11 A WORLD OF RELATIONS
Relational Words

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Children climb on jungle gyms, run around trees, and kiss their parents. The everyday world in which we live is fundamentally dynamic, with events defined in terms of the relations that objects have to actions. When we label these events and relations, we use relational words that come in all forms. They can be nouns such as *brother*, *island,* and *passenger* (Hall & Waxman, 1993; Keil & Batterman, 1984; Maguire, Golinkoff, & Hirsh-Pasek, 2006) or more prototypical verbs and prepositions such as *climb*, *run*, *on*, and *around*, each of which cannot be defined without specifying the referent in relationship to another object. For example, the verb *climb* refers to the relationship between an agent and something being ascended, and words such as *on* and *around* are defined by a ground object. Importantly, understanding these relational terms is not only central to a complete theory of language, but is also the key to understanding how children link words and grammar (Lidz, 2006). Until recently, we knew little about when and how children acquire *any* relational terms (see Hirsh-Pasek & Golinkoff, 2006, for a review). This chapter examines how children learn relational terms through the lens of verbs and prepositions. After reviewing evidence that verbs and prepositions are particularly difficult to learn, we examine several hypotheses to explain this disparity. We conclude that although children have the foundations necessary to learn these words, they have trouble mapping relational words to their referents.

RELATIONAL TERMS

Relational Terms Are Learned Later

Many have documented the fact that relational terms such as verbs and prepositions lag behind nouns in vocabulary acquisition (Braunwald, 1995; Choi, 1998; Choi & Bowerman, 1991; Choi & Gopnik, 1995; Clark, 1996 ; Fenson, Dale, Reznick, & Bates, 1994; Huttenlocher, Smiley, & Charney, 1983; Nelson, 1989; Smiley & Huttenlocher, 1995; Tardif, 1996; Tomasello, 1987; Tomasello & Kruger, 1992; but see Bloom, Tinker, & Margulis, 1994). These data come from two sources. First, *natural observation* studies reveal more concrete object words than verbs in children's vocabularies, a finding that generally holds across languages (Tomasello, Akhtar, Dodson, & Rekau, 1997; Gentner, 1982; Bornstein et al., 2004; but see Tardif, 1996). Second, *experimental paradigms* conducted in the laboratory also reveal that verbs are harder to learn than nouns (Imai, Haryu, & Okada, 2002; Imai, Haryu, Okada, Lianjing, & Shigematsu, 2006; Imai, Okada, & Haryu, AQ1

2005; Meyer et al., 2003; Golinkoff, Hirsh-Pasek, Bailey, & Wenger, 1992; Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996).

Why Are Relational Words So Difficult to Learn?

In 1982, Gentner offered a framework to explain why verbs and other relational terms are generally harder to learn than words from other lexical classes such as nouns; Golinkoff and colleagues (1996) built on this framework. First, verbs are polysemous. They are more likely to have multiple meanings than nouns. For example, *Merriam-Webster's Dictionary* (1998) has over 72 entries for the verb *run*, but only 11 entries for the noun *ball*. Second, most objects can exist in a vacuum; that is, they can be labeled in the absence of any other referent. Actions, on the other hand, require the presence of either an agent or an object to make the action happen (e.g., something needs to traverse a path by a certain manner). Third, attaching (or mapping) a word to an object is guided by clear principles that are rarely violated. For example, the whole object assumption (Markman, 1991) holds that children as young as 12 months of age attach a novel label to entire objects rather than subparts (Hollich, Golinkoff, & Hirsh-Pasek, 2007). Children who hear labels in the presence of an agent or object engaged in an action are faced with the problem of determining whether the label maps to the *entity* or to the *action*, thereby increasing processing demands and slowing down the mapping process (Kersten, Smith, & Yoshida, 2006). Fourth, children must decide which element of the action is being labeled: Is it the *manner* (how the action is performed) of the action or the *path* (i.e., where the object is going)? Any number of event components could be packaged into a given verb, and the particular components that are packaged differ cross-linguistically. Fifth, verbs label actions, and actions are more likely to be ephemeral. Nouns, on the other hand, generally label concrete objects such as cars and cakes (Langacker, 1987; Slobin, 2001; Smith, 2000). Sixth, actions are often labeled before or after an action has taken place (Tomasello & Kruger, 1992). Finally, children learning different languages hear different proportions of nouns and verbs from their caregivers. English-speaking caregivers of 12- to 36-month-old children, for example (e.g., Blewitt, 1983; Ringler, Trause, Klaus, & Kennell, 1978; Shipley, Kuhn, & Madden, 1983), include more nouns at 18 months than at 27 months of age (Furrow, Nelson, & Benedict, 1979). This change is reflected in the proportions of nouns and verbs present in children's vocabularies from 15 to 35 months of age (Casasola et al., 2006; Sandhofer, Smith, & Luo, 2000). Cross-culturally, children in the United States tend to hear proportionately more nouns than verbs, whereas children in China hear an equal number (Tardif, 1996).

Taken together, these findings lead to three hypotheses for why it might be more difficult for children to learn verbs and prepositions than nouns. First, according to the *conceptual prerequisite hypothesis*, children might not have the conceptual foundations necessary to learn verbs and prepositions. That is, they might not be able to isolate *climbing* from the scene in which a child runs to a slide, climbs a ladder, and slides down. Second, according to the *mapping hypothesis*, children might experience difficulty connecting words to the events they isolate (Gentner, 1982; Gentner & Boroditsky, 2001). That is, they might be able to focus on the action of *climbing*, and even hear the word "climb," but may not be able to link the word to the world. Third and finally, concordant with the *differential input hypothesis*, children learning Western languages might be slower to learn relational terms such as verbs because they hear them less frequently, whereas children who are exposed to languages such as Mandarin, which have a higher proportion of verbs in the input, will learn verbs earlier (Tardif, 1996; Tardif, Gelman, & Xu, 1999; Tardif, Shatz, & Naigles, 1997). We are only beginning to investigate how the differential input hypothesis interacts with other factors to facilitate verb learning (Ma, Golinkoff, Hirsh-Pasek, McDonough & Tardif, 2009), so this chapter seeks to answer the question "Why are more-relational words such as verbs and prepositions harder to learn than less-relational words such as nouns?" by examining evidence in support of the first two hypotheses: the *conceptual prerequisites* and *mapping* hypotheses.

THE CONCEPTUAL PREREQUISITES HYPOTHESIS

Despite their relatively straightforward appearance, verbs and prepositions do not unambiguously label actions. Rather, they label a subset of what occurs when an action or spatial relation takes place—what we call "semantic components." These semantic components include *path* (the trajectory of the object or agent; e.g., come, approach, enter), *manner* (the way in which an agent moves; e.g., walk, dance, swagger, sway, stroll), *motion* (the general fact that motion is taking place), *figure* (the primary agent or object in the event; e.g., the dog/person/car), *ground* (the reference point for the event's path; e.g., a chair, the food dish, a parking lot), and *cause* (the cause of the figure's motion; e.g., being pushed; Talmy, 1985, 2000).

Relational words in languages across the world encode the semantic components of actions and events differently (Slobin, 2001; Talmy, 1985; see also Langacker, 1987; Slobin, 2001; Gentner & Boroditsky, 2001). Although the components *path* and *manner* are encoded by relational terms in many languages of the world, some languages emphasize one component over the other (Jackendoff, 1983; Langacker, 1987; Talmy, 1985). For example, English tends to package motion and manner in its verbs (as in *jump*) whereas Spanish tends to conflate motion and path in its verbs (as in *exit*), often not mentioning the *manner* by which a person leaves. These cross-linguistic differences mean that to learn their native tongue, infants must differentially attend to the ways in which semantic components are encoded in the ambient language. Consequently, infants may need considerable linguistic experience before they notice which components are encoded in the relational terms of their particular language, and are able to package these components into relational words.

Do prelinguistic infants have access to the semantic components that underlie relational language? Some speculate about the ability of infants to perceive and discriminate the components of actions and spatial relations, and suggest that children possess the conceptual prerequisites necessary for relational word learning from an early age. In fact, Gentner (1982; see also Gentner & Boroditsky, 2001) hypothesizes that such prerequisites might be in place during infancy. Gentner (1982) states that

> relations that act as predicates over objects are, I suspect, perceived quite early. Movement, change, directionality, and so on, seem quite interesting to infants. . . it is not perceiving relations but packaging and lexicalizing them that is difficult. (p. 326)

Others suggest that "the young child's conceptual repertoire may be rich and varied enough from the start" (Snedeker & Gleitman, 2004, p. 261). Additionally, some contend that children are equipped with an abundant conceptual base at a very young age (Jackendoff, 1983; Mandler, 1991, 1992, 2004). These hypotheses have only recently been put to the test.

Research suggests that infants are keenly aware of movement and use movement to individuate objects and actions (Wynn, 1996; Sharon & Wynn, 1998). Even if infants are able to perceive and discriminate the semantic components of actions and spatial relations that become the referents of relational words, this is not the end of the task for babies learning language. As Golinkoff and colleagues (2002) point out, children must not only discriminate between the semantic components of relations, but must also be able to form categories of actions to learn and extend relational terms. The analogy with object nouns is clear (Oakes & Rakison, 2003). Just as the noun "apple" refers to the apple I just ate, it also refers to an apple in the store and the apple on a sign and an apple in a storybook. Similarly, the verb "squish" can refer to squishing a bug, squishing blueberries, and squishing yourself into an overfilled Mini Cooper. Verbs, then, do not label single actions, but rather refer to categories of actions and events. Categorization is a useful heuristic device that allows language learners to approach the world in an organized fashion; that is, rather than requiring a new concept and a new label for every instance of "squish," infants who are adept categorizers can analyze an event and call up the proper category of similar events. For example, "squish" might call to mind a number of instances of overly tight relations under which the current situation may be evaluated and understood. Rather than processing the current instance of "squish" as a completely novel event, infants call upon their knowledge of categories—thereby reducing processing demands. This suggests that after children develop the ability to attend to actions and parse them into distinct action components, they must detect similarities across such actions and categorize them efficiently. Only then are they ready to attach a relational word to an action.

We will now evaluate the conceptual prerequisites hypothesis using evidence from research on how babies discriminate and categorize events and spatial relations. Four sets of relations have been studied most extensively: (1) containment, support, and degree-of-fit, (2) path and manner, (3) source and goal, and (4) figure and ground.

Containment, Support, and Degree-of-Fit

Three spatial relations, *containment*, *support*, and *degree-of-fit*, have commanded much attention in recent years (Aguiar & Baillargeon, 1999; Baillargeon, 1998, 2001, 2002, 2004; Baillargeon & Hanko-Summers, 1990; Baillargeon, Needham, & DeVos, 1992; Baillargeon & Wang, 2002; Casasola, 2005a,b; Casasola & Cohen, 2002; Casasola, Cohen, & Chiarello, 2003; Casasola & Wilbourn, 2004; Casasola, Wilbourn, & Yang, 2006; Choi & Bowerman, 1991; Choi, McDonough, Bowerman, & Mandler, 1999; Hespos & Baillargeon, 2001a,b, 2006; Hespos & Spelke, 2004; Wang, Baillargeon, & Brueckner, 2004). *Containment* is defined as "something in any fully or partially enclosed space... bounded space with an inside and an outside" (Mandler, 2004, p. 78). In English, this spatial relation is lexicalized by the word "in." Lexicalized by the English word "on," the spatial relation *support* is "when the figure is in contact with—typically supported by, attached to, or encircling—an external surface of the ground" (Choi et al., 1999, p. 247). *Degree-of-fit*, on the other hand, makes a distinction between interlocking surfaces (e.g., tight-fit) and noninterlocking surfaces (e.g., loose-fit; Bowerman & Choi, 2003).

Containment, support, and degree-of-fit are especially interesting spatial relations because they are packaged in very different ways across languages. English speakers lexicalize the distinction between containment and support relations, but do not consider degree-of-fit. For instance, English speakers use the word "on" to mark both an instance of tight-fitting support and loose-fitting support. In the Korean language, speakers lexicalize the distinction between tight-fitting and loose-fitting relations, collapsing across containment and support. That is, Korean speakers use the word "kkita" to denote both tight-fitting containment (e.g., fitting a peg *tightly* into a hole) and tight-fitting support (e.g., fitting one Lego® *tightly* onto another).

Discrimination of Containment, Support, and Degree-of-Fit

Abundant research suggests that infants have some understanding of containment and support relations at an early age. A classic series of studies by Baillargeon and colleagues was among the first to examine infants' basic knowledge about containment and support relations (Baillargeon, 1998, 2001, 2002; Baillargeon & Wang, 2002; Hespos & Baillargeon, 2001a,b; Wang, Baillargeon, & Brueckner, 2004). Recently, Hespos and Baillargeon (2001a) showed that 2.5-month-old English-learning infants have a rudimentary understanding of both containment and support relations. Furthermore, these very young infants can reliably discriminate between possible and impossible containment and support situations, despite having no prior habituation or training in the laboratory. This suggests that 2.5-month-old infants enter the laboratory with knowledge of containment and support events—relations lexicalized in most languages.

In one study, infants were shown two types of events. In the possible event condition, infants viewed a scene in which an object was lowered into an open container. In the impossible event condition, infants saw the same object lowered into a closed container. Infants looked reliably longer at the impossible event, indicating that they were surprised when their expectations about a containment event were violated (Hespos & Baillargeon, 2001b).

Recent research also documents the ability of infants to discriminate spatial concepts that are *not* typically codified in their native language (Hespos & Spelke, 2004). For example, 5-month-old infants exposed only to the English language appear to be sensitive to the degree-of-fit feature, a distinction that is not marked in their native language. During habituation, infants viewed either objects fitting tightly or loosely in a container. At test, infants were shown both the familiar relation they had seen during habituation and a novel relation. For example, infants shown tight-fitting containment during habituation viewed this same familiar relation (i.e., tight-fit) and a novel relation (i.e., loose-fit) at test. Infants showed a marked increase in looking at the novel relation during the test phase, which indicates that they discriminate between tight-fitting and loose-fitting containment (Hespos & Spelke, 2004). These findings suggest that infants may be predisposed to pay attention to the kinds of spatial relations that are relevant to learning *any* language in the world.

Categorization of Containment, Support, and Degree-of-Fit If infants have the capacity to recognize and discriminate the spatial relations containment, support, and degree-of-fit by 5 months of age (Baillargeon, 1998, 2001, 2002; Baillargeon & Wang, 2002; Hespos & Baillargeon, 2001a,b; Hespos & Spelke, 2004; Wang et al., 2004), when are they able to group these relations into language-specific categories? Recent evidence from Casasola and colleagues (2003) suggests that by 6 months of age infants can form categories that include multiple instances of containment. Using a habituation paradigm, infants were shown four different events in which a containment relation was depicted (e.g., candle *in* cookie cutter, peg *in* block, car *in* larger car, and monkey *in* basket). Two of the relations with which the infants were familiarized were *tight-fitting* and two of the relations were *loose-fitting.* Once habituated, infants were presented with four test trials that varied in the degree of familiarity that the child had with the objects and containment/support relations: (1) familiar objects–familiar relation (e.g., candle *in* cookie cutter; tight-fit), (2) amiliar objects–novel relation (e.g., peg *on* block; loose-fit), (3) novel objects–familiar relation (e. g., cup *in* bowl; loose-fit), and (4) novel objects–novel relation (e.g., turtle *on* other turtles; tight-fit). Infants showed increased attention to clips depicting the new spatial relation, *support*, regardless of whether the objects were familiar or novel and regardless of tight-fit or loose-fit. By successfully completing this task, infants not only demonstrated that they could categorize containment relations not only across varying objects but also across *degree-of-fit* (e.g., tight-fitting containment and loose-fitting containment; see McDonough, Choi, & Mandler, 2003).

Containment appears to be the easiest spatial relation for children to discriminate and categorize (Casasola & Cohen, 2002). Although it is also lexicalized in the English language, *support* appears to be much harder to categorize than *containment*. In fact, Casasola (2005a,b) found that infants did not demonstrate the ability to form categories of the support relation until 14 months of age, and even then, they were able to form the categories only if the different exemplars of *support* were perceptually similar to one another. For example, infants in one study were habituated to multiple perceptually similar exemplars of the *support* relation (e.g., a block on top of a table). After habituating to these events, infants were shown four test trials that varied in the degree of object and relation familiarity. Like the infants in the containment study (Casasola et al., 2003), infants increased their attention to test clips depicting a novel spatial relation (i.e., containment). These findings suggest that by 14 months of age infants can form categories of the spatial relation *support* in certain limited circumstances.

To explore whether adding spatial language facilitates infant categorization of *support* across perceptually dissimilar exemplars, English-learning 18-month-old children heard a spatial word (e.g., *on*) while being familiarized with members of the category *support* (Casasola & Bhagwat, 2007). Results revealed that when provided with spatial language, children were able to form a category of *support* that included perceptually dissimilar instances such as a *tight-fitting* ring on a post and a *loose-fitting* cup on a table. Casasola (2008) concluded that, "When a spatial category consists of perceptually variable exemplars, spatial language scaffolds infants' spatial categorization" (p. 24).

Categorization of *degree-of-fit* has received less attention by researchers, as it is not lexicalized in the English language. One of the few studies to address whether English-reared infants form categories of spatial relations not typically encoded in their native language was conducted by Casasola and Cohen (2002). Seventeen- and 19-month-old children viewed events in which objects depicted tight-fitting containment or tight-fitting support relations. Four different tight-fitting relations were shown to infants during habituation (e.g., candle *tightly in* cookie cutter, lego *tightly on* block, peg *tightly in* block, and round man *tightly on* car). Once habituated to these events, infants viewed four different test trials—each varying in the degree to which infants were familiar with the objects and the spatial relation depicted. Interestingly, 17- and 19-month-old children looked longer at the novel than at the familiar spatial relation, but *only when the objects were familiar*. Thus, although infants showed evidence of discriminating among the spatial relations in this study, they did not show evidence of having formed a category of *degree-of-fit* when the objects used to depict the relation varied (Casasola & Cohen, 2002).

In sum, a preponderance of studies suggests that preverbal infants can form nonlinguistic spatial categories of the semantic components *containment*, *support*, and *degree-of-fit*. Furthermore, the research by Casasola and colleagues (Casasola, 2005a,b; Casasola, 2008; Casasola & Cohen, 2002; Casasola et al., 2003) revealed that some spatial concepts are more accessible than others: *Containment* is discriminated and categorized by English-reared infants earlier than *support*. Finally, children's failure to categorize a relation not encoded in their native language suggests that our ambient language may play a role in what commonalities are attended to, a position favored by Bowerman and colleagues (Bowerman & Choi, 2003; Choi, 2006).

Path and Manner

Path and *manner* are semantic components of motion events that are perceived very early in life. *Path* is typically defined as the movement of "any object following any trajectory through space, without regard to the characteristics of the object or the details of the trajectory itself" (Mandler, 2006). *Manner* is the way in which a path is traversed or a motion is carried out (Talmy, 1985). Path and manner tend to be studied in conjunction because each object moving along a *path* must do so in some *manner*. Although *path* and *manner* are codified in the relational terms of many languages of the world (Jackendoff, 1983; Langacker, 1987; Talmy, 1985), little is known about when and how infants detect and discriminate these semantic components. Like the spatial relations *containment*, *support*, and *degree-of-fit*, *path* and *manner* are packaged differently across languages, suggesting that children may need the ability to detect these components prior to learning their native language.

Path is a semantic component that is fundamental to acquiring concepts such as animacy and causality, which are then recruited to learn relational language (Mandler, 2004). It has been argued that *path* is the most perceptually salient of all conceptual primitives (Mandler, 2004). In fact, research with both hearing and deaf populations shows that there is a path primacy in the production of relational terms (Naigles, Eisenberg, Kako, Highter, & McGraw, AQ2 1992; Zheng & Goldin-Meadow, 2002). For example, English-speaking 2-year-old children produce more language that emphasizes the *path* of an entity over the *manner* (Naigles et al., 1992). In addition, both American and Chinese deaf children produce more gestures for paths than for manners (Zheng & Goldin-Meadow, 2002).

Discrimination of Path and Manner Our laboratories explore the development of *path* and *manner* by studying the ability of prelinguistic infants to attend to changes and discriminate these semantic components in nonlinguistic, dynamic motion events (Pulverman & Golinkoff, 2004; Pulverman, Sootsman, Golinkoff, & Hirsh-Pasek, 2003; Pulverman et al., 2006). Using a habituation paradigm, English-reared 7-month-old infants viewed a video of an animated starfish moving along a single *path* in a single *manner* (e.g., the starfish *spinning over* the ball). After infants fully habituated to this event, they were shown four different test trials: (1) a control trial, in which the starfish moved along the same path by the same manner as seen in habituation (e.g., *spinning over*), (2) a manner change trial, in which the starfish moved along the same path by a new manner (e.g., *bending over*), (3) a path change trial, in which the starfish moved along a new path by the same manner (e.g., *spinning under*), and (4) a path and manner change trial, in which both a new path and new manner were shown (e.g., *flapping past*). Seven-month-old infants showed increased attention to all of the test trials except the control trial, suggesting that they noticed changes in these events.

Pulverman and colleagues (2003) also tested English-reared 14- and 17-month-old children using the same exact stimuli and methods in order to determine if the ambient language influenced infants' discrimination patterns. Like the 7-month-old infants, both 14- and 17-month-old children showed increased attention to path and manner changes in the test trials. Unlike the younger infants, however, Pulverman and colleagues found that 14- and 17-month-old English-reared children who possessed a relatively rich vocabulary were more attentive to *manner* changes than to *path* changes. Taken together, these results suggest that even preverbal infants notice those components of actions that are typically encoded by the world's languages, and that infants who attend more to those components that are relevant to their native language have larger vocabularies.

The results reviewed so far are based on infants' attention to animated events. Do these findings apply to naturalistic events as well? Casasola, Hohenstein, and Naigles (2003) showed English-reared 10-month-old infants naturalistic scenes using human agents. Consistent with the results of our studies in which infants could discriminate path and manner changes in animated scenes, Casasola and colleagues found that infants noticed and discriminated path and manner changes in naturalistic events.

To assess cross-linguistic differences in early attention to and discrimination of *path* and *manner*, an extension of our laboratory's research was conducted on site in Mexico. Pulverman, Golinkoff, Hirsh-Pasek, and Sootsman-Buresh (2008) used the same stimuli previously described to examine *path* and *manner* discrimination in 7-month-old and in 14- to 17-month-old Spanish-reared babies. Like English-reared infants, Spanish-reared infants also discriminated changes in both *path* and *manner* in nonlinguistic events. When looking behaviors were correlated with vocabulary, however, Spanish-reared infants showed a pattern of results different from their English-reared counterparts. Spanish-reared infants who had *small* vocabularies were more attentive to *manner* changes than to *path* changes, whereas Spanish-reared infants with large vocabularies did not attend more to any one specific element. These data suggest that if individual children focus on the components of events that the verbs in their language encode, they restrict the range of hypotheses they must entertain for what verbs might refer to. Thus, the English-reared children with large vocabularies who attend to *manner* changes are likely to learn more *manner* verbs. However, if individual Spanish-reared children attend to *manner*, they are attracted (for whatever reason) to the wrong component of events, thereby disadvantaging their learning of vocabulary (Pulverman et al., 2008).

A recent cross-linguistic study examined the effect of language-specific packaging on attention to *path* and *manner* in Greek-speaking and English-speaking adults (Papafragou, Hulbert, & Trueswell, 2008). This study is similar to the Spanish–English comparative study conducted by Pulverman and colleagues in that Greek is a *path*-oriented language and English is a *manner*-oriented language. Participants were shown an event and were asked to either memorize the event or prepare a verbal description of the event. An analysis of eye-gaze direction revealed that when participants freely examined the event, speakers of both languages attended equally to *path* and *manner*. When participants were asked to prepare verbal descriptions of the event they saw, however, they immediately focused on the particular event components that are emphasized in their native language (i.e., Greek speakers attended more to parts of the event that gave them *path* information, whereas English speakers attended more to parts of the event that provided information about *manner*). Similarly, the eye gaze of participants who were instructed to memorize the event reverted to language-specific patterns after the event ended and they attempted to commit the event to memory. Thus, event perception per se is not affected by differences in the speaker's native language, but when linguistic forms are recruited to the task (either via purposeful commitment of the event to memory or by preparation of a verbal description of the event), language-specific biases become apparent (Papafragou et al., 2008).

Categorization of Path and Manner A significant body of knowledge exists about when and how *path* and *manner* are discriminated by people both within and across languages. Much less is known about how infants abstract and categorize the semantic components *path* and *manner*.

Our laboratory's recent explorations into how children categorize *path* and *manner* used the same animated stimuli as Pulverman and colleagues (Pulverman & Golinkoff, 2004; Pulverman et al., 2003). In two studies we addressed whether infants could abstract an invariant path across multiple exemplars of manner (Study 1) and whether they could find the invariant manner across varying exemplars of path (Study 2; Pruden, Hirsh-Pasek, Maguire, & Meyer, 2004). Three age groups were tested: 7- to 9-month-old, 10- to 12-month-old, and 13- to 15-month-old infants. The youngest age group tested (7- to 9-month-old infants) was known to discriminate changes in both path and manner in dynamic events (Pulverman et al., 2003).

In Study 1, we addressed the question of whether infants could abstract an invariant path across varying manners (that is, form a category of *path;* Pruden et al., 2004). During the familiarization phase, infants viewed an animated starfish performing exactly the same path across four different manners (e.g., "flap *over*," "side bend *over*," "toe touch *over*," and "spin *over*"). At test, two events were shown simultaneously on a split screen: (1) an in-category test event (i.e., same path and novel manner; e.g., "twist *over*") and (2) an out-of-category test event (i.e., novel path and novel manner; e.g., "twist *under*"). Infants' looking times to these two events were analyzed to determine if they had a preference for either event. Results revealed that by 10 to 12 months of age, infants show a significant preference for the in-category test event. This finding suggests that 10- to 12-month-old infants can abstract an invariant path across varying manners, which is a sign of the ability to categorize and ultimately conceptualize the referents of relational words.

In Study 2, we assessed whether infants could abstract an invariant manner across multiple exemplars of path (that is, form a category of *manner;* Pruden et al., 2004). During the familiarization phase of this study, infants were shown four exemplars in which the animated starfish moved in exactly the same manner, but varied its path (e.g., "*spin* around," "*spin* past," "*spin* in front," and "*spin* under"). During the test phase, infants viewed two events simultaneously: (1) an in-category test event (i.e., same manner and novel path; e.g., "*spin* over") and (2) an out-of-category test event (i.e., novel manner and novel path; e.g., "*side bend* over"). In contrast to Study 1, in which 10- to 12-month-old infants showed evidence of categorizing a *path* over various *manners*, only the oldest age group, the 13- to 15-month-old infants, showed evidence of the ability to abstract an invariant *manner* over multiple *paths*. Importantly, infants in both studies noticed path and manner per se and not just novelty or change, because both test scenes contained some novelty or change.

What happens to categorization when language is added to the familiarization that infants receive in these *path* and *manner* tasks? Results from studies of *containment* and *support* relations indicate that the addition of spatial language facilitates categorization (Casasola, 2005a; Casasola & Bhagwat, 2007). Is it possible that infant looking patterns will be affected by the addition of language to studies of *path* and *manner*? To answer this question, Pruden (2007) conducted a series of studies with 7- to 9-month-old infants. Stimuli were exactly the same, with the exception that the events in the familiarization phase were accompanied by a single word (e.g., *javing*). Results revealed that whereas infants younger than 10 months of age were not able to form a category of *path* in nonlinguistic studies, the addition of a word to the familiarization phase facilitated categorization of *path* such that 7- to 9-month-old infants were now able to abstract the invariant event component across multiple scenes. In contrast, although infants in the *manner* study heightened their attention to the familiarization phase when it was accompanied by a label, they did not show evidence of categorizing *manner* across multiple *paths*. This result is consistent with the robust finding that infants are able to discriminate and categorize *paths* earlier than they are able to discriminate and categorize *manners* (Pruden et al., 2004; Pulverman & Golinkoff, 2004; Pulverman et al., 2003, 2006).

Source and Goal Sources and goals represent a relatively new area of research concerning the prelinguistic foundations of relational language. Researchers recently found that *path* can be split into two subtypes: goal-oriented paths, in which an object moves toward or culminates in a goal or end point, and source-oriented paths, in which an object moves away from an origin or starting point (Lakusta & Landau, 2005). Exploration of children's prelinguistic understanding of source and goal has been both inspired and informed by multiple studies showing that a goal-bias in natural language is found across diverse ages and populations (Bowerman, 1996; Ihara & Fujita, 2000; Lakusta & Landau, 2005; Nam, 2004; Regier, 1996; Regier & Zheng, 2003; Zheng & Goldin-Meadow, 2002).

Discrimination of Source and Goal

Three studies conducted by Lakusta and colleagues (2007) revealed that 12-month-old infants are able to separate goals and sources when viewing events. In a goal-discrimination task, children were familiarized with a scene in which a duck waggled in place, accompanied by attention-getting audio, and then moved along a path to one of two possible goal objects (e.g., a green bowl, a red block). When the duck reached a goal object, it again stopped and waggled, accompanied by audio. At test, children saw the duck either move to the same goal in a different location, the same goal in the same location, a different goal in the same location, or a different goal in a different location. Variations in looking time indicated whether infants encoded the goal of the event. Increased looking to the "different-goal object" testing conditions but not the "same-goal object" conditions revealed that children preferentially encoded the goal of an action over its path or location and were surprised when the figure moved to a new goal but not when the figure moved to the same goal in a new location (Lakusta, Wagner, O'Hearn, & Landau, 2007; for a thorough review of the paradigm, see Woodward, 1998).

In a source-discrimination task also conducted by Lakusta and colleagues (2007), children viewed the same scenes, except that the *source object* of the action was manipulated. The same stimuli were used. For example, a duck waggled at one of two source objects (a bowl or a box) and then moved along a path and waggled at the end. During the test phase, infants saw the duck move from a different source object. An analysis of looking times revealed that 12-month-old infants did *not* reliably encode the source object of the action. In other words, they did not increase their looking time when the source of the duck's movement switched from the bowl to the box. In a follow-up study to determine whether 12-month-old infants could be *forced* to attend to source objects, infants were shown exceptionally salient source objects (e.g., a metallic blue block covered with sparkly pipe cleaners and a big orange bowl covered in puffs, bows, and sequins), and then viewed the same action sequence. Infants showed evidence of encoding "super-source" objects (Lakusta et al., 2007).

Do prelinguistic infants preferentially encode the goal of an action rather than the source, consistent with the bias toward encoding goals that is found in natural language (Bowerman, 1996; Ihara & Fujita, 2000; Lakusta & Landau, 2005; Nam, 2004; Regier, 1996; Regier & Zheng, 2003; Zheng & Goldin-Meadow, 2002)? To test this possibility, Lakusta and colleagues pitted these "supersources" against ordinary goals from the very first experiment and analyzed looking times to "different source/same goal" versus "same source/different goal" scenarios. Results revealed that 12-month-old infants preferentially encode goals over sources, even when the sources are very perceptually salient.

There is substantial evidence to suggest that the primacy of goal over source is directly related to infants' understanding of intentions or purposeful, rational behavior (Csibra, Biro, Koos, & Gergely, 2003; Csibra, Gergely, Biro, Koos, & Brockbanck, 1999; Gergely, Nadasdy, Csibra, & Biro, 1995). Infants as young as 12 months old successfully predict the rational ending point of an object's motion trajectory based on whether the action is intentional and "goal-directed," and likewise expect an agent to take the most efficient route to achieve a goal (Csibra et al., 2003; Wagner & Carey, 2005). Thus, at a very young age, children appear to have rational ideas about goal orientation, are able to distinguish between sources and goals, and are biased to encode goal objects over source objects (consistent with natural language usage).

Figure and Ground

A relatively unexplored pair of conceptual primitives that help form the foundation for relational language is *figure* and *ground* (Bornstein, Arterberry, & Mash, 2007). *Figure* is defined as the moving or conceptually movable entity, whose path, orientation, or site is variable (Talmy, 1985). Infant understanding of *figure* has been studied concurrently with *ground*, which is the reference entity providing a stationary setting with respect to the figure's path, site, or orientation (Talmy, 1985). Like *path/manner*, *containment/support*, and *tight-fit/loose-fit*, *figure* and *ground* are packaged differently across languages. In English, for example, satellites such as *over*, *into*, and *across* specify both a path that the *figure* follows and the spatial properties of the *ground* object. "Into" refers not only to a path along which the figure moves, but also mandates that the ground object be some kind of enclosure (Talmy, 2000). By the same token, "across" implies a relatively stable surface that can be traversed whereas "over" requires an obstacle to be scaled.

On the other hand, Japanese is a verb-framed language that conflates motion with *path* in the main verb and expresses *manner* in a subordinated verb. In Japanese, motion path verbs are classified as having one of two different semantic factors: directional path or ground path. *Directional Path* (DP) verbs define the direction of motion relative to a starting point or ending point. DP verbs do not restrict the *ground* on which motion occurs. The *figure* can be animate (self-moving and sentient) or inanimate, so there is no figure constraint with DP verbs (Muehleisen & Imai, 1997).

The other type of Japanese path verb is *Ground Path* (GP), in which the *ground* is incorporated into the verb's meaning. GP verbs are different from DP verbs in the sense that they incorporate information about the nature or shape of the ground along with the direction of motion. With GP verbs, a space is progressively and completely covered by the motion (Muehleisen & Imai, 1997). Thus, *figure* and *ground* present an interesting cross-linguistic example of different ways that verbs can be mapped onto events. Whereas English encodes ground in few of its path verbs and does not specify figure (that is, a vehicle, animal, or a person can "climb over" a mountain), in Japanese a subset of path + ground verbs (GP verbs) encodes both the nature of the ground and the figure that may perform the action as in *Jun wa yanna o nobotta* "Jun went up the mountain." In this case the verb *noboru* implies that Jun (a person) reached the top of the mountain by climbing up the slope from the bottom. However, we cannot use *noboru* for going up to the mountain by taking a cable car or helicopter. The existence of these different kinds of encodings allows us to compare how children package these primitives into the words of different languages.

Discrimination of Figure and Ground Given that languages differ in the way that they package *figure* and *ground* information into relational words, it is important to understand how infants at different ages detect changes of figure and ground, and when they distinguish them as separate components. Researchers in our laboratory have just begun to explore this issue.

Using the Preferential Looking Paradigm, 7- to 9-month-old, 10- to 12-month-old, and 13- to 15-month-old children were tested in either a figure discrimination or a ground discrimination task (Göksun, Hirsh-Pasek, Roseberry, & Golinkoff, 2008). Stimuli included four different figures (a woman, a man, a 6-year-old girl, and a 6-year-old boy) and six different grounds (railroad, road, narrow street, bridge, grass, and tennis court). Four of the grounds (railroad, road, narrow street, and bridge) were encoded by the same verb *wataru* (go across between points) in Japanese, and are characterized by clear starting and goal points. On the other hand, grass is not encoded by *wataru*, because it is an open space that does not have clear boundaries. Similarly, tennis court is not encoded by *wataru* in Japanese, because it does not have clear starting and goal points. Infants saw grounds from the same category (e.g., railroad and road) and from different categories (e.g., railroad and tennis court or road and grass).

Infants were familiarized with a scene in which one figure (e.g., woman) traversed one ground (e.g., railroad). In the *figure discrimination* task, they compared the old event (e.g., woman crossing railroad) with a new event in which only the figure differed from the event they saw during familiarization (e.g., *man* crossing railroad). In the *ground discrimination* task, infants saw the same old event (woman crossing railroad) paired with a new event that changed only the ground (e.g., woman crossing a *street*). The dependent variable was looking time; increased looking time to the novel event would suggest that children are able to discriminate between figures and grounds.

Results revealed that 7- to 9-month-old infants had no preference for novel events in either the figure or the ground task. Ten- to 12-month-old infants, on the other hand, were able to discriminate figures but not grounds. By 13 to 15 months of age, children were able to discriminate both figures and grounds (Göksun, Hirsh-Pasek, Roseberry, & Golinkoff, 2008), and, interestingly, discriminated grounds in a way that is consistent with the categorical distinction made in Japanese. Thus, it appears that figures may be more perceptually accessible or primitive than grounds for young infants, and that children learning both English and Japanese may initially discriminate grounds in the same way—and only later are shaped by the ambient language. This pattern of progressive entry mirrors findings from other research on the conceptual foundations of relational language, including studies of *containment/support*, *path/manner*, and *source/goal.*

Categorization of Figure and Ground Our laboratory has plans to conduct a series of experiments to determine how children categorize *figure* and *ground* in English and Japanese. Given the developmental decalåge found in English-learning babies' discrimination of *figure/ground*, we hypothesize that children will also categorize *figures* before *grounds* (T. Göksun, personal communication). Consistent with the finding that English-learning children discriminate grounds in accordance with Japanese categorical distinctions, preliminary data from our categorization studies suggest that children form the kinds of ground categories that are consistent with Japanese encoding (for example, grounds that have clear starting/end points fall into one category and grounds without clear starting/end points fall into another; T. Göksun, personal communication). It is as yet unknown how Japanese-reared children will categorize figures and grounds, and whether and when one component is shaped by the ambient language to become more primary.

The research presented here and in previous sections suggests that infants have the ability to perceive, process, and abstract semantic components that are encoded in languages across the world. Thus, infants bring to the language-learning task a set of concepts used to make sense of the world of events and spatial relations, as previously argued (Gentner & Boroditsky, 2001; Mandler, 2004). Given that infants appear to be equipped with the conceptual prerequisites needed to learn various relational terms at a young age, we turn to an evaluation of the second hypothesis, mapping, to explain why children have a harder time learning relational words such as verbs and prepositions.

THE MAPPING HYPOTHESIS

Evidence suggests that even prelinguistic children are equipped with the conceptual foundations necessary to learn relational words from a very early age. If conceptual readiness is not a problem for relational word learning, then perhaps relational words are harder to learn than less-relational words because children have difficulty packaging the semantic components of events so that relational words can be mapped. According to the "mapping hypothesis," children possess the relational concepts necessary for relational word learning but get "stuck" at the point of discerning how the language around them is linked to those concepts (Gentner, 1982; Gleitman, 1990; Maguire, Hirsh-Pasek, & Golinkoff, 2006). This hypothesis states that relational terms appear late in lexical time because it is difficult for children to discern how the language they are learning expresses the events observed in the world *in words*. Thus, the difficulty with relational language acquisition is not the result of an inability to form underlying concepts, but rather is specific to mapping words to these relations. Gleitman and colleagues write (2005):

> Why are words such as *know* harder for learners to acquire than words such as *dog* or *jump?* We suggest that the chief limiting factor in acquiring the vocabulary of natural languages consists not in overcoming conceptual difficulties with abstract word meanings but rather in mapping these meanings onto their corresponding lexical forms. (p. 23)

Even though infants form action categories very early in life, they fail to map a word to those same actions nearly 2 years later. Salkind, Golinkoff, Sootsman, and Hirsh-Pasek (2002) habituated 9- to 11-month-old infants to video clips of two different females performing the same jumping jack action. At test, infants saw three clips: (1) a *control* clip of the action that was identical to the habituation trials, (2) a *novel* actor performing the *familiar* action, and (3) the same *novel* actor performing a *novel* action. Results revealed that as early as 10 months of age, children with large receptive vocabularies relative to their peers could form abstract action categories that were independent of changes in actor.

If 9- to 11-month-old children can develop categories of action, then it is expected that children more than twice as old (with significantly larger vocabularies) should be able to learn a label for that same action. Using the Intermodal Preferential Looking Paradigm, Maguire et al. (2002) presented 18-, 24-, and 30-month-old toddlers with video clips of characters doing jumping jacks, while they heard a verbal description of the action *("Hey, she's blicking!")*. At test, the toddlers saw a new actor performing the familiar jumping jacks action on one side of the screen and a novel actor performing a new action on the other side of the screen. Results revealed that children *of all ages* watched the old and new actions to the same degree at test. In other words, they *failed* to map the verb onto the correct action. In light of the earlier studies revealing that children are capable of forming nonlinguistic categories of actions by 9 to 11 months old, this startling finding suggests that children still have difficulty mapping a verb to an *already formed* category nearly 2 years later (Salkind et al., 2002).

Is the mapping problem specific to *English?* It has been suggested that children learning Korean and Chinese, for example, have less of a problem with relational mapping than do English-reared children (Choi, 1998; Choi & Bowerman, 1991; Choi & Gopnik, 1995; Tardif, 1996). Research in English, Japanese, and Chinese, however, suggests that the mapping problem exists across languages (Imai, Haryu, & Okada, 2002; Imai, Haryu, Okada, Lianjing, & Shigematsu, 2006; Meyer et al., 2003). In a recent series of studies, English-speaking, Japanese-speaking, and Chinese-speaking 3- and 5-year-old children were shown video clips of a person engaged in a novel action with a novel object (Imai, Haryu, & Okada, 2002; Imai et al., 2006). Children were exposed to one of three conditions. In the "noun" condition, they were asked to "*Look at the blick*," encouraging a noun interpretation (that is, suggesting that the referent for the word "blick" is the object in the scene rather than the action being performed with it). In the "bare-frame verb" condition, children heard a novel verb in a bare syntactic frame ("*Look, blicking! Watch blicking!*"). In the "rich-syntax verb" condition, children were given additional syntactic information ("*Look, she's blicking it!*"). During test trials, children simultaneously saw the old object engaged in a new action on one side of the screen and the old action being performed with a new object on the other side. Children again heard either the noun ("*Where's the blick?*"), the bare-frame verb ("*Where's blicking?*"), or the rich-syntax audio ("*Where's she blicking it?*").

Across the three languages, 3- and 5-year-old children had no difficulty mapping a noun to an object in the noun condition. However, in *all three languages*, 3-year-old children were unable to map the verb to the action, and performed at chance levels. Not until 5 years of age was any consistency found in verb mapping. Thus, even 3-year-old children—who are language experts compared to 10-month-old infants—have difficulty mapping a word to an action, regardless of native language. These results suggest that although mapping to *verbs* is a problem, mapping itself is not; children readily mapped a novel noun to a novel object (Imai et al., 2002, 2005; Meyer et al., 2003).

A mapping problem specific to relational concepts has been found not only in children, but in adults as well (Gillette et al., 1999; Snedeker & Gleitman, 2004). In a simulated word learning paradigm, Gleitman and colleagues showed adults silent video clips of conversations between mothers and children. A tone or nonsense word was inserted exactly where a target word had been used. Adults were then asked to guess the target word. Results revealed that adults, who presumably have *no conceptual problems* understanding the objects and events represented on the tapes, still had more difficulty correctly guessing verbs than nouns. Interestingly, they performed better when asked to guess *concrete* verbs that described visible actions (e.g., *push* and *throw*) than abstract mental-content verbs (e.g., *think* and *love*). This suggests that mapping actions, especially mental actions, to words is a considerably more difficult task than mapping objects or concrete verbs to words (Gillette et al., 1999; Snedeker & Gleitman, 2004).

Why Is Mapping Relations So Hard?

There appears to be something more difficult about mapping to relational referents such as "run" than mapping to less-relational referents such as "cup." Regardless of age, conceptual ability, experience, or the specific language being learned, mapping words onto relations is hard even when the underlying nonlinguistic category is formed easily. However, research suggests that the mapping problem hinges on the *relationality* of the referent, not on form class membership (e.g., whether a word can be categorized as a verb, preposition, noun, etc.). Contrary to past theories, all nouns are not easier to learn than all verbs (Hall & Waxman, 1993; Keil & Batterman, 1984). Although children may begin to use the noun *brother* as a label for a specific person when they are young, they eventually grow to understand that *brother* actually denotes a *relation* between a male and his sibling. Children do not begin to use nouns such as *brother, island,* and *passenger* in flexible and extendable ways until relatively late in childhood (Hall & Waxman, 1993; Keil & Batterman, 1984).

Perceptual Salience Helps Children Map to Relational Referents If words from any form class are susceptible to the mapping problem, what characteristics make certain words easier to learn than others? Various studies of early vocabulary composition suggest that the actions labeled by early verbs and the entities labeled by early nouns share one important commonality: They are more perceptually grounded than other words (Ma, Golinkoff, Hirsh-Pasek, McDonough, & Tardif, 2009). Thus, whereas the noun *dog* may be one of a child's first flexibly extended words, the noun *truth* will probably not be. Similarly, the verb *kiss* might well be in the early vocabulary of a toddler (especially one who is frequently kissed), whereas the verb *think* will not be. *Dog* and *run* have perceptual instantiations; *truth* and *think* do not.

A number of theorists have suggested that perceptual factors affecting word learning are best described as variations in the *shape, individuability, concreteness,* and/or *imageability* of a concept (Bird, Howard, & Franklin, 2003; Gentner & Boroditsky, 2001; Gillette et al., 1999; Gilhooly & Logie, 1980; Golinkoff, Jacquet, Hirsh-Pasek, & Nandakumar, 1996; Landau, Smith, & Jones, 1998; Maguire, Golinkoff, & Hirsh-Pasek, 2006; Masterson & Druks, 1998; Snedeker & Gleitman, 2004). These theorists suggest that referents that are more perceptually salient, visible, countable, imageable, individuable, concrete, and/or uniquely shaped are easier to map to words than those that are not. Specifically, Gentner and Boroditsky (2001) suggest that the *key* mapping-relevant difference between verbs and nouns is that noun referents tend to be more individuated and less relational than verb referents. The referent of a noun is often something visible and countable, like a *dog*. The referent of a verb, on the other hand, is more likely to be intangible, less perceptual, and based on relations between objects, such as *tickle* or *run*. Therefore, the difficulty experienced in verb learning is not due to membership in the syntactic category "verb," but rather is due to difficulty abstracting and mapping complex, relational, semantic information (Gentner & Boroditsky, 2001; Smiley & Huttenlocher, 1995). A logical extension of this argument is that a highly individuated and less relational verb such as *jump* is more likely to be mapped correctly and extendably than a relational noun such as *island*.

Golinkoff, Hirsh-Pasek, Mervis, Frawley, and Parillo (1995) predicted that the earliest verbs in children's vocabularies would be those with a salient "shape" (like *dancing*) rather than those with a less visible "shape" (like *thinking*). Golinkoff, Jacquet, Hirsh-Pasek, and Nandakumar (1996) found that 37-month-old children exposed to static pictures with various Sesame Street characters performing actions extend a new verb to the characters whose bodies have the same shape (e.g., arms and one leg extended for an arabesque) but not to others with a different shape. Golinkoff and colleagues (2002) also found that 3-year-old children are sensitive to the body shape of actions displayed in "point lights," or small lights attached to the head and main joints of a person's body and filmed in the dark (Johansson, 1973). Children were shown four pairs of eight known actions (picking a flower, dancing, etc.) in point light displays on a split screen in the Intermodal Preferential Looking Paradigm (Golinkoff et al., 2002; Hirsh-Pasek & Golinkoff, 1996). The pair of videos was accompanied by a verb that labeled one of the actions. Despite the fact that children only saw lights moving about on a screen, they were able to find the match when asked to look at a particular action.

Another aspect of perceptual salience that affects which words are acquired by very young children is *imageability* (Bird et al., 2003; Gilhooly & Logie, 1980; Masterson & Druks, 1998). "Imageability" refers to the ability of a word to arouse a mental image (Paivio et al., 1968). Retrospective age of acquisition (AoA) studies have found that children's early words are more perceptually salient (or imageable) than words learned later (Bird et al., 2003; Gilhooly & Logie, 1980; Masterson & Druks, 1998).

McDonough, Song, Hirsh-Pasek, Golinkoff, and Lannon (under review) correlated imageability ratings with production data from the MacArthur Communicative Developmental Inventory (CDI; Fenson et al., 1994). After analyzing the 75 nouns and 44 verbs on the CDI that also had imageability ratings (Masterson & Druks, 1998), results revealed that AoA was significantly correlated with imageability. Words with higher imageability ratings, regardless of form class, were learned earlier than words with lower imageability ratings (McDonough et al., under review).

If the imageability construct predicts lexical acquisition, the findings from the work of McDonough et al. (2009) in English should extend to other languages, such as Mandarin Chinese (Ma, Golinkoff, Hirsh-Pasek, McDonough, & Tardif, 2009). An evaluation of early word imageability in Chinese indicated that early nouns have higher imageability ratings than verbs in both English and Chinese children's vocabularies. Furthermore, early Chinese verbs have higher imageability ratings than early English verbs (i.e., they tend to have very specific meanings), which may explain the finding that Chinese children learn more verbs at an earlier age than do English children (Ma et al., 2009).

An understanding of how various types of perceptual salience facilitate word–world mapping not only answers a long-standing question in the word learning literature (i.e., why more nouns than verbs are acquired in English but the proportion is roughly equal in Chinese), but also informs a general theory of word learning.

THE EMERGENTIST COALITION MODEL OF WORD LEARNING

There is significant evidence to suggest that the conceptual prerequisites for relational word learning are in place early. In seeming contrast to this conclusion, however, and despite the difficulty encountered by children when learning relational words such as verbs and prepositions in both naturalistic and laboratory settings, young toddlers nonetheless acquire a significant relational lexicon in their everyday lives. How can this be? We suggest that a unified theory of word learning can account for both relational and less-relational word acquisition. The Emergentist Coalition Model (ECM) of word learning holds that the process of relational language learning is multidimensional: Children draw on attentional, social, and linguistic cues differentially over developmental time to learn words (Hollich, Hirsh-Pasek, & Golinkoff, 2000; see also Lavin, Hall, & Waxman, 2006). Data from multiple studies conducted within the ECM framework suggest that to map words to the world, children first rely primarily on perceptual cues, followed by social and linguistic cues. Based on this model, we can make predictions about the first words learned by children, and explain why less-relational words (such as many nouns) predominate in early vocabulary.

The Role of Perceptual Cues

If the first strategy used by children acquiring language is to preferentially attend to referents that are highly perceptually salient, then words that map to perceptually salient objects or events should appear first. In addition, children in this first stage of language acquisition should be unwilling to map a word to an object that is low in perceptual salience. That is precisely what the data on noun learning suggest. In one study, children learned a label for a novel object at 12 months of age, but only if the object being labeled was the one they found most interesting (children always preferred the most perceptually salient object). Infants did not learn a word for an object that was not perceptually salient until 18 months of age (Hollich et al., 2000). A similar study by Pruden, Hirsh-Pasek, Golinkoff, and Hennon (2006) showed how powerful perceptual salience is at the start of word learning. They found that 10-month-old infants can also learn a name for a salient object. They further discovered, however, that if a boring object is labeled in the presence of an interesting object, babies will systematically *mismap a word onto the salient object!* This work coupled with the ECM and the evidence presented emphasizing the importance of perceptual salience suggests that increasing perceptual salience should help children accurately map words to relational referents.

The importance of perceptual salience to learning relational words has been confirmed across a number of paradigms. For example, one study found that young children (22 months of age) learned verbs when the actions being labeled also produced salient effects (e.g., a light turned on when the action was performed), but not when there was no outcome (Brandone et al., 2009). It was not until 34 months of age that children could learn a name for an action that did not have a salient result. Thus, a salient result that heightens the perceptual salience of a relational referent also facilitates word–world mapping.

The Role of Social Cues

Although attention to perceptual salience is an important strategy for solving the problem of mapping relations to words, and can help young toddlers develop a basic vocabulary, it is often insufficient by itself. For example, the meaning of a word that has an imperceptible referent (e.g., *presume*) is not readily available from the perceptual world. In such cases, children come to rely on social cues (e.g., eye gaze, pointing) in addition to perceptual cues to word meaning.

One particular type of social information that children often use when determining the referent of a word is *intentionality*. An intention is "a mental state or plan that precedes the conduct of an action" (Behrend & Scofield, 2006, p. 290). A significant body of research suggests that infants understand intentions from an early age (Baird & Baldwin, 2001; Baldwin & Baird, 1999; Gergely, Nadasdy, Csibra, & Biro, 1995; Meltzoff, 1995; Woodward, 1998, 1999; Woodward & Somerville, 2000). Although intentions may be understood by very young children, the clearest evidence to date that children can harness their understanding of another's intentions to determine the meaning of a relational word has been found in 2 year olds (Poulin-Dubois & Forbes, 2002; Tomasello & Barton, 1994). In a behavioral reenactment task, toddlers saw a person perform two actions (Tomasello & Barton, 1994). Before the action began, they heard the actor say, "I'm going to *gorp* it." The actor then revealed a social cue to his intentions by performing one action in silence, but saying "oops" after performing the other action. If children understood that the actor intended to "gorp" and that the "oops" was a social signal that the intention was not successfully completed, then they should deduce that the verb "gorp" labeled the action that was not followed by "oops." When children were given the opportunity to "gorp" with the toys after observing the actor, they more often produced the action that was *not* followed by "oops" during training (i.e., the "intended" action) than the "oops" action (i.e., the unintended or mistaken action; Tomasello & Barton, 1994).

Can children utilize social cues to an actor's intentions to learn a novel verb? Poulin-Dubois and Forbes (2002) showed 21- and 28-month-old children pairs of novel action verbs on a video. The extent to which the actions appeared perceptually similar and were intentional versus nonintentional was manipulated (e.g., *topple* and *knock over* are perceptually similar but the intention of the actor distinguishes the verbs). Children were familiarized with each action and heard audio labeling the action. At test, a split screen showed two actions side by side, and children were asked to find the target verb. Results revealed that by

27 months of age, toddlers are able to use subtle social cues to intentionality to decide which of two perceptually similar actions is the correct referent of a novel verb.

Linguistic Cues

A third source of information that children can access when solving the problem of mapping word to world is linguistic in nature. Numerous studies have revealed that 2- to 5-year-old children interpret novel verbs depending on the syntactic structure in which they hear the verb (Fisher, 2002; Naigles, 1996; Naigles & Kako, 1993), a strategy known as "syntactic bootstrapping" (Gleitman, 1990). In addition to evidence showing that toddlers are able to use abstract linguistic information (e.g., the number of noun phrases in a sentence) to determine the meaning of a verb (Fisher, 1996; Fisher, 2002), 16- to 18-month-old children are able to use word order information to determine the correct scene described by a transitive sentence such as "Big Bird is tickling Cookie Monster" (Hirsh-Pasek & Golinkoff, 1996).

In conclusion, the ECM does not make predictions about how easily a word can be mapped onto a referent based on form class membership. Instead, the ECM provides a framework for looking at the trajectory of word mapping over time. Referents that are more relational will be more difficult to connect to words than referents that are less relational. That is, those words that refer to more perceptually available referents will be learned first, whether they are nouns, verbs, or prepositions. With less perceptual guidance, word learning must await support from social and linguistic cues to indicate word meaning. Because relational referents have ambiguous word–world mappings, children rely on a coalition of cues to solve the word learning problem.

CONCLUSIONS

For decades, researchers have sought a theory of vocabulary acquisition that accounts equally well for concrete words such as many nouns and relational words such as many verbs and prepositions. In this chapter, we used the noun–verb debate to inform a general theory of word learning. We explored evidence in support of two hypotheses to explain why some words might be learned earlier than others: the *conceptual prerequisites* hypothesis and the *mapping* hypothesis. After a thorough review of the literature on *containment/support, path/manner, source/goal,* and *figure/ground,* we concluded that children demonstrate primitive, language-relevant concepts from an early age (Mandler, 2004), and are able to form categories of concepts including action categories from a very young age (Pruden et al., 2004). Thus, the *conceptual prerequisites* hypothesis cannot fully account for the late appearance of relational words in children's vocabularies.

Our review of the literature on *mapping,* on the other hand, revealed that children learning English, Japanese, and Chinese seem to have similar levels of difficulty mapping verbs to action categories in the laboratory (Imai et al., 2006), and even adults have difficult mapping verbs to actions in ambiguous situations (Gillette et al., 1999). Thus, although children appear to have the conceptual foundations for relational word learning at a very early age, they have trouble connecting words to the world.

The ECM explains the mechanisms behind early word acquisition, the reasons why children acquire the words they do, and why some words are learned earlier than others. It not only offers a framework for understanding both relational and less relational terms, but also explains several themes in the literature. Why are nouns easier to learn than verbs? Because the majority of nouns are more perceptually accessible than are the majority of verbs. Why do verbs nonetheless exist in the earliest vocabularies of young children? We argue that the verbs appearing in children's earliest vocabularies are more perceptually rooted than verbs that are acquired later. In fact, even "broad verbs" that appear early in lexical development—such as *go* or *make*—might initially be understood in limited, perceptually governed ways (Theakston, Lieven, & Pine, 2002). Finally, why do children learning Mandarin have proportionally more verbs in their early vocabularies than children learning English? Perhaps because the verbs used in Mandarin are more perceptually rich and contextually bound than the verbs used in English. The ECM offers a viable and general model for explaining word development by accounting for how both relational and less-relational words are mapped to the world, and thereby provides answers to long-debated questions in the field of language acquisition.

Understanding the processes that underlie the acquisition of words from all form classes not only is important to the field of language development in general, but also provides more information on the etiology of atypical language. For example, given that perceptual salience is highly important for initial word learning, might language-delayed children benefit from an intervention that focuses on learning words for salient objects and actions first, to give them a foothold into vocabulary? Children diagnosed with autism have communication problems (APA, 1994), and may have particular trouble with relational language (Ishikawa & Uda, 1996; Takata & Okuma, 1986; Watake, 1996). Given the importance of access to social and grammatical cues to relational word meaning, and the well-established variability of skill demonstrated by children with autism in those areas (Baron-Cohen, 1995), our theory might explain any difficulty with relational language found in this population. Indeed, recent research has demonstrated that children with autism are able to learn words for perceptually salient objects (similar to young typically developing children, Hollich et al., 2000) but have difficulty using social cues to determine word meaning (Parish-Morris, Hennon, Hirsh-Pasek, Golinkoff, & Tager-Flusberg, 2007).

Based on our review of what is known about conceptual primitives and the processes underlying relational language acquisition, where should the field direct its future research efforts? Talmy (2000) listed numerous conceptual primitives that underlie the concepts ultimately packaged into categories and codified by language. Exploring each and every posited primitive has the potential to further illuminate our understanding of how both typical and atypical language develops in children across the world. This chapter reviews the first steps that have been taken toward understanding these primitives, advances the field by viewing this evidence through the framework of a unified theory of word learning, and suggests a clear direction for research that can guide us toward a better understanding of our most fundamental human faculty: language.

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QUERIES TO BE ANSWERED BY AUTHOR (SEE MANUAL MARKS)

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Chapter 11

Q. No.	Pg No.	Query
AQ1	221	Please check whether the year should be "1995" as in the reference list.
AQ2	227	Please check whether the year should be "1998" as per the reference list.
AQ3	238	Please cite American Psychiatric Association (1994) in text.
AQ4	239	Update Brandone et al. (2009).