanisse (2011), for example, included into

their so-called “fully transparent” condition items representing ten different derivational processes as target words (*-ness, -er, -ly, -able, -ment, -ful, -ity, -ation, -ion, -y*), some of which do indeed have additional meanings or stem changes that are not transparently related to their base forms. Collapsing diverse linguistic processes into broad categories in this way is perhaps not the optimal way of designing experimental conditions, particularly for derivational morphology.

A more promising approach is to directly compare closely related derivational processes that minimally differ in a small number of parameters. Havas et al. (2012) compared ERPs to derived nominals in Spanish (*-ez(a)* and *-ura* nominalizations) that differ in terms of their productivity and semantic properties but are similar in terms of their surface-form properties to straightforward morphosyntactic processes, namely gender agreement inflection in noun phrases. Recall that previous ERP research has led to the identification of distinct ERP components involved in lexical-semantic and grammatical (combinatorial) processing, N400 effects for the former and LAN/P600 effects for the latter. Havas et al. (2012) obtained a pattern of ERP responses for derived word-forms that differed from both the familiar lexical-semantic and grammatical ERP effects. Violations of derivational morphology elicited an increased N400 component, particularly for the less productive *-ura* forms (e.g., *verdura* ‘vegetables’ from *verde* ‘green’) plus a late positivity (P600). By contrast, gender-agreement violations produced the biphasic LAN/P600 ERP pattern known from previous studies of morphosyntactic violations. These results indicate that the processing of derived word-forms engages both word-level (lexical-semantic) and grammatical (decompositional) processes.

Derivational processes are different from inflectional ones in that in addition to grammatical recategorization, the outputs of derivational processes may also serve as labels to name concepts or objects, just like any other lexical item (Kastovsky 1986; Plag 2003). Cases of “labeling” yield semantically richer and often idiosyncratic meanings that are not predictable from their grammatical components. Baayen and Neijt (1997) examining large samples of newspaper texts in Dutch found that the different functions of nominalizations with *-heid* were correlated with their frequencies. While the highest frequency formations were cases in which *-heid* forms functioned as a semantic label with a specific meaning (e.g., *snelheid* ‘speed’), the lowest frequency formations were cases in which the derived form had a clearly transparent meaning (e.g., *onregeerbaarheid* ‘ungovernableness’). Baayen and Neijt (1997: 584) attributed this contrast to different lexical representations, morphologically structured ones for the latter (hence their compositional meanings), and whole-word representations for the former (hence their specific meanings, e.g., for *snelheid*).

An experimental study on the different functions of derivational processes comes from Clahsen and Ikemoto (2012) examining de-adjectival nominals with *-sa* and *-mi* in Japanese, which have parallel formal

properties but differ with respect to their semantic and functional properties. While *-sa* essentially serves to form nouns out of adjectives, *-mi* forms function as semantic labels with specific meanings. To take an example, while the nominals *tuyo-mi* and *tuyo-sa* are both derived from the adjective *tuyo-i* ‘strong,’ *tuyo-sa* simply refers to the degree of strength, a case of grammatical recategorization, and *tuyo-mi* has an abstract meaning denoting a virtue or talent. The results of the three experiments reported in Clahsen and Ikemoto (2012) revealed a detailed picture of how these word-forms are processed in (written) language comprehension. Experiment 1 used eye-movement monitoring during reading presenting *-sa* and *-mi* forms in semantically appropriate or inappropriate contexts. The results revealed shorter reading times for *-mi* than for *-sa* forms, but only in cases in which the context was compatible with the particular semantic labels of *-mi* forms. In contrast to that, parallel results for *-sa* and *-mi* words were obtained in the two-word recognition experiments in which word-forms such as *tuyo-sa* or *tuyo-mi* were presented in isolation without semantic context. Experiment 2 revealed whole-word frequency effects in unprimed lexical decision, and experiment 3 showed significant priming effects of similar magnitudes for these word-forms; see Fiorentino et al. (2015) for parallel results. These findings indicate that although *-sa* and *-mi* nominals have the same type of form-level representation, which are tapped by the two-word recognition experiments, *-mi* forms contain additional pointers to specific semantic labels, which become visible in the semantic context experiment. At a more general level, these results provide support for linguistic accounts of derived words that treat derivational processes as the result of combinatorial operations but (unlike regular inflectional processes) associate their outputs with lexical entries (e.g., Andersen 1992).

5 Morphological Paradigms and the Representation of Morphosyntactic Information

From the perspective of a morphologist, the main purpose of morphology, specifically of inflectional morphology, is to link syntactic objects or structures to phonological representations (Anderson 1992; Aronoff 1994; Carstairs 1987; Zwicky 1985; Stump 2001). In Stump’s (2001) realizational model, for example, inflectional morphology realizes or spells out syntactic features or entities with phonological forms. The objects to be realized (e.g., different inflected forms of the same lexeme such as *walk-s*, *walk-ed*, *walk-ing*) comprise a morphological paradigm (i.e., a multi-dimensional matrix consisting of slots defined by morphosyntactic feature values). Paradigms provide productive systems for generating inflected word-forms of any lexeme that belongs to a given syntactic category. The formation of paradigms is thought to be constrained by general principles of information processing (Wunderlich 1996; Kiparsky 1998). In Wunderlich’s account, for example,

paradigm entries are required to be maximally informative and avoid redundant feature specifications. Consequently, paradigm entries are underspecified, with direct paradigm specifications for positive feature values only. For a binary morphosyntactic category such as number, for example, plural forms receive a positive specification ([NUM: +PL]), whereas the corresponding singular forms do not require any extra specification for number, but instead receive a negative feature value ([NUM: -PL]), simply by virtue of their paradigmatic opposition to a positively specified form. Alternatively, from the perspective of associative models of language and language processing (e.g., Eddington 2002), surface forms are thought to be linked to functional or meaning representations, without directly encoding inflectional information. In connectionist models (e.g., Hare et al. 1995), the hidden layers of these networks have sometimes been interpreted to function as abstract representations that mediate between form and meaning (e.g., Goldsmith and O'Brien 2006), but even in these accounts paradigms and (potentially underspecified) morphosyntactic features are not conceived of as a distinct substrate of language knowledge and use.

Here, we will point to a number of experimental studies indicating not only that morphological paradigms and feature underspecification are sophisticated notions of linguistic description but also that they may contribute to better understanding of how inflected word-forms are used by the human language processor.

A number of experimental studies have used the unprimed lexical decision task to assess the role of inflectional paradigms for word recognition. The results are, however, partly contradictory. For Italian, Colombo and Burani (2002) and Traficante and Burani (2003) found that lexical decision latencies were correlated with the size of the inflectional paradigm. Adjectives, for example, which have relatively few inflectional variants (in Italian) were recognized faster than verbs which have richer paradigms. For Dutch and English, Baayen et al. (2006) and Moscoso del Prado Martín et al. (2004) found the opposite: word-forms from richer paradigms are recognized faster than words with fewer inflected variants; see also Milin et al. (2009) for discussion.

Priming and ERP studies have revealed a somewhat clearer picture, in support of the role of paradigmatic representations and underspecification of morphosyntactic features in language processing. A number of studies have examined German attributive adjectives such as *kaltes*, *kalte*, *kaltem*, *kalter*, *kalten*. These forms are inflectional variants of the lexeme *kalt* 'cold' that carry a portmanteau-affix expressing the grammatical features gender, number, and case, as for example in *kalt-em Wein* 'cold-masc.sg.dat. wine.' Leminen and Clahsen (2014) examined such forms in an ERP priming study with grammatically well-formed stimuli. Two morphological test conditions (e.g., *kaltes*–*kalte*; *kaltem*–*kalte*) were compared to corresponding repetition priming control conditions with identical prime-target pairs (e.g., *kalte*–*kalte*). The advantage of this design is that the prime-target pairs share

the same lemma across conditions so that differences in priming must be due to the inflectional exponents involved. Leminen and Clahsen's (2014) experiment 2 specifically compared priming from *-s* to priming from *-m* forms relative to *-e* forms. These exponents have different paradigmatic representations. While *-m* is restricted to just one case (= dative), *-s* forms occur in both nominatives and accusatives. Thus, the entry for *-m* contains a unique positively specified feature ([CASE: +Dative]) that is not present for *-s*, *-e*, or any other affix in the paradigm. Leminen and Clahsen (2014) found that differences in paradigmatic specificity between *-m* and *-s* forms were reflected in different ERP responses. Results from twenty-four native speakers of German who were asked to perform a same-different matching task on word pairs such as *kaltes–kalte* (with aurally presented primes and visually presented targets) revealed a significantly increased positivity for the *-m* prime condition in an early (200–300ms) time window after the onset of the target word relative to both the one with *-s* primes and the repetition priming condition. This early positivity could be identified as a P300 component, the amplitude of which is believed to reflect processing effort and cognitive workload (e.g., McDowell et al. 2003). Leminen and Clahsen (2014) argued that the observed P300 modulations for the different priming conditions correspond to the degree of morphosyntactic feature overlap in the prime and the target, in that a prime-target pair such as *kaltem–kalte* combines a dative form in the prime with a nominative/accusative form in the target, whereas a prime-target pair such as *kaltes–kalte* combines two nominative/accusative forms. The increased P300 for prime-target pairs with *-m* (relative to those with *-s*) reflects this difference in the morphosyntactic feature content of the prime words. Priming asymmetries have also been found in a behavioral cross-modal priming study (Clahsen et al. 2001a). Again, reduced priming effects were found for word pairs in which the target was an *-m* form with positively specified feature values (e.g., [+DATIVE]) and the prime word a related form of the same adjective that did not contain any such directly specified features. When presented as a prime, however, *-m* adjective forms did not produce any reductions in (repetition) priming. These priming asymmetries reflect paradigmatic oppositions, namely the distinction between affixes with positively specified features on the one hand versus affixes with negatively specified or unspecified features on the other hand. Taken together, the behavioral and ERP findings reported above provide experimental evidence for underspecified paradigmatic representations of inflectional exponents.

Other experimental studies compared responses to different kinds of ungrammatical word-forms to gain insight into the morpholexical representation of a lexeme's inflectional variants. Opitz et al. (2013), also examining attributive adjectives in German, recorded ERPs for ungrammatical Adj+N combinations relative to correct forms. They found contrasts in the ERP record for different kinds of ungrammatical feature combinations. Consider, for example, an expression such as *ohne besonderes*_[+masc, -fem] *Detail*_[+masc, -fem]

‘without specific detail,’ a singular neuter noun in an accusative context that requires *-s* on the attributive adjective. Opitz et al. (2013) compared the correct forms to incorrect ones such as (i) *ohne *besonderen*_[+masc,-fem] *Detail*_[-masc,-fem] versus (ii) *ohne *besondere*_[-masc,-fem] *Detail*_[-masc,-fem] and obtained a significantly larger left anterior negativity (LAN) for (i) than for (ii), both relative to the grammatically correct forms. This contrast corresponds to the different feature contents of the incorrect forms. While the feature specifications of the exponent *-n* in *besonderen*_[+masc,-fem] contains positively specified features that are incompatible with the subsequent noun, the maximally underspecified feminine exponent */e/* in *besondere*_[-masc,-fem] does not have any feature specifications that are in conflict with the noun’s gender, number, and case features. Opitz et al.’s (2013) finding that the magnitude of the LAN component is sensitive to these subtle differences in (un)grammaticality provides evidence for feature underspecification in inflectional paradigms.

Similar conclusions were reached by Penke et al. (2004) from an earlier behavioural study. Penke et al. (2004) used the sentence-matching technique in which participants had to decide as quickly and accurately as possible whether two visually presented stimuli are same or different. They reported an ungrammaticality effect (i.e., a delay in sentence-matching response time) when an inflected word-form was incorrect, but only for forms with positively specified feature values (e.g., for *-m* adjective forms). Additional mismatching negative feature values, for example in the case of *-e* adjective forms, did not produce any extra cost. Penke et al. (2004: 423) attribute these findings to the distinction between positively and negatively specified morphosyntactic features in the inflectional paradigm of German adjectives.

Inflected verb forms have also been experimentally examined with respect to morphosyntactic feature specification and paradigmatic representation. Consider a number of studies on German and Dutch. In German, person and number marking on finite verbs has three overt inflectional exponents that apply to all tenses and moods, *-st* for 2sg, *-t* for 2pl, and *-n* for 1pl and 3pl. The 1sg and the 3sg do not have overt person/number affixes in the preterite and the subjunctive. Only in the present tense indicative, they have different exponents, *-e* for the 1sg and *-t* for the 3sg. Note also that the 1sg *-e* form – pronounced as schwa – is optional in spoken German. Indeed, many speakers prefer 1sg forms without the schwa, such as *ich sag, trag, werd* ‘I say, wear, will.’ By contrast, elision of *-st* in 2sg forms (and indeed all other person and number exponents) is simply ungrammatical (*du *sag, *trag, *werd*). Clahsen et al. (2001b) examined these kinds of inflected verb forms in two cross-modal lexical priming experiments, one with *-st* and the other with *-e* forms as (visually presented) targets. The two experiments produced different priming patterns, similarly to the priming results for inflected adjectives reported above. While *-st* target forms yielded significantly longer recognition times when primed by *-e* forms (e.g., *lache–lachst* ‘laugh_[1sg present]–laugh_[2sg present]’) than the corresponding control condition

with identical primes and targets (e.g., *lache*–*lache*), the reverse test condition with *-e* forms as targets and *-st* forms as primes (e.g., *lachst*–*lache*) produced a full priming effect—that is, the same amount of facilitation as in repetition priming. Clahsen et al. (2001b) interpreted these findings as an effect of paradigmatic specificity. The reduced priming effect for *-st* targets was attributed to the fact that the feature set for the exponent *-st* contains a positively specified feature ([+2]) that is unavailable from *-e* primes. By contrast, *-e* targets are compatible with other inflectional variants, as these are phonological variants of the unmarked bare stems. For both inflected verbs and adjectives, exponents with highly specific feature sets, namely the affix *-m* in the declensional and the 2sg *-st* in the conjugational paradigms, are more difficult to prime than corresponding exponents with less specific feature sets, providing support for a paradigmatic analysis of these inflectional systems. Additional evidence for this comes from the results of a sentence-matching experiment on person and number inflection in German (Janssen et al. 2001) showing that violations with *-st* that contained a person and a number error (e.g., **wir park-te-st* ‘we park-pret-2sg’) produced significantly longer response times than violations of either person or number, indicating that the feature specifications of the inflectional variants involved affect response times.

Finally, a study by Bien et al. (2011) revealed effects of paradigmatic representation on the *production* of inflected word-forms. Using an implicit production priming paradigm, they investigated regularly inflected verb forms in comparison to deverbal adjective forms in Dutch. Bien et al. noted that while regularly inflected verb forms have a relatively rich paradigm with seven different variants ($-\emptyset$ _[1sg present]; $-t/-d$ _[2, 3sg present]; $-en$ _[present pl, infinitive]; $-end$ _[present participle]; $-de/-te$ _[past sg]; $-den/-ten$ _[past pl]; $ge- \dots -d/-t$ _[past participle]), the adjective forms have just two inflectional variants (singular, plural), a difference in what Bien et al. (2011) labeled inflectional entropy. They reported increased naming latencies for inflected verb forms (that come from paradigms with many inflectional variants) relative to adjectives (which have fewer variants). Hence, Bien et al. (2011) argue that this difference is due to the higher information load of a paradigm with many variants, which makes selecting an inflected variant from such a paradigm more difficult. Although this study provides *prima facie* evidence that differences in paradigmatic representation may also affect language production, it should be noted that Bien et al.’s account presupposes fully specified feature matrices for every single inflectional variant such as the ones shown above. If instead the verbal paradigm is represented in a more economical way (making use of feature underspecification), the differences between the verbal and the adjectival paradigms (in terms of inflectional entropy) will almost certainly turn out to be less dramatic than Bien et al. (2011) proposed.

Taken together, these results indicate that morphological paradigms are used by the human language processor and that models of

morpholexical representation which try to do without morphological paradigms are not supported.

6 Perspectives for Experimental Research on Morphology

In these final remarks, I will briefly sketch some topics that might become foci of experimental research on morphology in the near future. One such topic concerns the brain systems involved in representing and processing morphology. Several research teams are currently working toward developing precise neurocognitive models for morphology; recent studies from these teams include Božić et al. (2013), Fruchter et al. (2013), and Walenski et al. (2014). Although this research has not yet reached any definitive conclusions, most of the evidence currently available indicates that morphological processing engages two functionally distinct brain systems, one system represented in bilateral perisylvian brain areas that controls direct mappings of sensory inputs (e.g., orthographic and phonological codes) to full-form representations stored in lexical memory, and a second specialized left-hemisphere perisylvian system that supports morphological (de)composition, and more generally, combinatorial processing.

Simulation models are another promising line of research on morphological processing and representation. They force the researcher to formalize and specify every detail of a theory, in the form of a running algorithm. Furthermore, by using simulations, responses to experimental tasks can be tested against large-scale lexicons and a range of complex interactions or non-linear combinations of participant and item-level factors. Such predictions are quantitative as well as qualitative, which means that they can be directly compared to data produced by human participants. Implemented simulation models are available in different computational formats for a number of morphological phenomena; see Baayen et al. (2011) for a review.

Although morphologically complex words are typically used in sentence contexts, most previous experimental research has examined them in isolation, using, for example, word/non-word decision or naming tasks on single (inflected or derived) words. This is not only unnatural but may also lead to misinterpretations. Results from lexical decision tasks, for example, led to the claim that word-forms with homonymous affixes (e.g., -s in *walk-s*, which could be 3sg present tense or the plural form of a noun) or with affixes that are similar to non-morphemic word endings behave differently from word-forms with unambiguous affixes (e.g., Laudanna and Burani 1995). However, studies examining morphologically complex word-forms in sentential contexts, measuring for example eye-movements during reading (e.g., Kuperman et al. 2010) did not find any modulation of the reading patterns by factors such as affix homonymy and affix confusability, indicating that in sentential contexts in which readers may be able to anticipate

its morphosyntactic function, the potential ambiguity of an affix is less disruptive compared to the recognition of the same word-form in isolation. With techniques such as eye-movement monitoring and ERPs becoming more widely available in experimental psycholinguistics, theories of morphological processing will not only rely on results from single-word decision or naming tasks, but will also be informed by studies investigating morphologically complex words in context.

Another recent focus in this field of research is developmental studies of morphological processing. It is unfortunate that much previous research on morphological processing has exclusively been based on data from mature speakers, because adults only represent one specific case, the steady final state of a developing system, and it would be unwise to characterize the endstate of any cognitive system in a form that could not be reached by a feasible developmental process. Against this background, several research teams have begun to examine children's morphological processing using child-friendly adaptations of the experimental techniques familiar from psycholinguistic studies with adults; see Sekerina et al. (2008) for a review. To take a recent example, Clahsen and Fleischhauer (2014), investigating morphological priming in primary-school children, found the same stem-priming effects in children as in adults for regular inflectional processes, but developmental changes with reduced priming effects in younger children (relative to older ones and to adults) for irregular inflection. These results could mean that the basic computational mechanisms for morphological processing (e.g., stem-affix decomposition) are available to children in the same way as to mature speakers, and that developmental changes in performance are largely due the gradual growth of a child's lexicon including connections for word-specific (irregular) forms and advances in quickly retrieving these forms. It should be noted, however, that experimental research on children's morphological processing is still in its infancy and that a coherent picture has not yet emerged.

In any case, with these (and probably other) future perspectives, the experimental study of morphology and morphological processing will remain an exciting field of research.

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Computational Morphology

Lynne Cahill

This chapter looks at computational approaches to the study of morphology. Reflecting the dual nature of computational linguistics, it looks at both computational methods for testing theories and approaches to handling morphology for practical computational applications. The chapter starts with a history of the field and an explanation of two principal approaches. It continues with a detailed look at the methods of implementation used, followed by the range of applications in the field of Natural Language Processing (NLP) that have some reliance on morphological processing. Finally it presents the recent work which has seen the field to some degree split into approaches to typologically distinct language families.

1 A Brief History

1.1 Finite State Transducers and Two-level Morphology

The history of computational morphology has been dominated for many years by the Finite State or two-level approach. The work which triggered an explosion of work in this vein was the doctoral dissertation of Kimmo Koskenniemi (Koskenniemi 1983), although Kaplan and Kay (1981) had been developing the underlying ideas before this. Koskenniemi's work was revolutionary because it focused attention on the fact that morphology, especially in languages other than English, required more than simple concatenation. In fact, the concatenation, or affixation, aspect of Koskenniemi's model was not the aspect which was adopted by most people. The two-level aspect is what has been taken and adapted in much theoretical and applied work ever since.

The two-level morphology defined by Koskenniemi is more accurately described as morphophonology, as the two-level rules handle the morphophonological adaptations which accompany the morphological affixation processes. The model was initially developed to handle Finnish, a language

which has an extensive system of affixation or agglutination. The two-level rules define sets of Finite State Transducers (FSTs),¹ which are very simple computational devices that take an input string of symbols and map it to an output string. For example, a simple FST might match a string of lower case letters to a string of upper case letters thus:

Input string:	a	b	c	d	e
Output string:	A	B	C	D	E

Koskenniemi, Karttunen, and Kay realized that much of what happens in morphophonology (or morpho-orthography for that matter, on which more later) could very obviously be viewed as a case of input string (underlying form) mapped to output string (surface form). Thus, the idea of mapping an underlying string such as /kat+z/ to the surface string [kats] could be represented with a simple FST with the following input and output:

Input string:	k	a	t	+	z
Output string:	k	a	t	Ø	s

Of course, languages are often much more complex in their morphology, and in particular require deletion and insertion, which can cause difficulties in computational terms, but two-level morphology puts constraints on the kinds of things that can be defined to ensure a system that is computationally tractable.

One of the key features of the two-level model is that it can equally be applied to strings of phonemes (segments, sounds) or to strings of letters, and this leads us to one of the main areas of difference between the historical approaches of theoretical and computational morphology. The earliest work in computational morphology worked with written rather than spoken language. Early NLP applications were largely confined to processing written texts and so orthographic processing was required. This is in stark contrast to theoretical linguistics for which spoken language is primary. Indeed, until relatively recently, orthographic representations were not considered to be of interest to theoretical linguists at all. This focus on the written (or more accurately printed) word led to a focus on dealing with spelling rules (*cry+s~cries*) rather than the morphophonology ([kæts]~[dɒgz]~[hɔ:sɪz]). Of course, the two-level approach can deal with either as it simply views inputs and outputs as strings of symbols.²

The original two-level work was developed for Finnish, but it was rapidly applied to other languages with varying morphological systems, such as English (Karttunen and Wittenburg 1983), French (Lun 1983), and Japanese (Alam 1983). A further development was the work by Kay (1987) who

¹ A Finite State Automaton is a machine with nodes and arcs. To cross an arc from one node to another requires recognizing or processing the label on the arc. A Finite State Transducer is essentially the same thing but, instead of single labels, the arcs have pairs of labels representing the two levels which can be viewed as input and output.

² There is a whole other area of application using FSTs to map orthographic to phonological strings or vice versa and interesting interactions with morphology (see, e.g., Herring 2006) but this is not our concern here.

applied the framework to Arabic, introducing a system of three input tapes rather than one, to deal with the consonant roots, vowel inflections, and CV-templates which define different derivations. For example, the surface form /kattab/ ‘... wrote ...’ can be viewed as consisting of the three morphemes *k-t-b*, *a-a*, and *CVCCVC*. See Section 4.1 below.

The two-level approach has been used in numerous NLP applications. It has been used to represent many typologically very varied languages. However, for the average linguist wanting to try out their analyses of the morphology of a language, FSTs can be difficult to work with, despite various attempts to provide automatic compilation tools to take phonological rules and compile them into FSTs (e.g., Karttunen et al. 1987). This brings us to a rather different approach to computational morphology.

1.2 Default Inheritance and DATR

Default inheritance is particularly appropriate for representing the kinds of things that are characteristic of the inflectional systems of languages – that is, regular, sub-regular, and irregular behaviour (see Chapter 11 of this volume). The DATR lexical representation language (Evans and Gazdar 1996) makes use of default inheritance to represent this kind of behavior. In computational terms, DATR can be viewed as a higher-level language for representing relationships that can be reduced to FSTs. However, DATR represents a powerful way of capturing the relationships in a more compact and intuitive way.

While DATR is not restricted to use in lexicons or for morphological description, this is the original intended use and it has been widely used in this way. DATR itself is a language which can be used to define inheritance networks. To use a very simple example, consider the English nouns *cat*, *fish*, and *ox*. The plural forms of these nouns are formed differently. The first, *cat*, is regular and forms its plural by adding the regular plural suffix *-s* (we will ignore for now the question of spelling vs. pronunciation). The second, *fish*, belongs to a small class of nouns which has a sub-regular plural form with no suffix or adaptation. The third, *ox*, is fully irregular, having a unique *-en* suffix in the plural. We can view this situation as a hierarchy such as in Figure 29.1.

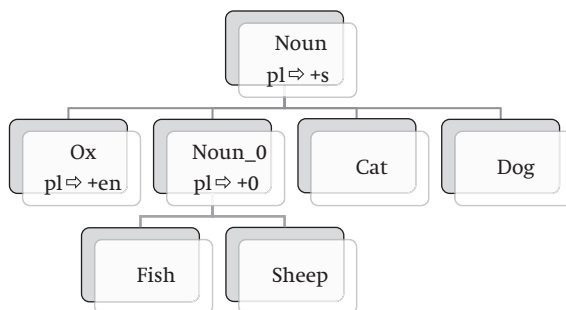


Figure 29.1. Simplified English plurals hierarchy

Table 29.1. *A hypothetical case system*

	Noun_1	Noun_2	Noun_3
nom	a	a	a
acc	b	c	d
gen	e	f	f
dat	g	h	h

In this very simplified diagram, the top node tells us that nouns, by default, form their plural by adding an *-s* suffix. *Cat* and *dog* inherit that information from this node (as would most regular English nouns). *Ox* also inherits by default from the noun node, but it has a statement that overrides the information about plurals, specifying its own plural suffix. *Fish* and *sheep* both inherit from the Noun_0 node, which itself inherits, by default, from Noun, but also specifies a different suffix, in this case a zero suffix.³ The fact that inheritance happens *by default* means that we can specify information high in the hierarchy and simply override it for any subclasses or forms to which it does not apply.

One of the key differences between these two approaches to computational morphology is the basic aim. The two-level approach makes use of computational techniques that are proven to be efficient and readily implementable. It offers a practical way of handling some quite complex linguistic phenomena in the development of NLP systems. On the whole, however, it contributes relatively little to linguistic understanding of the languages involved. The DATR approach, on the other hand, allows linguists to test their theories of how the morphological system of a language works. It is possible to define different sets of word classes with different quantities of information defined at different levels and test whether they produce the correct forms. More interestingly, it is possible to compare how many individual pieces of information need to be specified depending on the different decisions. The noun example above is too simple to really illustrate this, so let's consider a slightly more complex example. Suppose we have three noun classes which have different inflections for four cases, as in Table 29.1.

If we choose Noun_1 as our highest-level, “default” class then we have to define different values for three of the cases for both other noun classes, as in the DATR code:

```
Noun_1:
    <nom> == a
    <acc> == b
```

³ The example may make it appear that there is no purpose served by *Ox* and Noun_0 inheriting from Noun, but there will, of course, be other information shared by nouns, not least the syntactic category. See Chapters 11 and 28 of this volume.

```

    <gen> == e
    <dat> == g.
Noun_2:
    < > == Noun_14
    <acc> == c
    <gen> == f
    <dat> == h.
Noun_3:
    < > == Noun_1
    <acc> == d
    <gen> == f
    <dat> == h.

```

If, on the other hand, we choose one of the other classes as the default then we only have to define the accusative value for one class and three case values for Noun_1:⁵

```

Noun_2:
    < > == Noun_1
    <acc> == c
    <gen> == f
    <dat> == h.
Noun_1:
    < > == Noun_2
    <acc> == b
    <gen> == e
    <dat> == g.
Noun_3:
    < > == Noun_2
    <acc> == d.

```

Using a system such as DATR (or indeed FSTs) to test linguistic theories has several advantages. As suggested above, it allows us to measure things like the number of distinct pieces of information that need to be specified and thus how efficient our theory is. However, perhaps more importantly, it forces us to be complete in our theories. It is tempting as linguists to provide accounts of linguistic phenomena which leave some (peripheral, uninteresting, or overly complex) aspects unaccounted for. Computational approaches encourage us to deal with all aspects or at least explain what we are choosing to ignore and why. They can be particularly useful when the morphological system of a language is very complex. For example, the verbal morphology of Arabic is extremely regular (i.e., there is very little

⁴ The empty path "<>" here indicates "inherits by default from."

⁵ There may of course be other linguistic or psycholinguistic reasons for choosing a default which does not lead to the most economic representation of this type, such as the number of lemmas that belong to each class or the productivity of the class.

truly lexical irregularity),⁶ but the complexities (morphological, phonological, and morphophonological) are such that it is not always simple to determine what the rules are and how they interact. By implementing the rules computationally it is possible to test whether and how they interact to give the correct forms for a range of different verbal roots (see, for example, Cahill (2007)).

One question is whether it is really necessary to implement your theory or whether it is enough to be theoretically formal and explicit. On one level it is clear that exercising sufficient rigor in a linguistic specification of some specific phenomenon should be enough for that theory to be tested. When we are dealing with a relatively restricted area that may indeed be the case. However, as soon as our language models begin to reach a certain level of complexity, it is impossible to reliably account for all of the potential interactions between different rules or sets of rules without the aid of computer implementations. For linguists working on small detailed aspects of the morphology of a language, therefore, there may well be no advantage to using a computational implementation to test their theory. For anyone wanting to cover a broader scope, however, there may well be such advantages.

DATR has been used both for testing linguistic theories and as the basis of practical applications. The most prominent of the former is Network Morphology: for example, Brown (1998), Brown and Hippisley (1994), Fraser and Corbett (1997), as well as Chapter 18 of this volume; Luengen (1992) is another example. The latter include systems such as POETIC (Gaizauskas et al. 1992), CLIME (Evans et al. 2008), and ChartEx (Petrie et al. 2013).

1.3 Statistical Approaches

In NLP generally there has been an increasing reliance on statistical rather than symbolic approaches. Although these approaches are generally of less interest to the linguist interested in the nature of language, they have proved very effective for practical language engineering tasks. They are also pursued for the purpose of modeling the language acquisition process (see Chapter 27 and Chapter 28, Section 6), which is in its nature a form of unsupervised learning (e.g., Clark 2002). The basic premise of these approaches is that, if you have sufficient data then standardized machine learning techniques will “learn” the morphological patterns of a language sufficiently accurately to enable processing of novel words and occurrences. For example, if we have a large corpus of a language which has been tagged for part of speech and morphosyntactic information, such as tense, person, number, case, and so on, then statistical learning techniques will be able to match the patterns found in words that are tagged with the same morphosyntactic information and deduce the morphological processes in effect.

⁶ Although the “broken plural” is often viewed as irregular, it is in fact a case of phonologically determined alternation and can be handled in a rule-based way. See Cahill (2010) for a rule-based account of this.

Using tagged corpora amounts to supervised learning, as the process is assisted by the presence of additional information. Unsupervised learning involves using untagged corpora or raw text.

Supervised (or semi-supervised, depending on how much linguistic information is fed to the algorithm beforehand) learning of morphological systems has been undertaken in a number of ways, and there is a body of work aimed at automatically inducing DATR hierarchies (e.g., Barg 1996), which is based on making decisions along the lines of those illustrated in Section 1.2 above. Unsupervised learning, although very much a recent trend for much NLP, not only morphology, has a long history, with the earliest work going back to Harris' (1955) work on English. This was based on the assumption that affixes will represent unusually high frequencies of those particular combinations of phonemes. This work was further formalized by Hafer and Weiss (1974). More recently, Goldsmith (2000, 2001, 2006) developed a system *Linguistica*, which was initially only aimed at identifying suffixes (although it can be applied to other types of affixation), and was applied to English, French, Spanish, Italian, and Latin. Work to automatically learn the much more complex morphological system of Arabic using an unsupervised approach has used more sophisticated algorithms and has proved very successful (Khaliq and Carroll 2013). The advantages of using unsupervised approaches are twofold. As mentioned above, they can help in modeling the human language acquisition process, and so they can be informative for linguists and psycholinguists. From an engineering perspective, they require fewer resources and, in particular, do not require the labour-intensive manual tagging of corpora. This is particularly an advantage for languages for which there are fewer resources available and for which there is less inclination to fund expensive projects to develop those resources.

In the remainder of this chapter we discuss some of the decisions involved in approaching the implementation of morphological systems, review some of the practical applications of computational morphology within NLP systems and then take a look at some recent work that addresses specific issues relating to different language families with typologically different morphologies.

2 Methods of Implementation

The choices that need to be made when implementing either a system for testing theories or a practical NLP system will depend on a number of different parameters, such as whether our morphological component has to interface with particular other components, which language(s) we are interested in and whether we are dealing with spoken or written language. However, there are a number of key overarching criteria that must be considered. This section begins by discussing some of these key issues and the implications of the various choices. The second part discusses how the two main approaches mentioned above handle these decisions.

2.1 Key Issues

2.1.1 Procedural versus Declarative

The question of whether our account of morphological phenomena should be procedural or declarative is not as obvious as it might at first appear. The distinction is a fundamental one within computing. Procedural approaches are what we might consider to be canonical computer programs: follow a series of steps, undertaking a series of tasks each of which has an input and an output. Declarative approaches are perhaps best viewed as akin to a set of grammatical rules or constraints. To put it in simple morphological terms, it equates to the difference between saying that English plural nouns are formed by adding an *-s* suffix (procedural) and saying that the relationship between the singular and plural forms of English nouns is that the singular has only a root while the plural has the root and a suffix *-s* (declarative). This can be a rather subtle difference, and traditional Artificial Intelligence programming languages use both. Prolog, which has been used extensively in the past, particularly for NLP, is a declarative language in which all information is coded as a set of rules and processing information, such as interpreting a string of sounds, letters, or morphemes involves asking the computer to tell you if there is a solution to your query equation which complies with all of the rules or constraints you have defined.

2.1.2 Grammars versus Lexicons

This is a distinction which is relevant to various different language processing tasks, but is particularly crucial for morphology (see Chapter 10 of this volume). The Chomskyan view emerging from his early syntactic work (Chomsky 1957, 1965, discussed in more detail in Chapters 8 and 21 of this volume) was that anything that was rule-based should be a part of the grammar and anything that was idiosyncratic or irregular should be part of the lexicon. Thus, the “grammar” of a language included the rules of how to combine sounds, morphemes, words, and phrases, but word meanings and anything that was not regular in the morphological behaviour was defined in the lexicon, which was, for Chomsky, uninteresting. More recent approaches to both theoretical and computational morphology (and, indeed, Chomsky’s later work, such as Chomsky (1970)—see Chapters 8 and 21) have tended to take the view that languages rarely make such a clear-cut distinction. This has led to a move towards associating the rule-based behavior at all levels more directly with words and so including it in what we might call the lexicon. Indeed, some have chosen to take a “radical lexicalist” approach, viewing the grammar as largely if not totally redundant (Evans 2013).

2.1.3 Lexemes, Lemmas, and Word-forms

Whether or not we choose to include much of the rule-based information about morphology in the lexicon, we need to distinguish the very different senses of “word.” The fully inflected tokens that occur in natural language are the most straightforward to define and identify. In applications it is more difficult, and

especially in highly inflected languages, to identify the others. Do we need to distinguish stems and roots? Should affixes be considered as separate lexical entries with a similar status to stems or roots? Do we consider derivation and inflection as effectively the same kind of thing? Let us consider how these questions might apply within the relatively simple example of English. (See Chapter 3 of this volume for a thorough discussion of these distinctions.)

If we consider the word *unblocks* we can identify three distinct morphemes: *un+block+s*. In a computational account of English morphology, there are numerous different ways in which this could be analyzed.

1. We could posit three separate lexical entries, and provide a set of rules that include how and when to combine them as well as the concomitant spelling (or pronunciation) changes required.
2. We could posit a single lexical entry *block* which is combined with a prefix and a suffix, each of which has a similar status to each other but different from the root.
3. We could posit a lexical entry *unblock*, where the derivational process is considered to be fully lexicalized. We may want to include some link, maybe only at the level of semantics, between this lexical entry and the separate lexeme *block*.
4. We could, alongside 3, suggest a separate lexical entry *-s*, which can combine with it.⁷
5. We could posit a single lexical entry *block* which undergoes two affixation processes (assuming that affixation of some material is different from combining lexical entries, which might happen only in compounding).
6. We could posit a lexical entry *unblock*, which undergoes a suffixation process.

The decisions of how to deal with languages where there are distinctions between stems and roots, and between stems/roots and citation forms, and where the distinction between derivation and inflection is less obvious can be much more complex. The historical and semantic status of affixes also makes the decision more complex in many cases. As affixes frequently emerge via a historical process of grammaticalization from function words or even ultimately from full content words, these decisions can be based on somewhat fluid distinctions. Chapter 2 of this volume and Spencer (2000) discuss the relationship between morphology and the concept of the lexeme at some length. In terms of how this affects the implementational decisions, the crucial point is that we need to decide whether we are going to treat these different types of morphological material in the same way or in different ways, and if the latter, how many different ways.

⁷ The idea of an inflectional affix having the status of lexical entry might seem bizarre, but there is no *technical* reason why we should not approach the situation in this way. Cahill and Gazdar (1999), for example, treats inflectional affixes in German as having the status of lexical entry, although this does not necessarily equate in any theoretical sense with the status of lexeme.

2.2 Technological Approaches

Having made decisions about the criteria discussed above, the next step for the computational morphologist is to attempt an implementation. This section will not provide a tutorial on how to go about doing this, but will give a brief overview of implementational issues of the two main approaches presented above.

2.2.1 Finite State Transducers

As mentioned above, Finite State Transducers (FSTs) have been the predominant approach to computational morphology for several decades. There are a number of off-the-shelf packages that allow computational linguists to implement their own FST-based morphological analyzers or generators.

As an example, let's assume we want to produce a simple analyzer for English verbs. As a first step to devising our FST we might decide on a simple grammar which we wish to encode. A verb in English can basically consist of a stem or a stem and a suffix. The suffix must (obviously) be a verb suffix. We can express this with a single simple rule:

Verb $\rightarrow$ Stem (Verb_Suffix)

A Finite State Machine which implements this rule, with its optionality, should take the form of a collection of nodes and arcs and might look something like Figure 29.2, where the double circle around state 1 indicates that it is a legal end state (i.e., when we get to there we can assume the word is finished).

However, this is actually just a FSA (Finite State Automaton) which recognizes that a word is well formed (and it would also permit any number of affixes, which is not correct). An FST which extracts information and only permits a single suffix would look something more like Figure 29.3.

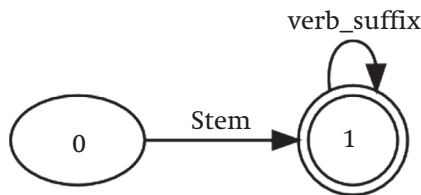


Figure 29.2. A simple Finite State Machine

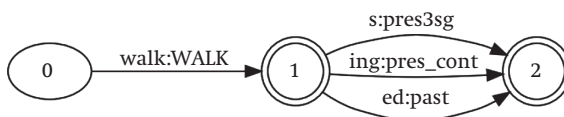


Figure 29.3. A simple Finite State Transducer

This FST recognizes the specific verb stem “walk” and transduces it to the semantic representation “WALK” and then does the same for a range of possible suffixes. Notice that it is possible for “walk” to be a whole word (indicated by the fact that state 1 is marked as a possible end state) but it is also possible for a single suffix to be present (any of “-s,” “-ing,” or “-ed”) as there are two possible end states.

For FST approaches the linguist is free to make the decisions about lexemes, lemmas, word-forms, and affixes and their respective statuses. In the example above, it would be possible to interpret the labels on the paths between the states as being essentially the same kind of thing, but it is equally possible to specify that those labels on the path between states 0 and 1 are stems or lemmas and have a different status from the labels on the paths between states 1 and 2, which are suffixes. In Koskenniemi’s KIMMO system the affixation is taken care of with a fairly simple set of “sub-lexicons,” each of which contains the possible morphemes that can occupy particular slots in words. The stems and affixes essentially have the same status in purely computational terms, but the linguist can specify the different status of the sub-lexicons. In terms of the procedural/declarative distinction, FSTs, despite being described as processors or machines are actually essentially declarative. The FSTs themselves merely define the relationships between input and output strings. In fact, Koskenniemi’s system was developed as a means of both analyzing and generating word-forms, which the declarative nature of FSTs permits.

2.2.2 DATR

The DATR language has been implemented in a variety of formats. Most implementations are based on Prolog,⁸ but there is no requirement that any system they are embedded within needs to use Prolog. In addition to the original DATR language (available at date of writing in Version 2.11.0).⁹

In a DATR-type inheritance-based approach the decisions discussed above are particularly important, but DATR itself does not impose any decisions on the developer. The principal objects used in DATR are nodes and paths. The standard way of using these is to have nodes representing the lexemes and paths representing ordered lists of the morphosyntactic features (see, for example, work in the Network Morphology tradition: Chapter 18 of this volume and Brown and Hippisley (2012)). For example, a typical DATR equation might specify:

```
Cat:<plural> = [ kats]
```

⁸ There are existing implementations for SWI Prolog, POPLOG Prolog, and Sicstus Prolog as well as an implementation in C.

⁹ www.datr.org.uk. The Kentucky adaptation, KATR, which allows paths to be unordered sets, is available at www.cs.uky.edu/~raphael/linguistics/KATR.html (accessed April 21, 2016).

However, nodes are also used for higher levels in the inheritance hierarchy, for word classes, such as Noun, Verb, and so on, and subclasses, such as Noun_0 as in the example above. There is nothing to stop the linguist from defining nodes for any representational level and that includes things at a lower level. It is possible to define word-form nodes which may inherit from what might be defined as lexeme nodes and indeed individual lexical entries for individual morphemes, whatever their status in terms of lexemes, stems, roots, or affixes, inflectional or derivational.

The German lexicon in Cahill and Gazdar (1999) has nodes for lexemes and affixes, but the status of the affix nodes is understood to be distinct. These are decisions that must be taken by the developer – DATR itself is only a tool for representing whatever distinctions and levels the linguist chooses.

The two-level approach has been used in numerous NLP systems. Systems like the Xerox Finite State Toolkit¹⁰ (which is available under both commercial and non-commercial licenses) and alternative open source versions, such as Foma,¹¹ allow both linguists and NLP developers to make use of the approach.

3 Applications

As discussed above, there are two principal reasons for doing computational morphology—to test theories and to contribute to practical NLP systems. In this section we focus on the latter, with an overview of the kinds of contributions computational morphology makes to a range of NLP applications. First we look at large-scale systems which require morphological processing as a part of the whole task and then we take a look at more specialized computational tools for more specifically morphological tasks. Finally we take a look at a series of competitions which have taken place in recent years with the aim of pitting different morphological systems against each other.

3.1 NLP Systems

When we talk about NLP, the usual assumption is that we are dealing with written language rather than spoken. Systems that process speech tend to take rather different approaches, and may be effectively bolt-ons to text-based NLP systems. We shall therefore deal with speech processing separately below.

NLP systems come in broadly three main varieties:¹² Natural Language Understanding (NLU) systems, Natural Language Generation (NLG) systems,

¹⁰ <https://open.xerox.com/Services/fst-nlp-tools> (accessed April 21, 2016).

¹¹ <https://code.google.com/p/foma> (accessed April 21, 2016).

¹² For the purposes of this discussion, Information (or Text) Retrieval (IR) is not included. Although some language processing is required for this task, generally the level of sophistication of the linguistic processing is fairly minimal and particularly limited in the case of morphology. The chief morphological task required by IR is lemmatization, which is covered in Section 3.2 below.

and Machine Translation (MT) systems.¹³ All three require some kind of morphological component.

NLU systems need to understand the linguistic structure of their input at the level of morphemes, words, sentences, and discourses. Evidence from psycholinguistic experiments as well as from aphasias in which grammatical processing is affected suggest that we are actually very good at making sense of much human language understanding without needing to process the details of morphology or syntax. We are able to understand because we have such a good notion of context, conversational behavior, and general world knowledge. Computers, on the whole, are rather lacking in that area, so they have much more need to understand the full grammatical intricacies of language. Imagine that you see the words “Girl paint picture.” You will probably assume that what is being implied is that a girl painted a picture. You assume this because you know that pictures don’t paint but that they are the result of painting. Similarly, if you see the words “Picture paint girl” you will probably assume that it is still the girl doing the painting and that this grammar-less “sentence” is actually a passive or some other kind of fronting construction and should have read “The picture was painted by a/the girl,” or something similar. That kind of knowledge is much harder to program into a computer than grammar and morphology rules, so computers tend to need good grammar and morphology processing.

The same is true for NLG. If a computer is going to generate correct language, it needs to have the correct morphology. For a morphologically relatively simple language like English, it would be technically possible to simply list the different forms of each word in the system’s lexicon. However, for a language with a complex morphology for which there may be potentially hundreds of distinct inflected forms for each noun or verb, for example, that is simply impractical. In those cases, it is essential to have appropriate morphological processing so that each word-form can be generated in its correct fully inflected form.

For MT, the issues are largely the same. If a system is going to translate between languages then it needs to both recognize the inflected forms in the source language and generate the inflected forms in the target language. There are automatic translation systems which are not perfect in their grammatical knowledge. They have a place and can be useful for getting a rough translation from an unfamiliar language, but a lack of sophisticated morphological knowledge can cause problems – sometimes amusing ones. If you put “Il a chanté avec ses amis” into Google translate it translates into English as ‘He sang with his friends.’ If you change the “friends” to be female, “Il a chanté avec ses amies,” it translates as ‘He sang with her friends.’ This is not

¹³ On one level MT can be viewed as a combination of NLU and NLG, but MT systems in practice may be implemented to do the translation more directly than this view warrants, so we treat them as distinct.

strictly incorrect, but it highlights one of the difficulties of machine translation. The French “ses” can be translated as “his” or “her” in English.

It is not only inflectional morphology that is important, either. Productive word formation processes such as compounding throw up novel forms which systems need to recognize. It is less important (and probably less viable or desirable) to expect systems to generate new words, but there may be situations where this is useful or even essential.

It was stated above that most NLP work involves text rather than speech and, indeed, the two communities working on text and speech are largely distinct. Nevertheless, research on speech analysis and synthesis does, or at least can, require morphological processing.

For most people, experience of speech processing applications comes in the form of dictation software (Dragon dictate, Siri, etc.) or automatic telephone systems which may recognize and/or generate speech with different levels of automatic processing. These systems may take one of two broad approaches. The first involves bolting a speech-to-text or text-to-speech processor on top of a NLU or NLG system. The second involves full processing from speech-to-concept or concept-to-speech. The first is much more widespread, and usually makes use of statistical approaches to the processing of acoustic signals. The use of linguistic information, even at the level of phonology is limited. However, even with such systems, morphological information can be extremely important. For example, knowing that the <s> in English is pronounced as voiced or voiceless depending on the sound that comes before it, but only when it is functioning as a suffix. Recognition of affixes can be used in word segmentation for speech recognition, as, for example, the presence of a suffix indicates the end of a word. The second approach is less well established and makes little, if any, use of morphological information.¹⁴

3.2 Specialized Tools

One of the major advances in NLP in recent decades has been the development of toolkits, or off-the-shelf tools for specific sub-tasks of the overall process. The GATE architecture (Cunningham et al. 2011) was developed at Sheffield University in the late 1990s, to provide tools and resources for text analysis. It provides an overall architecture into which specialized processing units can be “plugged” as well as a range of such units. This enables researchers to focus on individual tasks and yet still test the results within systems that perform the whole processing task. Perhaps more importantly, it allows for the testing of individual components against one another, so that it is possible to evaluate which of a selection of different

¹⁴ Speech-to-speech translation is another related area of development and again has the two broad approaches, with speech-to-speech via concept rather than text as a less well-developed option.

processing units, perhaps applying different theoretical approaches, performs the task better (within a particular system, at least).

In terms of morphological processing, the units of interest are units which break input words down into their component parts and identify the syntactic and morphosyntactic features of the words. The tasks themselves will be rather different for typologically different languages (see Section 4), but there are three principal kinds of morphological processing unit: part of speech taggers, lemmatizers, and morphological analyzers.

Part of speech (POS) tagging is one of the tasks within NLU which, it is widely acknowledged, has been largely solved. That is, there are automatic POS taggers which perform at least to the same level as human taggers. Given a piece of text, if we ask human annotators to tag them for their part of speech (from a given agreed set of tags) those humans will not always agree on the tags, particularly for peripheral and controversial cases. For this reason, when developing resources that are deemed to be the “gold standard,” it is important to measure inter-annotator agreement. The highest level of inter-annotator agreement reached for tagging English is between 96 percent and 99 percent. There are now POS taggers which also perform to this level. The CLAWS4 tagger (widely used for tagging English) achieves 96–97 percent accuracy, depending on text type, but most of the “errors” are cases of unresolved ambiguities (Garside and Smith 1997).

The early POS taggers used a variety of linguistic information, including identifiable affixes (if a word ends in *-ly* then it is probably an adverb), grammatical information such as function words (if a word follows a determiner then it is probably either an adjective or a noun) and punctuation/capitalization (if a word follows a full-stop then it is probably the beginning of a noun phrase, so likely to be an article). In more recent years the field of POS tagging has been dominated by statistical approaches, with systems being trained on human-annotated data. The most recent work in this area has focused on developing systems which will work for languages where there are limited resources, so that the amount of hand-annotated data is smaller.

Lemmatizers go one step further than POS taggers, identifying each individual word and associating it with a lexical entry or lemma. In the earliest versions this amounted to little more than stripping affixes (so *loves*, *loving*, and *loved* were all identified as belonging to the lemma LOVE with the only complication involving the presence or absence of the <e>). The term stemmer is often used to refer to tools which identified the stem by simply removing affixes. Now, however, largely inspired by the need for systems processing languages with more varied morphological systems, lemmatizers perform more sophisticated processing tasks, including recognizing the roots within templatic forms of Arabic, for example.

The next step in terms of sophistication is full morphological analysis. Knowing that *loves*, *loved*, and *loving* all belong to the lemma LOVE is all very well, but for many tasks it is essential to know that they differ in terms of

Table 29.2. *Comparison of POS tagger, lemmatizer, and morphological analyzer*

	POS tagger	Lemmatizer	Morphological analyzer
loves	V(erb)	LOVE	LOVE + pres + 3rd sg
loving	V(erb) or Adj(ective)	LOVE	LOVE + pres cont
loved	V(erb)	LOVE	LOVE + past

tense, aspect, or person/number. A full morphological analyzer will tell us this information. An example of a widely used morphological analyzer is the one for Arabic mentioned in Section 4.1 below (Buckwalter 2004). Table 29.2 shows the respective output for these three words as input from these three types of processor.

These tools may be used together or as alternatives in a variety of ways in NLU (or MT) systems. For example, a system may use a POS tagger to do a first pass over a text (or sentence) and then use the information gleaned from this pass to make the lemmatization or analysis easier. This would allow the other processing units to make use of the fact that a word is or is not followed by a verb, for example. Similarly, a lemmatizer may be used to deduce the likely lemmas before full morphological analysis is undertaken. Alternatively, a morphological analyser may be used on its own to do all of the processing. Which approach is chosen will depend on the language, the nature of the input and the required output.

3.3 Competitions

In many areas of NLP from the 1990s onwards there have been competitions to test the performance of systems against one another on common sets of data. The earliest of these were NLU (or Message Understanding) and Information Retrieval competitions which were organized by government agencies in the USA (Grishman and Sundheim 1996; TREC proceedings).¹⁵ The advantage of these competitions is that systems can be genuinely compared, since they are all being asked to perform the same task on the same set of data. Arguably the disadvantage is that it tends to result in many groups all focusing on solving the same task, potentially even in essentially the same way, rather than directing research effort across different problems. Nevertheless, the trend for such competitions has spread to the field of morphological processing. The first of these was the Morpholympics competition which was held in 1994 at the University of Erlangen (Hausser 1996). This competition focused on the German language. In 2003 a further Morpholympics took place, with Portuguese as the test language (Santos et al. 2003). Subsequently, there have been

¹⁵ <http://trec.nist.gov/proceedings/proceedings.html>.

several Morpho Challenge competitions, which were held annually between 2005 and 2010 (Kurimo et al. 2010). These only involved statistical systems, but covered a broader range of languages. The first, held in 2005, included Finnish, Turkish, and English, but only required systems to segment the input text into morphemes and was restricted to unsupervised (fully automatic) learning. The next, held the following year, added German and required further analysis to link variant forms of single morphemes. Arabic was added in 2007, and in 2010 semi-supervised learning was allowed. In each of these competitions, teams were provided with training and test data for each of the languages and evaluated against gold-standard analyses.

It is important to note that these competitions do not simply assess according to a single measure of “correctness.” There are two key measures, known as precision and recall. Precision measures how many of the answers a system gets are correct. Recall measures how many answers the system generates. Thus it is possible to trade off precision for recall or vice versa. A system might not make “guesses,” and so score very highly on precision but very low on recall. A standard method of combining the two scores to generate what is known as an *F-score* is used in order to give overall rankings, but developers of different systems may nevertheless choose to focus on one or other of the basic measures.

4 Languages

The computational morphology community increasingly is dividing itself along language typological lines. This section looks at recent work addressing the morphological challenges of four language groups:

1. Arabic/Semitic languages: work focusing on the “templatic” morphology of the Semitic languages
2. Chinese/East Asian languages: work focusing on word segmentation issues in languages like Chinese
3. European languages: especially work on Eastern European languages which is focusing on automatic (unsupervised) learning of morphological systems
4. African languages: work focusing on the highly inflectional Bantu languages.

Early approaches to computational morphology, largely for economic and political reasons, began with English as well as some other European languages and Japanese. As more different language families have been addressed there has increasingly been something of a split with people working on different language groups, with typologically very different morphological systems. These in turn present their own challenges to computational approaches, and researchers in these areas increasingly organize their own

workshops, conferences, and publications.¹⁶ In this section, we examine four specific areas of work relating to four different language groups: Arabic and other Semitic languages, Chinese and other East Asian languages, Eastern European (Slavic) languages, and the highly inflected Bantu languages.

4.1 Arabic/Semitic Languages

There has been an explosion of interest in computational approaches to Arabic morphological processing since the mid-1990s due in part to political events, but also to the recognition that Arabic is spoken by around 250 million people from North Africa across to the Persian Gulf, and to the availability of language resources such as large-scale corpora.

The Semitic languages have long been of interest to morphologists for their so-called “templatic” morphology. In the 1980s linguists (from McCarthy (1981) onwards) debated the best way to represent the consonantal, vocalic, and pattern tiers assumed to form the verbal and nominal morphology of most Semitic languages. In computational linguistics, the first to address the templatic morphology was Kay (1987), who proposed an extension to the two-level morphology of Koskenniemi (1983), which made use of three rather than one input tape to the FSTs, as mentioned above.

The early work addressed phonological, not orthographic, forms, so there was no need to address issues of Arabic script. Subsequent work has moved on to looking at orthographic forms, with questions relating to whether the script is vocalised or not. There are still problems with Unicode processing of Arabic script (as there are with the Brahmi derived scripts of South Asia) as there has not been full standardization, although these mostly affect mixed script processing.

As discussed in Section 1 above, Koskenniemi’s two-level morphology involved a series of FSTs with a single input tape and a single output tape. The implementation assumed sets of sub-lexicons which provided roots and affixes which were concatenated in the permitted order, with the FSTs handling the morphophonology. For the Semitic languages, the input to the FSTs consisted of three tapes: one had the consonants of the stem, one had the vowels of the inflection, and the other had the CV template which specified how the consonants and vowels were arranged. For example, a fully inflected form like /aktub/ consists of the three morphemes: k-t-b, a-u, and $V_1C_1C_2V_2C_3$. These can be arranged on three tapes which together correspond to the single output tape a-k-t-u-b.

Soudi et al (2007) is a collection of papers on computational morphological approaches to Arabic which gives a good overview of the state of the art at the time. It divides the work into two categories: knowledge-based and empirical. The knowledge-based methods include two DATR-based

¹⁶ The Association for Computational Linguistics has Special Interest Groups for various sub-areas and two exist for Chinese (SIGHAN) and Semitic languages (SEMITIC).

approaches (Al-Najem 2007; Cahill 2007), one using “lexeme-based” morphology (Cavalli-Sforza and Soudi 2007), and one stem-based, based on the SYSTRAN Arabic-English MT system (Dichy and Farghaly 2007). The empirical methods covered include machine-learning approaches which learn to identify Arabic roots by means of either supervised or unsupervised learning.

Cavalli-Sforza and Soudi (2007) include a treatment specifically of the weak verbs, which are verbs where one of the three root consonants is a glide and which behave differently from other roots. These are often viewed as irregular, but they are in fact regular, with rule-based behavior, the apparent morphological irregularities being phonologically conditioned. Cahill (2010) gives an alternative account of the weak verbs in the syllable-based framework.

One of the most influential researchers in the field of Arabic NLP is Tim Buckwalter. His transliteration system (Buckwalter 2001) is widely used and his freely available morphological analyzer (Buckwalter 2004) forms the basis of many systems.

Another very influential piece of work is that by Habash (2010) which addresses issues more broadly in Arabic NLP, but which includes a thorough introduction to the key issues and terminology involved in Arabic computational morphology.

4.2 Chinese and other East Asian Languages

Chinese is famous for having very little inflectional morphology at all. However, there is sufficient to make it an interesting challenge within NLP applications. As with Arabic, there are very different challenges for orthographic and phonological treatments of language processing in Chinese.

The key issue in Chinese NLP is the relationship between characters, morphemes, and words. Chinese script characters represent either words (as in the term “logograms”)¹⁷ or sound combinations derived from words. Crucially, characters do not correspond to units of linguistic organization. They combine to make morphemes and words, but these combinations are not represented in the spacing as words in alphabetic scripts are. This means that probably the most fundamental problem for Chinese NLP is word segmentation. To illustrate the problem, consider the following example from Wong et al. (2009):

香港 人口 多 ‘The population of Hong Kong is large.’

香港 人口 多 ‘Hong Kong people are talkative.’

The same sequence of characters can be interpreted very differently depending on how the string of characters is segmented. The issue is similar

¹⁷ The term “logogram” is the accurate one for Chinese script characters, rather than “ideogram,” since the characters represent words of the language rather than concepts or ideas.

to attachment questions in English, i.e. who has the telescope in the sentence “the boy saw the man in the park with a telescope”? There are heuristics which can be applied to the problem but, just as with the attachment examples, these are often defined in terms of general knowledge or common sense rather than strictly linguistic rules, which make them difficult to specify formally. The example above is explained by Wong et al by stating that the first interpretation would be more likely because the expression “□多” is less common and viewed as a slang expression, mostly used in Hong Kong only.

There are other challenges that are largely specific to Chinese morphological processing. The large number of possible characters makes the lowest level of word recognition apparently more challenging. However, in many respects this is not actually any more of a challenge than in alphabetic writing systems. Although a system processing English can identify an unknown word or morpheme as being composed of individual letters which are all recognized, this does not help in retrieving a meaning for the word or morpheme. Thus the issue of recognizing individual Chinese characters is more akin to the problem of recognizing English morphemes than English letters. The use of variants on the characters (there are broadly two sets of characters: the traditional and simplified) needs to be taken into account, but once again does not represent a significant problem. Similarly, the dialectal variation within Chinese is of a slightly different level from that in other languages, but still poses the same kinds of problem. Although the written versions of Mandarin and Cantonese use a common core of characters, the spoken varieties are quite distinct. Not surprisingly, there is also some degree of dialectal variation in the written versions.

Some other typographic challenges in processing Chinese texts, as outlined in Wong et al. (2009) are:

- Textual orientation: Chinese can be written right-to-left, left-to-right, or top-to-bottom.
- No case distinction: there is no upper/lower-case distinction to mark grammatical function.
- No distinction between native and transliterated words: borrowed words are transliterated using characters based on their pronunciation, but there is no a priori way of knowing which is which.
- No hyphens: there are no hyphens to indicate relations between morphemes.
- Number, date, percentage, and currency formats are different.

Approaches to the major problem of word segmentation broadly fall into two types: character-based and word-based. Character-based approaches largely use machine-learning techniques to learn from pre-segmented texts the probabilities of certain character combinations. Success rates of the systems in the word segmentation “bake-off” (Sproat and Emerson 2003) were mostly over 90 percent, suggesting that these techniques can be very reliable.

Word-based approaches involve a mix of rule-based and statistical techniques, including those which make use of lexicons to identify possible words and those which make use of grammatical information. See Wong et al. (2009) for more information about the different approaches.

4.3 Eastern European Languages

Recent work on Eastern European languages has focused on automatic, or unsupervised, learning of morphological systems as mentioned in relation to Arabic in Section 4.1 above. The basic idea behind this work is that data (either structured database data or unstructured corpus data) can be input to a system which will then deduce the morphological system of the language, including the various morphological paradigms, the patterns of realization, syncretism, and so on. The requirements for developing such systems include at least one example of a language for which there is sufficient data and a well-documented system in order to develop the algorithms and train a system on. The Slavic languages lend themselves well to this, as there are several languages which have complex inflectional systems and which are well documented, as well as several others which are not well documented to apply the resulting system to (see below about African languages for more on processing poorly resourced languages).

Sagot (2007) on Slovak and (2009) on Polish and Oliver et al. (2003) on Russian are examples of work in this tradition. They each describe methodologies to build computational lexicons for use in NLP systems by using unstructured (and untagged) corpora. One important feature of these approaches is that they are not, in fact, restricted to a particular language family, but can be applied to any language with a rich, and largely affixal, morphological system.

4.4 Bantu Languages

Computational work on Bantu languages has largely taken two forms: approaches to grammatical tone and approaches to the complex agglutinative morphology. The agglutinative morphology lends itself readily to treatments in the two-level FST tradition, as exemplified by Elwell (2008). The tone issues led to the development of the event phonology of Bird and Klein (1990).

The early work on two-level morphology was developed for Finnish, a similarly agglutinative language. The appearance of large numbers of morphemes, each of which represents a single, clearly defined morphosyntactic feature, makes agglutinative languages particularly amenable to FST-based accounts, which favour linear left-to-right processing. The challenge for FST approaches to Bantu languages is that there are often long-distance dependencies across morphemes within a word-form. However, this applies also to Finnish and so these problems were largely solved many years ago.

The issue of grammatical tone is more interesting and adds a complicating factor in some ways similar to the challenges posed by Semitic morphology. Grammatical tone is associated, not with individual segments, but with syllables, and can be subject to spreading. That is, a high tone marked on a stem may spread to a suffix in some cases (but not all). The conditioning factors for this spreading can be both phonological (is it a particular type of vowel or followed/preceded by a particular type of consonant?) or morpho-syntactic (the tone spreads to a number but not a case suffix).

A further challenge for the computational processing of Bantu languages is that the linguistic tradition treats the complex noun classes rather differently from the way noun classes and genders are treated in European languages. In contrast to the European way, singular and plural nouns tend to be classed as separate classes. For example, there might be a class 1 which includes singular humans and a class 2 which includes plural humans. While this might not seem a major issue (and in practical terms, it is not) it does lead to conceptual confusion when one tries to apply a framework in which noun classes are specified for their behaviour in terms of how they inflect for number, case, and so on.

Another aspect of computational morphology that is being explored in relation to African languages and mentioned above in relation to Eastern European languages is the application of techniques for developing applications with scarce resources. Many African languages (not just Bantu languages) have relatively sparse resources compared to the major European languages, Chinese, Arabic, and Japanese. This means that those NLP techniques which rely on large training corpora or large existing lexicons cannot be applied to these languages. The principal approaches to this issue involve bootstrapping systems and resources developed for (hopefully) similar languages or handcrafting systems. An example of the former is de Pauw et al. (2012). The most successful approaches make use of specific linguistic features of the language in question that are shared with better resourced languages and, in the case of many African languages, the process is helped by the fact that, in many cases, the spelling systems used are very similar and crucially shallow (i.e., transparent). The largely affixal nature of the Bantu languages also means that the algorithms developed for Slavic languages discussed above can also be applied to the Bantu language family. An example of the second kind is Hurskainen (1992), which was an early attempt to model Swahili morphology in a two-level system.

5 Summary

This chapter has given a brief introduction to the kinds of applications morphology can be used for in NLP as well as suggesting ways in which computational approaches can be used to test theories of morphology. The

field of computational morphology is constantly advancing in response to both linguistic imperatives and technological advances. When many of the key approaches discussed here were first being developed, issues of computational processing power and storage led to certain requirements that are simply not relevant today. The processing power in most people's telephones equates to what was once accommodated in a large main-frame computer. Information can be stored in "clouds," and the World Wide Web provides vast quantities of linguistic data in the form of corpora of varying types (see Chapter 24 for more on using corpora). It is thus inevitable that the technological techniques and applications discussed here will change rapidly in the future. Nevertheless, the theoretical underpinnings of the technologies described remain relevant to anyone hoping to use computational techniques either to process language for practical applications or to further develop theories of the nature of language and languages.

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