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Trading Spaces: Carving Up Events for Learning Language

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Abstract

Relational terms (e.g., verbs and prepositions) are the cornerstone of language development, bringing together two distinct fields: linguistic theory and infants' event processing. To acquire relational terms such as *run*, *walk*, *in*, and *on* infants must first perceive and conceptualize components of dynamic events such as containment-support, path-manner, source-goal, and figure-ground. Infants must then uncover how the particular language they are learning encodes these constructs. This review addresses the interaction of language learning with infants' conceptualization of these nonlinguistic spatial event components. We present the thesis that infants start with language-general nonlinguistic constructs that are gradually refined and tuned to the requirements of their native language. In effect, infants are *trading spaces*, maintaining their sensitivity to some relational distinctions while dampening other distinctions, depending on how their native language expresses these constructs.

Trading Spaces: Carving Up Events for Learning Language

If we are ultimately to understand how children learn to express the semantics of their language, we will need to understand the conceptual foundations on which those semantics rest (Mandler, 2004, p. 281).

Learning relational terms such as verbs and prepositions is fundamental to language development. Verbs, in particular, are centerpieces of sentences. Verbs and prepositions afford us the capability to describe static and dynamic relations between objects and participants in events (e.g., the cup is *on* the table or the dog is *chasing* the woman). In some languages (e.g., Korean), verbs are used to capture the spatial relations that English reserves for its prepositions. For example, while English uses a single preposition for “on” (as in “put a cap *on* a pen” or “put an apple *on* one’s hat”), Korean has many verbs for “on,” depending on what article of clothing is being put on, and how tightly the “on” relation appears (as a cap *on* a pen versus an apple *on* a table). The study of the acquisition of relational terms draws on literature from two distinct fields: linguistic theory and infants’ event processing. Research has begun to investigate the acquisition of relational terms (e.g., Casasola & Cohen, 2002; Choi & Bowerman, 1991; Golinkoff & Hirsh-Pasek, 2008; Lakusta, Wagner, O’Hearn, & Landau, 2007; Mandler, 2004; Pulverman, Golinkoff, Hirsh-Pasek, & Sootsman-Buresh, 2008) and this review considers what we have learned thus far. The issue we address is how learning a language interacts with the conceptualization of four nonlinguistic foundational constructs: containment-support, path-manner, source-goal, and figure-ground. Reviewing evidence

from four distinct domains, this paper offers new avenues for both theoretical and practical research.

What does it take to learn relational terms?

Relational term learning is a two-step process. First, infants must perceive the actions and events that languages express. Second, infants must learn which event components are encoded in their native language and how their language packages these components (Gentner, 1982; Gentner & Boroditsky, 2001; Gentner & Bowerman, in press; Golinkoff & Hirsh-Pasek, 2008; Tomasello, 1995). To do this, infants must perceive and individuate the actions within events, categorize these actions, and learn how to map words onto these actions (Golinkoff et al., 2002). Given that languages comment on different aspects of the same event, this is a daunting task. For example, to learn the verb ‘march,’ an English-reared infant must differentiate the act of ‘*marching*’ from, say, ‘*jumping*’. The Turkish-reared infant must make this distinction as well. However, the act of “marching” is encoded as a verb in English “*march into the class*” whereas in Turkish “*sınıfa yürüyerek girdi - go into the class *marchingly**”) it surfaces as an adverb – if at all. In her Natural Partitions Hypothesis, Gentner (1982) claimed that “lexicalizing” relational terms is more demanding than simply perceiving movement, connections between actors, and directional changes within events (Gentner & Bowerman, in press). Tomasello (1995) called this the “packaging problem”: the child must discern to which aspect of an event an adult is referring.

Foundational Constructs in Events

Talmy (1985) outlined a number of components that describe the relational terms codified across languages (see also Jackendoff, 1983; Lakoff, 1987; Langacker, 1987;

Talmy, 2000). Among them are *path* or the trajectory of an action with respect to a ground (e.g., over or under); *manner* or how the action is performed (e.g., jumping or rolling); *figure* (the moving or conceptually movable entity) and its relation to the *ground* (the reference entity or a stationary setting); *source* (beginning point of an event) and *goal* (ending point of an event). Other constructs refer to spatial relations (Choi & Bowerman, 1991; Talmy, 1985) like *containment* (putting things *in* a container) and *support* (putting things *on* a surface). Conceptual foundations such as these create the semantic bases for world-to-word relations.

This linguistic taxonomy for relational terms meets psychological theory in two dominant theories. Slobin (1996) suggests that languages are not “neutral coding systems of an objective reality” (p. 88). That is, the very same event will be described differently depending on the language. To learn to *think for speaking* (Slobin, 1996, 2001), children must notice the set of distinctions that speakers make in daily conversation. Thus, language learners pay attention to events and to how their particular language community encodes aspects of those events in the ambient language.

Mandler (1992, 2004) adopts an explicitly developmental perspective focusing on how children view the events that language will encode. She suggests that prior to language, infants construct *image-schemas* to store fundamental meanings that derive from perceptual meaning analysis (i.e., through attention infants redescribe perceptual information into a simpler form that reaches awareness). Common image-schemas are those of path, link, containment, and support, which are later combined to derive basic conceptual categories such as *animacy*, *causality*, and *agency*. For example, by noting a

figure's ability to rapidly change path (without apparent external impetus), infants come to identify animate objects.

These theories have in common that children begin by analyzing the events taking place around them and learn to focus on just those aspects that their language expresses. They differ in that while Slobin is agnostic to the source of the nonlinguistic constructs language encodes, Mandler considers these constructs to be conceptual "primitives," available very early in development. Here we present the thesis that infants start with language-general concepts that are gradually construed in language-specific ways. Sensitivity to distinctions in events becomes refined or abandoned as the conceptual framework makes contact with language. Therefore, infants bring new perspectives to their interpretation of spatial and event components. In a way then, they are *trading spaces* as they learn language.

Consider an imperfect analogy from the domain of phonological development. At the start of language learning, infants around the world possess an auditory system that affords them the ability to distinguish between phonemes in the world's languages, regardless of the language to which they are exposed (e.g., Eimas, Miller, & Jusczyk, 1987; Kuhl et al., 1997; Werker & Lalonde, 1988; Werker & Tees, 1984). However, exposure to the particular phonological contrasts of their native tongue apparently lessens the ability to make phonological distinctions that appear in non-native languages. Thus, "perceptual reorganization" (e.g., Galles-Sebastian, 2006; Kuhl, 2004; Werker & Tees, 1984) occurs when infants narrow the spectrum of sounds that they attend to between those encoded by their native language and those not encoded.

Infants might learn relational language in a similar fashion (for similar arguments see also Choi, 2006; Clark, 2003, 2004; Hespos & Spelke, 2007). They might notice a common set of foundational components of events regardless of the language they are learning. Then, influenced by distinctions encoded in the native language, they might focus on a subset of these components, just those that are relevant to their native language. Analogously, this phenomenon might be called “semantic reorganization,” in which *universal* perceptual constructs are *reorganized* to match the expressional tendencies of one’s native tongue. Language in this case would have the function of orienting infants’ attention to some relations in events over others.

To evaluate this thesis, we revisit some of the key semantic distinctions proposed by linguists (Jackendoff, 1983; Talmy, 1985) that are available in events and lexicalized across languages differently by relational terms. By examining ‘semantic reorganization’ across four domains, this paper offers a unique panoramic view of the interaction between infants’ nonverbal conceptual processing of nonlinguistic event components and their expression in language.

Processing Non-linguistic Foundational Constructs

An event can be defined “a segment of time at a given location that is perceived by an observer to have a beginning and an end and their relations” (Zacks & Tversky, 2001; p.3). Before infants process components of events like path-manner or source-goal, we need to ask whether infants use “events” as psychological units.

Research suggests that infants discriminate changes in patterns of motion (e.g., Bogartz, Shinskey, & Schilling, 2000; Cashon & Cohen, 2000) and remember specific patterns (Bahrick & Pickens, 1995). During the first year, infants can distinguish

biological from non-biological motion for both people and other mammals (Bertenthal, 1993; Arterberry & Bornstein, 2001), identify both rational and intentional actions (Csibra et al., 1999; Woodward, 1999), and reason about the physical interaction between objects such as causality (e.g., Leslie, 1982; Oakes, 1994). Infants also parse actions in events (e.g., Baldwin, Baird, Saylor, & Clark, 2001; Sharon & Wynn, 1998; Spelke, Born, & Chu, 1983; Wynn, 1996). Once infants attend to and represent events, they must also detect those aspects of events that are related to linguistic expressions (Clark, 2003).

To make the case that infants are sensitive to event constructs that will be realized differently across various languages, we need to illustrate how infants 1) detect the specific distinctions of event components realized in the worlds' languages, and 2) that they can categorize these components (Golinkoff & Hirsh-Pasek, 2008). We do not mean to imply that these are the only conceptual distinctions infants attend to when reasoning about events, but rather focus our work only on those constructs that are central to language processing.

Four event components closely examined in the literature are containment-support, path-manner, source-goal, and figure-ground. These constructs share three features. First, they are *perceptually* accessible to infants (Mandler, 2004). For these constructs to be useful for language, they must be noticed and categorized across different actors and locations. Second, these components are universally codified across languages (Jackendoff, 1983; Talmy, 1985, 2000). For example, the *path* of an event is expressed in many languages with verbs (e.g., *descend*, *exit*) and prepositions such as *into* and *across*. Third, while they are all linguistically expressed, languages differ in the ways

in which they encode these constructs (e.g., English uses climb *up* while Turkish uses *tırmanarak çıktı* “go up climbingly”).

The common features among these constructs, as well as the burgeoning empirical data in these four areas, allow us to discuss our thesis in an integrated way. Thus, we will present infants’ nonlinguistic conceptualization of these foundational constructs under four subheadings.

Containment-Support

A *containment* relation occurs when something is fully or partially surrounded by a container (e.g., in), and a *support* relation refers to the contact of an object on top of surface (e.g., on). Although many languages use terms similar to *in* and *on* in encoding containment and support, they express them in vastly different ways. In Korean, for example, containment and support events are labeled on the basis of tight or loose fit between the objects (i.e., degree of fit). The spatial verb *kkita* crosscuts the English categories of *put in* and *put on*, that describes a tight-fitting relation between the objects (Choi & Bowerman, 1991; Gentner & Bowerman, in press). Putting a ring *on* a finger and putting a book *in* a cover are both described with the verb *kkita* in Korean (Choi, 2006).

Using the dependent variables of both looking time and reaching behavior, Baillargeon and her colleagues show that by 6 months of age, infants are capable of discriminating the spatial relations of containment, support, occlusion, and covering (e.g., Aguiar & Baillargeon, 1999; Baillargeon, Needham, & DeVos, 1992; Baillargeon, 2004; Baillargeon & Wang, 2002; Hespos & Baillargeon, 2001a, 2001b, 2008; Hespos & Piccin, 2009). Further, even English-reared 5-month-olds distinguish between tight- and loose-fit events in both containment and support categories (Hespos & Spelke, 2004)

demonstrating that prelinguistic infants are sensitive to spatial distinctions that are not lexicalized in their native language. Hespos and Piccin (2009) also demonstrated similar patterns in covering events.

Six-month-old infants categorized containment relations (Casasola, Cohen, & Chiarello, 2003), but support relations were not categorized before 14 months of age unless the task was simplified as when the number of exemplars of the category was reduced (Casasola, 2005a). Additionally, both English- and Korean-reared 9-month-old infants categorized events observing the common degree-of-fit relation (i.e., tight- or loose-fit; McDonough, Choi, & Mandler, 2003), considering “a key in a keyhole” to be the same relation as “a cork in a bottle”.

Path-Manner

Path is defined as a figure’s trajectory relative to a ground and *manner* refers to how the action is performed. For example, in the sentence “John is *running into* the room,” John is the figure, *running* is the manner and *into* is the path of the event.

However, English often conflates motion with *manner* in the main verb (as in *running*) and expresses the *path* in a “satellite” prepositional phrase, as in, “... *into the room*.” In contrast, Turkish conflates the motion with *path* in the main verb (as in *girdi* “go into”) and expresses *manner* in a subordinated verb or adverbial phrase; *kosarak* “*runningly*.”

Seven-month-old English infants attend to path and manner changes in nonlinguistic dynamic events (Pulverman & Golinkoff, 2004). In particular, after being habituated to an animated starfish performing both a *path* and a *manner* (e.g., a starfish twisting over a ball), in test trials, infants increased their attention to both a *path* change (e.g., starfish twisting *under* a ball) and a *manner* change (e.g., starfish *spinning* over a

ball). Similar results were obtained from Spanish-reared and Mandarin-reared infants (Pulverman, Chen, Chan, Tardif, & Meng, 2007; Pulverman et al., 2008).

Infants also *categorize* paths and manners by 10 and 13 months of age, respectively, when these are performed in an invariant manner. For example, upon seeing the same path (e.g., under) presented with different manners (e.g., spinning, twisting, toe-touching; Pruden, Hirsh-Pasek, Maguire, & Meyer, 2004), children notice when the path changes but not when the manner changes in test events. Ten- to 15-month-old infants also formed nonlinguistic categories of two manners (i.e., hopping and marching) over five different actors (Song, Golinkoff, Seston, Ma, Shallcross, & Hirsh-Pasek, 2006).

Source-Goal

In a motion event, *source* refers to the figure's movement from a reference object by a variety of possible "from or away from paths." Thus, a source might be the chair from which the dog moves toward his bowl – the goal. *Goal* refers to the figure's movement to a reference object, using "to or towards paths" (Jackendoff, 1983; Talmy, 1985). Languages code goals more frequently than sources, possibly because the endpoint of an event is more important for further action.

Twelve-month-olds prefer to attend to goals rather than sources in nonlinguistic dynamic events (Lakusta, Wagner, O'Hearn, & Landau, 2007), corroborating the frequently reported goal-bias in the literature (e.g., Csibra & Gergely, 1998; Regier & Zheng, 2007; Woodward, 1998). Apparently, 14-month-old infants can form a category of goal, but not a category of source, involving different goal objects, spatial relations, and agents (Lakusta & Carey, 2008).

Figure-Ground

The *figure* in an event can follow any path or move from any source. The *ground* is a stationary setting with respect to a figure's movement. For example, in the sentence "John is walking across the street," John is the figure and the street is the ground. Notably, *figure* and *ground* are packaged differently in languages like English and Japanese. Japanese *ground-path* verbs such as *wataru* "go across" or *koeru* "go over", incorporate constraints on the physical geometry of the ground along with the direction of motion (Muehleisen & Imai, 1997). For example, *wataru* "go across" implies two things: 1) that there is both a starting point and a goal, and 2) that the ground should be a flat extended surface. The typical grounds for *wataru* "go across" are railroad, road, or bridge. In contrast, when the ground does not contain a barrier between two sides (e.g., a tennis court, grassy field) the verb *tooru* "go through" is used.

English-reared infants differentiate figures (e.g., a man or a woman crossing a railroad) and grounds (e.g., crossing a railroad vs. crossing a tennis court) in dynamic events by 10 and 13 months of age, respectively. Importantly, the same infants distinguish grounds that are coded differently by Japanese ground-path verbs (e.g., crossing a railroad vs. a grassy field) (Göksun, Hirsh-Pasek, & Golinkoff, 2008, 2009).

In sum, empirical data across these four domains suggest that infants possess a set of nonlinguistic constructs that form the bases for learning relational language. Infants appear to discriminate and form categories of these components of dynamic events. These four lines of research suggest criteria for good candidates of foundational semantic constructs when we move from linguistics to the study of event perception and language development.

The Role of Language

Once they isolate and categorize components in events, children need to lexicalize these event components in their native language. Language might assist toddlers how attuning their conceptual distinctions to their native language (Spelke & Hespos, 2002). Here, we explore three issues related to the role language plays in processing events: 1) how the vocabulary level of the child relates to perception of the event components; 2) how the presence of labels facilitates the abstraction of these constructs from events; and 3) how language learning interacts with the interpretation and expression of these components.

Vocabulary knowledge

One might expect that children's non-native analysis of event components would be inversely related to vocabulary level in their native language. That is, we might hypothesize that children who have more words in their lexicons relative to their peers might be worse at noticing non-native semantic distinctions whereas children with fewer words might still differentiate between event components not expressed in their native language. This assumption is similar to the weak analogy from phonetic discrimination. For example, English-reared 7-month-olds who were better at discriminating native phonemes, when tested at 14, 18, 24, and 30 months, produced a greater number of words and larger utterances with greater sentence complexity. In contrast, better *non-native* phoneme discrimination (Mandarin Chinese) predicted to reduced later language ability (Kuhl, Conboy, Padden, Nelson, & Pruitt, 2005; see also Tsao, Liu, & Kuhl, 2004).

Studies on event components confirm that vocabulary size correlates with the detection of non-native semantic distinctions. English-speaking 29-month-old children

with more words in their vocabularies relative to their peers, or the ability to produce the word *in*, were *less* likely to perceive the difference in the Korean degree-of-fit compared to low vocabulary children or those who did not yet produce the word *in* (Choi, 2006). In contrast, Korean-speaking children at the same age, and regardless of vocabulary level, still demonstrated sensitivity to tight- versus loose-fit containment categories. Likewise, Pulverman et al. (2008) found that 14- to 17-month-old English-reared infants who had greater vocabularies by maternal report were more attentive to *manner* changes than to *path* changes, which mirrors English's vastly greater number of manner than path verbs. On the other hand, Spanish-reared infants with low vocabularies paid more attention to manner than their high vocabulary counterparts. Spanish uses path verbs and has very few manner verbs. Perhaps the low vocabulary Spanish learners were still attending to the event component less frequently encoded in Spanish. Alternatively, attention to manner might delay Spanish-reared infants' ability to learn more verbs (Pulverman et al., 2006).

These findings taken together suggest that learning language dampens the detection of categorical differences that are not encoded in one's native tongue. To the extent that vocabulary is a reflection of native language learning, children who acquire more words are more likely to make native distinctions in events and less likely to make non-native distinctions.

Labeling a Target Event Component

Prior research has shown that labeling increases attention to objects (e.g., Baldwin & Markman, 1989) and facilitates categorization of both familiar and novel objects (e.g., Balaban & Waxman, 1997; Booth & Waxman, 2002, 2003; Fulkerson & Haaf, 2006; Waxman, 1999; Waxman & Booth, 2003). Does labeling promote or hinder the detection

of components in dynamic events? Pulverman, Golinkoff, Hirsh-Pasek, and Brandone (under review) presented 14- to 17-month-old English-reared infants with the same videos used to test children in silence by Pulverman et al. (2008), but using either a noun label (i.e., *He's a jame!*) or a verb label (e.g., *He's jaming!*) only during habituation. Hearing a verb, children increased attention to manner but not path in test trials, suggesting that a novel verb label selectively influences infants' event processing. Additionally, only a novel verb, but not a novel noun, enhanced attention to events. In a potential verb learning task with appropriate labels, English-reared infants increasingly attend to the most frequently expressed component of events in English: *manner of motion*.

Does labeling also facilitate infants' *categorization* of event components?

Casasola (2005b) found that hearing the familiar word "on" helped 18-month-old infants to abstract the category of *support* for both familiar and novel objects. Similarly, the use of a novel verb label (e.g., *javing*) aids *earlier* categorization of paths and manners at 7- and 10 months of age, respectively (Pruden & Hirsh-Pasek, 2006).

These findings suggest that both familiar and novel labels buttress the detection and categorization of foundational event components. Yet, the precise role of labeling in influencing the formation of spatial event categories is still unclear. Does labeling, for example, heighten the similarities between events?

Event Interpretation and Expression by Adults and Children

If language has an impact on which event components children attend to, perhaps it also influences how adults' and toddlers' perception of events in silence. This weak version of the Whorfian hypothesis predicts that people should interpret nonlinguistic

events differently depending on their native language. What does the research tell us about how adults from different linguistic environments interpret the same *nonlinguistic* events? Does the language they speak influence their perception? Studies suggest that Korean-, but not English-speaking adults, differentiated between tight- and loose-fit containment in a nonlinguistic discrimination task (McDonough et al., 2003; see also Hespos & Spelke, 2004). In contrast, Munnich, Landau, and Doshier (2001) did not find differences in nonlinguistic tasks for contact/support relations when testing English-, Japanese-, and Korean-speaking adults (see also Norbury, Waxman, & Song, 2008). The only difference among language groups appeared when people *named* these relations (but see Boroditsky, 2001; Boroditsky & Ramscar, 2002). Nevertheless, the ability to note non-native spatial relationships is not completely lost as adults' attention can be drawn to note these distinctions (Hespos & Spelke, 2004).

When do toddlers and preschoolers make language-specific interpretations of event components? Few studies have as yet examined this question. Maguire and her colleagues found that English-, Spanish-, and Japanese-speaking 2.5-year-olds preferred to extend a novel verb to the *path* of the action, but 3-year-olds speaking these languages presented more language-specific patterns of verb construal. For example, English-speaking children assume that a novel verb labels *manner*, Spanish-speaking children are less likely to interpret the novel verb as manner (Maguire et al., under revision).

This asymmetry in encoding non-linguistic event components also appears in children and adults' linguistic expressions of events. Choi and her colleagues demonstrated that starting at around 2 years of age, English- and Korean-speaking children use spatial terms for containment and support in language specific ways

(Bowerman & Choi, 1994; Choi & Bowerman, 1991). Similarly, children starting at 3 years of age encode language-specific patterns for path and manner (e.g., Allen et al., 2007; Papafragou, Massey, & Gleitman, 2006; Papafragou, Hulbert, & Trueswell, 2008; Özçaliskan & Slobin, 1999). For example, Papafragou et al. (2006) found that Greek-speaking children and adults mentioned the *path* of the motion significantly more than the manner, consistent with the dominance of *path* verbs in Greek whereas English speakers demonstrated the opposite encoding. The cross-linguistic analyses on the expression of source and goal indicate that both adults and children are more likely to talk about endpoints compared to starting points in motion events (Johanson, Selimis, & Papafragou, 2008; Regier & Zheng, 2007) as well as typically developing and deaf children manifest a goal bias in their use of language and sign, respectively (Lakusta & Landau, 2005; Zheng & Goldin-Meadow, 2002). Thus, an astounding and “universal” goal bias is maintained in both nonlinguistic event processing and linguistic descriptions presumably because languages code goals more frequently than sources (for Japanese findings see Lakusta, Yoshida, Landau, & Smith, 2006).

In sum, at around 3 years of age, children become language-specific event interpreters as they gain more experience with their native tongue. These findings suggest that children restructure the available nonlinguistic spatial constructs with respect to the language being learned.

Trading Spaces

This paper tracked infants’ nonverbal conceptual processing of nonlinguistic event components and how children learn about the way in which these events components are expressed in their native language. The literature suggests that infants

detect and categorize at least four conceptual categories described here by the beginning of the second year of life. With these constructs in place, the underpinnings for the learning of a language's relational terms are in place. As children lexicalize these components in their native tongue, they appear to tune into certain semantic distinctions over others, influenced by the ambient language. Furthermore, there is the suggestion that the more language they know, the more attentive they are to native over the non-native encodings of these constructs. *Trading spaces* occurs when a semantic component (such as containment or support) is semantically reorganized to match the expression of that component in the ambient language. In fact, the native language might play a causal role in how children divide their spatial world, as they gradually adopt the particular relational terms their language uses. Unlike in phonological development, however, reorganization in semantic development refers to the hierarchy of preferences people develop rather than to the loss of the ability to note these non-native event distinctions in the absence of lengthy training as adults (Tees & Werker, 1984).

Different from previous discussions about the similarities between phonological and semantic development that only hinge on the categories of containment-support (Choi, 2006; Hespos & Spelke, 2004, 2007), this paper adds force to the argument by extending it to the dynamic event components of path-manner, source-goal, and figure-ground. The view that semantic reorganization takes place in early development is systematically strengthened by the inclusion of other spatial event constructs.

Our analyses yield three broad conclusions. The first is that infants come prepared to divide the events in their world into a universal set of categories that are relevant to later language. They parse events and abstract these components in ways that lay the

groundwork for the learning of relational terms like verbs and prepositions (e.g., Göksun et al., 2009; Lakusta et al., 2007; McDonough, et al., 2003; Pruden, 2006; Pulverman et al., 2008). Moreover, and despite the fact that more research needs to be done, the research suggests that sensitivity to these constructs is universal in two senses: 1) irrespective of the language environment in which infants are raised, they detect non-linguistic components of events; and 2) infants attend to fine-grained distinctions in events even when these are not codified in their native language (Hespos & Spelke, 2004; Goksun et al., 2008).

The second conclusion is that, not all conceptual precursors emerge at the same time. Infants seem to be able to detect or categorize relations of containment earlier than support relations, path before manner, goal before source, and figure before ground (e.g., Casasola & Cohen, 2002; Göksun et al., 2008; Lakusta et al., 2007; Pruden et al., 2004). This apparent inconsistency in the developmental progression may be a function of which constructs are expressed more *universally* than others. That is, the more prevalent a distinction is across languages, the more likely it is to come early. Rather, the differential trajectories might reflect the perceptual saliency of some of the components over others. Regier and Zheng (2007) suggested that attention might shape language such that elements of events that universally attract attention might induce linguistic semantics. For example, the spatial configuration of a resulting event (goal) is more salient and accessible than a starting event (source). Thus, both non-linguistic visual discriminations and language encodings favor the endpoint of events across languages (Regier & Zheng, 2007). Just how much the perceptual environment influences language or how language

heightens attention to perceptual information is still hotly debated (e.g., Bowerman & Levinson, 2001; Li & Gleitman, 2002; Munnich et al., 2001).

The third conclusion is that, with development and increased exposure to the ambient language, children begin to package these non-linguistic constructs in the way that they are encoded in their native language (e.g., Allen et al., 2007; Choi, 2006). Children seem to interpret events along the lines of the statistical tendencies of their native language and assume that speakers will package language in ways consistent with their language. As Li and her colleagues suggested “Speakers will use differences in language patterns as a probabilistic basis for inferring how new words and sentences will relate to new objects and events... the words and sentences we utter map only very approximately onto the thoughts we mean to express, a truism that requires humans to apply considerable inferential analysis to make sense of the speech of their interlocutor” (Li, Abarbanell, Gleitman, & Papafragou, submitted, p.35). The orientation towards the native language’s distinctions and encoding system, *thinking for speaking*, can only occur after sufficient language is learned.

We are not here arguing in favor of a position that endorses Whorfian linguistic relativity (Whorf, 1956). That position proposes that the learned language affects the way people *think*. Rather, it appears that language exposure increases sensitivity to some aspects of events and influences the way people understand the language that they hear (for detailed discussions see Gleitman & Papafragou, 2005; Munnich et al., 2001).

Future Questions

We are beginning to discover the nonlinguistic constructs necessary for the learning of relational terms like verbs and prepositions. This paper offers a multi-

disciplinary approach to the semantic foundations for language by investigating evidence from linguistics, event perception, and language development across four categories of events. For our arguments to go through, research on conceptual precursors must be broadened to include other categories (e.g., force dynamics, causation, or distance). We suggested that good candidate semantic constructs should be perceptually accessible, universally seen in the world's languages, and "packaged" differently across languages. Few studies have asked how language influences event perception and whether the trend for infants is from universal to language-specific patterns. To validate our assertions about trading spaces, more cross-linguistic studies as well as studies with bilingual children are also required. Developmental patterns across typologically varied languages and ways in which children acquire the biases of their native language will shed light on the links between language and thought.

Little is known about the long-term consequences of perceiving and categorizing relations in events. Some of the research reviewed here is tantalizing for its links to language development. Longitudinal studies examining multiple conceptual precursors and their later relations to language development, specifically to verb learning, must be conducted. Preliminary results from ongoing research are promising: infants' ability to categorize foundational components in a nonlinguistic task of *path* and *manner* is correlated with verb learning, but not with a nonlinguistic spatial task (Roseberry, Göksun, Hirsh-Pasek, Newcombe, Golinkoff, Novack, & Brayfield, 2009). Finally, the mechanisms underlying relational language development might provide insights for at least two practical domains: second language learning and atypical language development. How might educators teach relational terms to second language learners

when these terms are notoriously difficult? Perhaps verbs and prepositions would become more transparent if taught in terms of semantic components (Infiesta, Song, Pulverman, Golinkoff, & Hirsh-Pasek, under review). Just as children do, second language learners must trade spaces for learning relational terms. This new perspective might have implications for how second language are taught.

A second domain is atypically developing children's acquisition of relational vocabulary. Studies show that children with autism have delayed language development, particularly in the learning of verbs (Chan, Cheung, Leung, Cheung, & Cheung, 2005). Possibly problems in the learning of relational terms are not specifically linguistic in nature but instead stem from difficulty with finding the precursors for verb meaning in dynamic nonlinguistic events. Our lab is currently investigating this question (Parish-Morris, Hirsh-Pasek, & Golinkoff, in progress).

Conclusions

Children's relational language acquisition has its roots in their understanding of nonlinguistic spatial and event constructs. Represented in the world's languages although expressed in different ways, these event constructs are the subject matter of the prepositions and verbs that name them. Children appear to distinguish between and categorize the components of events in a somewhat universal way. They then *trade spaces* based on how their native language expresses these relations. Thus, just as language learning narrows children's phonological space, language exposure promotes semantic reorganization, inclining children to focus on those relations that are uniquely packaged by their native language.

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