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## CHAPTER 7

### *Early Word Learning*

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*That living word awakened my soul, gave it light, hope, joy, and set it free!*  
—HELEN KELLER, 1904

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#### **EARLY WORD LEARNING: THE GATEWAY BETWEEN LINGUISTIC AND CONCEPTUAL ORGANIZATION**

Word learning, perhaps more than any other developmental achievement, stands at the very crossroad of human conceptual and linguistic organization (P. Bloom, 2000; S. A. Gelman, Coley, Rosengren, Hartman, & Pappas, 1998; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Waxman, 2002; Woodward & Markman, 1998). Like Janus, the two-headed Roman god of beginnings, word learners must set their sights in two distinct directions. Facing the conceptual domain, infants form core *concepts*<sup>1</sup> to capture the relations among the objects and

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<sup>1</sup>We use the term *concept* to refer to a symbolic mental representation. For the concepts considered in this chapter (e.g., DOG or FURRY), the extension of that representation include

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events that they encounter. Facing the linguistic domain, infants cull *words* and *phrases* from the melody of the human language in which they are immersed. Even before they take their first steps, infants make important advances in each of these domains. And perhaps even more remarkably, recent evidence reveals that from the onset of word learning, infants' advances in the conceptual and linguistic domains are powerfully linked.

Janus was known to the Romans not only as the god of beginnings, but also as the guardian of gateways and transitions. Like Janus, young word learners stand at an important gateway. Across the world's communities, infants' first words are greeted with a special joy because they mark infants' entrance into a truly symbolic system

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individual instances that the infant has encountered (e.g., her own pet dog; its furry tail). The representation must also be sufficiently abstract to include in its extension (at least some) instances that she has not encountered (e.g., my dog; her furry ears). Used in this way, the term *concept* refers to an abstract mental representation that may be built up from infants' direct experiences and whose semantics may be organized around various kinds of relations, including category-based, property-based, or action-based commonalities.

of social commerce. In acquiring their first words, infants acquire much more than a symbolic means of reference. Word learning serves as a gateway into the fundamental social, conceptual, and linguistic abilities that are the hallmark of the human mind. From a social perspective, word learning permits infants to apprehend and to influence the contents of other minds. From a conceptual perspective, word learning supports the evolution of the increasingly abstract and flexible mental representations that are the signature of the human conceptual system. There is no doubt that other species of animals also have sophisticated social and conceptual abilities (see Cole, Chapter 15, this *Handbook*, this volume). But in the human, these systems stand out for their flexibility, force, and inductive strength; and each of these is supported strongly by language. As will become apparent as the chapter unfolds, word learning both contributes to and is supported by infants' discovery of the fundamental syntactic and semantic properties of human language, and the interactions among these.

Just as young word learners are faced with the task of pulling together their knowledge with the linguistic and conceptual domains, our goal in this chapter is to bring together two distinct intellectual traditions—generative linguistics and cognitive psychology—within a distinctly developmental framework. In wedding these two disciplines, our primary aim is to highlight synergies between them and to forge a path for new investigations that take advantage of the contributions of each. We therefore focus on those facets of word learning where the two intellectual traditions come together most richly, which leads us to focus primarily on how the links between the conceptual and linguistic systems evolve. More specifically, we consider the developmental trajectory of several kinds of words (e.g., nouns, adjectives, verbs) and how they become linked to meaning. We acknowledge that one grammatical form—*noun*—has held a privileged position, dominating both the infants' early lexicon and the developmental research agenda. But we also point out that nouns are not, in fact, the paradigm case for word learning. After underscoring the central role played by nouns in acquisition, we move on to highlight the very different conceptual entailments and linguistic requirements underlying the acquisition of other grammatical forms, including adjectives and verbs.

### The Puzzle of Word Learning

In the course of their daily lives, human infants naturally find themselves in situations in which an individ-

ual (perhaps a parent or an older sibling) gazes at an ongoing stream of activity (perhaps a puppy playing in a park) and utters a string of words (perhaps “Look at that adorable puppy! He’s running away! Let’s go find its mommy”). To successfully learn a word (e.g., *puppy*) from this (indeed from any) context, infants must (a) identify the relevant entity from the ongoing stream of activity (focusing in this case on the puppy and not the act of running, etc.), (b) parse the relevant piece of sound (pup´ē) from the ongoing stream of continuous speech, and (c) establish a mapping between that entity and that sound.

At first glance, this appears to be straightforward. After all, don’t we essentially solve the puzzle for infants when we focus their attention on the object of interest while introducing its name? Certainly, adults may strive to teach words in this way, and they apparently do so more in some cultural communities than in others (cf. Hoff, 2002; Ochs & Schieffelin, 1984). However, a closer look reveals that word-learning tutorials like these are the exception instead of the rule. To begin, many words, even in infant-directed speech, do not refer to an object or to anything else that we can point to (e.g., “He’s *running* away!” or “*No!*”). And even for words that do refer, the referent is often absent at the time of the naming episode (e.g., “Time to go get your *sister*,” “Where’d your *mom* put your *shoes*?” or “You really need a *nap*”).

Even in the most straightforward tutorials, when the word has a referent and the referent is present throughout the naming episode, matters are not so simple. Successful word learning requires that the learner map a word (e.g., *puppy*) to a concept (PUPPY),<sup>2</sup> and this means extending that word systematically beyond the individual(s) with which the word was initially introduced.<sup>3</sup> In our example, this means extending the word *puppy* to certain other objects (other puppies), but excluding all the rest (kitties, adult dogs, bunnies, and televisions).

<sup>2</sup>Throughout this chapter, we use the following typographical conventions: italics = refer to a word, small capitals = refer to a concept.

<sup>3</sup>There is one special class of word—the proper noun (e.g., *Lassie*)—whose function is to pick out a distinct individual (e.g., the dog Lassie). However, two points bear mentioning. First, these words do refer to concepts (that happen to include only one unique member; see Hall, 1999; Hall & Lavin, 2004; Macnamara, 1994; Markman & Jaswal, 2004; Xu, Carey, & Welch, 1999). Second, the vast majority of words, and indeed most of the words first acquired by infants, do not refer to a distinct individual but to a range of individuals.

Notice, then, that the names for concrete objects depend on a pairing between a word and an abstract concept. To establish such mappings, infants must hold some principled expectations about the range of possible extensions for a given word, and these may come from the conceptual, perceptual, or linguistic system (Bates & Goodman, 1997; Chomsky, 1975; Murphy, 2002; Quine, 1960; Quinn & Eimas, 2000).

Finding the linguistic units also requires the learner to engage in a certain degree of abstraction. Just as knowledge of a concept like PUPPY requires that one be able to inspect anything in the world and decide whether it is a puppy (whether it is in the extension of the concept), knowledge of the phonological form of a word requires that one be able to pull out varying instances of that word in the flow of the speech stream. Just as the concept PUPPY requires us to abstract over instances of short puppies, black puppies, and furry puppies, knowledge of the phonological word /pup̩/ requires us to abstract over different utterances of the word that show wide variation in acoustic features due either to differences between speakers, to effects of coarticulation with surrounding words, or to phonological rules that alter the form of the word (e.g., *electric/electricity*; see Saffran, Werker, & Werner, Chapter 2, this *Handbook*, this volume for an excellent review; also Aslin, Saffran, & Newport, 1998; Fisher, Church, & Chambers, 2004; Fisher & Tokura, 1996; Jusczyk, 1997; Mehler et al., 1988; Morgan & Demuth, 1996).

The third piece of the word-learning puzzle—establishing a mapping between the conceptual and linguistic units—is also much richer than it appears at first glance. It is a universal feature of human language that many kinds of words (e.g., nouns, adjectives, verbs) can be applied correctly in the very same naming episode, and that each kind of word highlights a unique aspect of that episode and supports a unique pattern of extension. Consider again the vision of puppies playing in the park. Count nouns (e.g., “Look, it’s a *puppy*”) not only refer to an individual puppy, but extend broadly to other members of the same object category (to other puppies, but not to bunnies). In contrast, proper nouns (e.g., “Look, it’s *Lassie*”), which refer specifically to the named individual, cannot be extended further. And if we provide an adjective (“Look, it’s *fluffy*”), the meaning is again quite different. Here, we refer to a property of the named individual, but not the individual itself, and we can extend that word to other instances of that property, independent of the particular entity embodying it (e.g., to any other fluffy thing, including [some, but not all] puppies,

bunnies, and bedroom slippers). Finally, verbs (“Look, it’s *running*”) refer to a relation or an activity involving that individual at that moment in time, and are extended to similar activities, involving very different actors (e.g., horses, children) at different times and places.<sup>4</sup>

To summarize, to be successful word learners, infants must (a) identify the relevant conceptual units (e.g., an individual, a category of individuals, an event), (b) identify the relevant linguistic units (e.g., words), and (c) establish a mapping between them. We have argued that at its core, word learning requires a certain degree of abstraction in each of these domains. Any given utterance of a word must be related to an abstract phonological representation, and any given individual must be related to an abstract concept.

### Early Solutions to the Puzzle of Word Learning

Despite these apparent logical difficulties, infants learn words with impressive ease and alacrity. By roughly 12 months, infants reliably recognize words in fluent speech and are beginning to produce words on their own; by roughly 24 months, they produce hundreds of words and begin to combine them systematically to form phrases. Perhaps more remarkable still is the fact that by 2 to 3 years of age, they discover that there are distinct kinds of words (distinct grammatical forms) and that these are linked to distinct kinds of meaning (Brown, 1957, 1958; Gentner, 1982; Macnamara, 1979; Waxman, 1990; Waxman & Gelman, 1986). In fact, the evidence reveals that they mine these links, taking the grammatical form of a novel word as a cue to establishing its meaning (for thorough reviews of recent literature, see Hall & Lavin, 2004; Markman & Jaswal, 2004; Woodward & Markman, 1998).

Toddlers acquiring English systematically restrict the extension of a proper noun to the named individual (Hall, 1991, 1999; Hall & Lavin, 2004; Jaswal & Markman, 2001), but extend count nouns more broadly, to the named individual and to other members of the same object category (Waxman, 1999; Waxman & Markow, 1995). They systematically extend adjectives to properties of objects (Klibanoff & Waxman, 2000; Mintz & Gleitman, 2002; Prasada, 1997; Waxman & Klibanoff, 2000; Waxman &

<sup>4</sup>And, don’t forget that the speaker is under no obligation to talk about what is happening in the world at that moment. A speaker is about as likely to say, “remember our camping trip last summer” as “what a cute puppy” in the context of a puppy (Chomsky, 1959).

Markow, 1998) and verbs to categories of events (Fisher & Tokura, 1996; Hollich, Hirsh-Pasek, et al., 2000; Naigles, 1990; Tomasello, 2003; Tomasello & Merriman, 1995).

But how do infants discover the mappings between grammatical form and meaning? The full repertoire of such mappings cannot be innately specified because languages differ in the grammatical forms that they represent, in the way they mark these grammatical forms on the surface, and in the ways they recruit these forms to convey fundamental bits of meaning (Baker, 2001; Croft, 1991; Frawley, 1992; Hopper & Thompson, 1980). In the face of these differences, there appear to be some universals. In particular, in all human languages, object concepts are lexicalized as nouns and event concepts as verbs (Brown, 1957, 1958; Dixon, 1982). But at the same time, there is considerable cross-linguistic variation. Within the class of nouns, some languages (like English) make a grammatical distinction between mass and count nouns, whereas others (like Japanese) may not (Imai & Haryu, 2004). Even more dramatic evidence for this kind of flexibility comes from cross-linguistic comparisons of the grammatical form *adjective*. Some languages (including English, Spanish, and the African language Dyrirbal) have richly developed, open-class systems of adjectives, but others (e.g., the Bantu languages) have sparse adjective systems, including as few as 10 terms (Dixon, 1982; Lakoff, 1987). Moreover, in many languages (e.g., Mohawk, Mandarin) it is extremely difficult to determine whether there is a grammatical category *adjective* that is distinct from the category *verb*. In Mohawk, for example, most morphological and syntactic tests put the class of concepts that are labeled by adjectives in English into the class of verbs (Baker, 2001).<sup>5</sup>

<sup>5</sup>In some languages, it is even difficult to determine whether any words can be assigned to specific grammatical categories at all, leading some to argue that in these languages, the grammatical categories are perhaps better characterized as phrase-size units rather than as words (Davis & Matthewson, 1999; Demirdache & Matthewson, 1996; Wojdak, 2001). The putative category-neutrality in these languages makes it clear that we should separate the lexical category of a word from its syntactic usage. That is, a word may be lexically specified as, say, being a noun, but in certain uses, it will be performing the function of a verb (or vice versa). This point can be seen clearly even in English when we examine gerunds (e.g., The *sinking* of the boat was ordered by the admiral), where a verbal concept (SINK) is used as the head of a noun phrase. In cases like this, a word that is lexically a verb behaves syntactically like a noun. (see Abney, 1987; Frank & Kroch, 1995; Harley & Noyer, 1998 for discussion and analysis).

Even within a given language, the boundaries around the grammatical forms are permeable. Although a core semantic function of nouns is to refer to object concepts (e.g., PUPPY, TABLE), nouns can also be used to refer to properties (e.g., HEIGHT, BELIEF), events (e.g., EARTHQUAKE, DESTRUCTION), and abstract notions (e.g., FREEDOM, IDEA). And although a core semantic function of verbs is to refer to events (DECIDE, JUMP), verbs can also refer to properties (APPEAR, KNOW) or states (LIKE, STAND). Indeed, the very same underlying concept can sometimes be expressed by both a noun and a verb:

- (1) The results of the election were a *surprise* to me (N).

The results of the election *surprised* me (V).

It therefore follows that the links between grammatical categories (noun, verb) and semantic categories (thing, event) are not rigidly fixed, even within a given language, but are correlational (P. Bloom, 1994; Macnamara, 1986; Pinker, 1989).

How do infants discover these links? It would be unreasonable to assume that from the start, infants' expectations mirror those of the mature speakers of their language, because as we have seen, infants must discover which grammatical forms are represented in their language and how they are recruited to convey meaning. It is reasonable, however, to ask whether infants might approach the task of acquisition with some language-general expectations in place to guide acquisition from the start and which could then be fine-tuned as the infant gained experience with the details of their native language (see Saffran et al., Chapter 2, this *Handbook*, this volume, for a similar developmental view).

## PLAN OF THE CHAPTER

To address these issues, we open with a section on initial acquisitions, focusing briefly on the linguistic, conceptual, and social underpinnings that precede the advent of infants' first words. We then consider infants' initial forays into mapping their first words to meaning. To foreshadow, recent evidence reveals that infants cross the threshold into word learning equipped with a powerful and initially general expectation linking the linguistic and conceptual units. This general initial link gets bona fide word learning off the ground and sets the stage for subsequent lexical, grammatical, and conceptual developments. In the next section, we ask how young word learn-

ers move beyond this initially broad link. The evidence suggests that infants first tease out the grammatical category *noun* from among the other grammatical forms, and map them specifically to individual objects and categories of objects. This early establishment of a noun-to-category link serves as the foundation that enables infants to discover the other essential grammatical forms (e.g., adjectives, verbs) and map them to their respective meanings. After considering several consequences of the early acquisition of nouns, we focus on the acquisition of adjectives and verbs. In both cases, the patterns of acquisition differ importantly from the acquisition of nouns, and appear to depend on the prior acquisition of (at least some) nouns. We suggest that this follows directly from the distinct informational requirements and conceptual entailments of each of these distinct predicate forms.

Several overarching themes appear throughout the chapter. Each has figured largely in the history of research on word learning and each continues to exert considerable force in contemporary theoretical and empirical work.

### Cross-Linguistic Evidence

One theme is related to the place of cross-linguistic evidence in theories of acquisition. As noted, the mappings between grammatical and conceptual categories vary across languages. This variability illustrates two related points. First, the precise mappings between particular grammatical and conceptual categories must involve learning. Second, cross-linguistic comparisons can be a powerful tool for discovering which aspects of word learning (if any) might derive from principles of grammatical architecture and which might be more malleable across development and across languages (Bornstein et al., 2004; Bowerman & Levinson, 2001; Gentner, 1982; Imai & Gentner, 1997; Maratsos, 1998; Sera, Bales, & del Castillo Pintado, 1997; Sera et al., 2002; Snyder, Senghas, & Inman, 2001; Uchida & Imai, 1999).

### The Privileged Position of Nouns

This chapter also calls attention to the developmental priority of one grammatical form—*noun*—in early acquisition. We consider the evidence for and the sources underlying the dominance of nouns over other grammatical forms in the early lexicon. But we also point out that the very fact that nouns are acquired so early serves as a strong signal that this grammatical category may differ importantly from the others. From this observation, it

follows that noun learning may not be the paradigmatic case for word learning more generally. As a result, the vast majority of research and theory on word learning, which has focused predominantly on the acquisition of nouns (primarily those nouns referring to individual objects and categories of objects), can only take us so far. Language is filled with words referring to properties (*blue*), events (*jump*), and relations (*meet*) and with words that quantify over objects (*the, every, some*) and events (*always, never, sometimes*). The language learner must ultimately come to understand the mapping between a wide range of linguistic devices and the meanings they convey. A fully representative theory of word learning requires that we adopt a broad perspective, encompassing the acquisition of the full range of word-types learned by children. In essence, then, we are suggesting that the very real developmental priority for nouns in early acquisition should not be equated with a research priority to focus on nouns to the exclusion of other kinds of words.

### Structure: In the Input or in the Mind

The cognitive sciences have been shaped by the fundamental tension between nature and nurture, and the field of word learning is no exception. Although this tension has traditionally been viewed as oppositional, it is now clear that these are best seen as complementary, working hand-in-glove to support acquisition. Researchers must study the input to detect what structure, if any, is available to help infants discover words and assign them to meanings (L. Bloom, 2000; Bornstein et al., 2004; Hoff, 2002; Hoff & Naigles, 2002; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; Huttenlocher & Smiley, 1987; Huttenlocher, Vasilyeva, Cymerman, & Levine, 2002; MacWhinney, 2002; Naigles & Hoff-Ginsberg, 1995, 1998; Samuelson, 2002; Tomasello, 2003). It is also important to bear in mind that what *counts* as the input may be a function of development. At different developmental points, the learner may be able to apprehend different aspects of the very same piece of input, due either to maturation of their perceptual and conceptual systems or to their knowledge about the particular language they are learning.

In addition to examining the input, researchers must examine the representational capacities of the learner to detect what structure, if any, is inherent in the mind to make acquisition possible (R. Gelman & Williams, 1998). In these ventures, one must be mindful that structure may derive from the perceptual system (Jusczyk, 1997; Quinn & Eimas, 2000; Smith, 1999), the

conceptual system (Baillargeon, 2000; Spelke, 2003), the linguistic system (Crain, 1991; Lidz, Waxman, & Freedman, 2003), or might be the product of interactions among these systems (Hirsh-Pasek, Golinkoff, Hennon, & Maguire, 2004). Moreover, because word learning is a cascading developmental phenomenon, different representational structures or constraints on acquisition may become available at different points in development.

Recent research has made great strides in integrating these formerly oppositional sources of acquisition, documenting that learners are exquisitely sensitive to the input and at the same time, that there is structure within the learner that guides acquisition. The current mandate is to be as precise as possible about the balance between these sources and the interplay between them as development unfolds.

In word learning, this interplay between expectations inherent in the learner and the shaping role of the environment is essential (P. Bloom, 2000; Chomsky, 1980; Gleitman, 1990; Gleitman, Cassidy, Nappa, Papafragou, & Trueswell, in press; N. Goodman, 1955; Jusczyk, 1997; Quine, 1960). Certainly, infants cull information from the environment, for they learn precisely the words and the grammatical forms of the language that surrounds them, and precisely the concepts to which they are exposed (e.g., CD PLAYERS and SQUIRRELS in the United States; SCYTHES and PECCARIES in rural Mexico). But just as certainly, infants are guided by powerful internal expectations that guide the process and are themselves shaped in the course of acquisition.

This observation is especially important because, as pointed out, human languages differ not only in their cadences and their individual words, but also in the ways in which kinds of words (e.g., nouns, adjectives, verbs) are recruited to express fundamental aspects of meaning. Any theory of word learning must be sufficiently constrained to account for what appear to be universal patterns of acquisition in the face of this cross-linguistic variation. At the same time, it must be sufficiently flexible to accommodate the systematic variations that occur across languages and across developmental time.

In view of these overarching themes, our goal is to consider word learning from an integrative, dynamic, and distinctly developmental perspective, treating seriously the relative contributions of expectations held by the learner and the shaping role of the environment, as they unfold over time. In our view, infants' initial expectations, and their initial perceptual, conceptual, social, and linguistic sensitivities are not rigidly fixed. At each

step along the way, their abilities and sensitivities unfold, calibrated on the basis of the knowledge and structure that they have culled from the ambient language. Word learning, then, is a cascading process, in which information becomes available incrementally, as learners work their way toward solving pieces of the acquisition puzzle. Each accomplishment makes apparent a new problem and a new set of potential solutions.

## SETTING THE STAGE FOR WORD LEARNING: FOUNDATIONAL CAPACITIES

In this section, we consider the linguistic, conceptual, and social underpinnings to word learning and their evolution over the 1st year of life.

### Identifying the Words

Before word-learning can begin in earnest, infants must be able to parse a word from the continuous speech stream, and recognize that word across a range of utterances and from a range of different speakers. This task is difficult because there are few overt breaks in the speech stream and because the acoustic signature of a word varies dramatically as a function of the surrounding words and the speaker. Infants' solution to this piece of the word-learning puzzle emerges gradually over the 1st year of life. During this very active period, their sensitivities become increasingly tailored by the structural features of the native language in which they are immersed. Because this very active area of research is covered ably and in elegant detail in Saffran et al. (Chapter 2, this *Handbook*, this volume), we touch only briefly on two issues that are intimately tied to word learning (for other excellent reviews, see Aslin et al., 1998; Echols & Marti, 2004; Fisher et al., 2004; Guasti, 2002; Jusczyk, 1997; Werker & Fennell, 2004).

### *Discovering the Words and Word-Sized Units*

Decades of research have revealed that there is considerable structure in the linguistic input, to which infants gradually and systematically become sensitive. But it is also clear that infants approach the task equipped with some perceptual preferences or biases that enable them to take advantage of the structure in the input and, in this way, to discover the potential words of their language (Christophe, Mehler, & Sebastián-Gallés, 2001;

Fernald & McRoberts, 1996; Johnson, Jusczyk, Cutler, & Norris, 2003; Jusczyk, 1997; Liu, Kuhl, & Tsao, 2003; Morgan & Demuth, 1996).

Even at birth, infants prefer human speech (and particularly infant-directed speech, with its exaggerated rhythmic and pitch contours) over other sources of auditory stimulation (Jusczyk & Luce, 2002; Mehler et al., 1988; Singh, Morgan, & White, 2004; Vouloumanos & Werker, 2004). However, infants' attentional preferences for particular features undergo dramatic developmental change. During roughly the first 5 to 6 months, the melodies of infant-directed speech serve a primarily affective and attentional function, engaging and modulating infants' attention. By approximately 6 months of age, "words begin to emerge from the melody" (Fernald, 1992, p. 403) as infants become increasingly sensitive to cues in the speech stream that permit them to segment the continuous speech signal into word-sized units (Echols & Marti, 2004; Guasti, 2002; Jusczyk & Aslin, 1995; Saffran, Aslin, & Newport, 1996). Some cues (e.g., distributional, prosodic, and coarticulatory cues) appear to be universal and to be available early enough to get the process of word segmentation and identification off the ground. Other cues (e.g., phonetic, phonotactic, and morphologic cues) appear to be language-specific and to become available later, as infants discover which features carry the most weight in the language they are acquiring (Bosch & Sebastián-Gallés, 1997; Friederici & Wessels, 1993; Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; Nazzi, Jusczyk, & Johnson, 2000; Werker & Tees, 1984).

But whatever their origin, infants' evolving attention to these cues supports their discovery of the word and phrase boundaries of their native language. By 5 to 6 months of age, infants recognize their own names (Mandel, Jusczyk, & Pisoni, 1995), and by 6 to 7 months, they have begun to establish the meaning of other highly salient words (Tincoff & Jusczyk, 1999). These segmentation skills, in turn, make it possible for infants to track the relations (statistical and algebraic) among linguistically relevant units (Brent & Cartwright, 1996; Chambers, Onishi, & Fisher, 2003; Gomez & Gerken, 1999; Marcus, Vijayan, Rao, & Vishton, 1999; Mintz & Gleitman, 2002; Pena et al., 2003; Saffran et al., 1996; Shi & Werker, 2001; Shi, Werker, & Morgan, 1999). This is key, because successful word learning depends not only on the individual elements (sounds, syllables, words) but also on the relations among them.

### *Discovering the Distinction between Open- and Closed-Class Words*

Infants' sensitivity to the relations among words permits them to distinguish between two very broad classes of words: open class (content words, including nouns, adjectives, verbs) and closed class words (function words, including determiners, quantifiers, and prepositions; Gómez, 2002; Morgan, Shi, & Allopenna, 1996; Shady, 1996; Shady & Gerken, 1999; Shi et al., 1999; Shi & Werker, 2003). By 9 to 10 months of age, infants prefer to listen to open class words, possibly because they receive greater stress and enjoy more interesting melodic contours than do closed class words.

This preference for open class words represents an important step on the way to word learning, for it ensures that by the close of their 1st year, infants not only parse words successfully, but also devote special attention to just those words (the open class, content words) that have rich conceptual content and that will appear first in their productive lexicon. Moreover, infants' rather exquisite sensitivity to the relative position of open and closed class words provides an entry point into the discovery of other distinct grammatical form categories (Brent & Cartwright, 1996; Gómez, 2002; Redington, Chater, & Finch, 1998; Shi & Werker, 2003).

### **Identifying the Relevant Concepts**

The solution to this second piece of the puzzle rests on the infants' ability to identify objects and events in the environment, and to notice relations among them. Once again, the evidence suggests that this ability is supported both by structure that is available in the input (perceptual similarities among members of a given concept) and structure in the infant. In particular, there is evidence that even before they begin to learn words, infants have an impressive repertoire of core concepts involving objects, events, and relations (Baillargeon, 2000; Spelke, 2003). Some of their prelinguistic concepts are focused primarily on perceptual or sensory properties (e.g., RED, FAST, HAS EYES; see Quinn & Eimas, 2000); other prelinguistic concepts are more conceptual in nature. By 6 or 7 months, infants can identify distinct objects (e.g., a particular puppy) and can also categorize individuals into several different richly structured object categories at various levels of abstraction (e.g., basic-level categories like *dog*, and more abstract domain-level categories, like *animate*; Behl-Chadha, 1995; Mandler & McDonough,

1998; Quinn & Johnson, 2000; see S. A. Gelman & Kalish, Chapter 16, this *Handbook*, this volume, for a discussion of animacy; and Booth & Waxman, 2002b; Keil, 1994; Prasada, 2003; Spelke & Newport, 1998, for evidence pertaining to the early emergence of the concept ANIMATE). Infants also appear to represent individual actions within a host of richly structured event-based relations, including CAUSE, CONTAINMENT, and SUPPORT (Baillargeon, 2000; Leslie & Keeble, 1987; Michotte, Thines, & Crabbe, 1991; Oakes & Cohen, 1994; Wagner & Carey, 2003).

The richness and depth of the infants' early conceptual repertoire is impressive in and of itself. But it also raises a thorny problem for the infant as she breaks into a system of word learning: For if infants appreciate such a rich range of concepts and relations, and if each is a viable candidate for a word's meaning, then how do infants discover which of these candidates is to be mapped to the word that they have parsed (Quine, 1960)? In the next section, we consider the ways in which infants' sensitivity to the intentions of others helps them to solve this piece of the learning puzzle.

### Interpreting the Intentions of Others

Neither the ability to identify a novel word nor the ability to represent individuals or concepts guarantees that the infant will successfully weave these linguistic and conceptual units together. To successfully map words onto their intended referents, the infant must also be able to infer something about the goals and intentions of the speakers around them. Research into this issue has flourished in the past decade, fueled in large part by an ingenious program of research aimed at uncovering what infants understand about the intentions of others and how they recruit their emerging social and pragmatic acumen to infer the intention of speakers in the task of word learning (see Woodward & Markman, 1998, for an excellent overview; also Baldwin & Moses, 2001; L. Bloom & Tinker, 2001; Jaswal & Markman, 2003; Meltzoff, 2002; Tomasello & Olguin, 1993; Woodward, 2004; Woodward & Guajardo, 2002). By 9 to 10 months of age, infants successfully and spontaneously follow speakers' eye-gaze and gestures (especially pointing), and they use these to home in on the intended focus in a naming episode: Infants are more likely to map a novel word to an object if the speaker is attending to that object than if her attention is directed elsewhere (Brooks & Meltzoff, 2002; Carpenter, Akhtar, & Tomasello, 1998; Hollich, Hirsh-Pasek, et al., 2000;

Meltzoff, Gopnik, & Repacholi, 1999; Moore, Angelopoulos, & Bennett, 1999; Woodward, 2003).

### Conclusions about Initial Acquisitions

By the close of their 1st year, the foundations for word learning are in place. Infants have made significant headway in identifying the phonological units that will become their first words and in representing the conceptual units that will underlie their first meanings; and they are sensitive to the social and pragmatic cues that help them to weave these linguistic and conceptual units together (Baldwin & Baird, 1999; Baldwin & Markman, 1989; L. Bloom, 1998, 2000; Diesendruck, Markson, Akhtar, & Reudor, 2004; Echols & Marti, 2004; Fulker-son & Haaf, 2003; Gogate, Walker-Andrews, & Bahrick, 2001; Guajardo & Woodward, 2000; Tomasello & Olguin, 1993). In the next section, we consider how infants, armed with these foundational capacities, make their first forays into word learning.

### FIRST STEPS INTO WORD LEARNING: A BROAD INITIAL LINK BETWEEN WORDS AND CONCEPTS

How can we best characterize infants' initial steps over the threshold into word learning? This issue has been a virtual magnet for attention on both the theoretical and empirical fronts. Some have argued forcefully that infants cross this threshold as *tabulae rasae*, with no links between their linguistic and conceptual units to serve as guides. In one especially influential version of this argument, Smith and her colleagues have claimed that early word learning is no different from any other kind of learning (Smith, 1999; Smith, Colunga, & Yoshida, in press). In this view, infants' first words are acquired in the absence of any guiding expectations, and it is only after infants have acquired a sizable productive lexicon that they begin to detect any links between linguistic and conceptual units (Smith, 1999). Moreover, in this view, words are tied tightly to perceptual experience, with little or no influence of conceptual relations. Others have argued with equal force for a very different view, asserting that infants harbor powerful, albeit general, expectations linking linguistic, perceptual, and conceptual units from the start (Balaban & Waxman, 1997; Booth & Waxman, 2003; Gopnik & Nazzi, 2003; Graham, Baker, & Poulin-Dubois, 1998; Poulin-Dubois,

Graham, & Sippola, 1995; Waxman & Booth, 2003; Waxman & Markow, 1995; Xu, 2002).

To adjudicate between these positions, we must start at the beginning, asking whether we can discern any links, however rudimentary, between the linguistic and conceptual systems of infants at the very onset of word learning. As noted, if such links exist, they will likely be less precise than those of mature speakers, because languages vary in the grammatical forms they represent and the way they recruit these forms to convey meaning. But it is certainly possible that infants begin with a broad language-general link that supports infants' first steps in lexical acquisition and that can then be more finely tuned as infants gain experience with the particular language being acquired.

Waxman and Markow (1995) used a novelty-preference design to discover whether infants ranging from 12 to 14 months of age harbor any links between linguistic and conceptual organization. During a *familiarization phase*, an experimenter offered the infant four different toys from a given object category (e.g., four animals), one at a time, in random order. This phase was immediately followed by a *test phase*, in which the experimenter simultaneously presented both (a) a new member of the now-familiar category (e.g., another animal) and (b) an object from a novel category (e.g., a fruit). Infants manipulated the toys freely throughout the task. Their total accumulated manipulation time served as the dependent measure. Each infant completed this task with four different sets of objects, two involving basic level categories (e.g., horses versus cats) and two involving superordinate level categories (e.g., animals versus fruit).

To identify any influence of novel words, infants were randomly assigned to one of three conditions that differed only during the familiarization phase of the experiment. Infants in the noun condition heard, for example, "See the *fauna*?" Those in the adjective condition heard "See the *faun-ish* one?" Those in a no-word control condition heard "See here?" At test, infants in all conditions heard precisely the same phrase ("See what I have?"). The experimenters presented novel words, rather than familiar ones, because their goal was to discover what links, if any, infants hold when it comes to mapping a new word to its meaning. If they had used familiar words (e.g., *dog*), performance could have been influenced by their understanding of those particular words, and could not speak to the more fundamental issue of the links between words and meaning.

The predictions were as follows: If infants noticed the category-based commonality among the four familiar-

ization objects, then they should reveal a preference for the novel object at test. If infants detected the presence of the novel words, and if these words directed their attention toward the commonalities among the objects presented during familiarization, then infants hearing novel words should be more likely than those in the no word control condition to reveal a novelty preference. Finally, if the initial link between words and concepts is general at the start, then infants in both the noun and adjective conditions should be more likely than those in the no word condition to form categories.

These predictions were borne out. Infants in the no-word control condition revealed no novelty preference, suggesting that they had not detected the category-based commonalities among the familiarization objects. In contrast, infants in both the noun and adjective conditions revealed reliable novelty preferences, indicating that they had successfully formed object categories.

This result provides clear evidence for an early, foundational link between word learning and conceptual organization. Infants in these experiments reliably detected the novel words, and these words held consequences for their conceptual organization. In essence, the words served as *invitations* to form categories (Brown, 1958). Providing infants with a common name (at this developmental point, either a noun or an adjective) for a set of distinct objects highlighted the commonalities among them and promoted the formation of object categories. More recent work has revealed that this invitation does more than simply highlight concepts that infants may already represent; it also supports the discovery of entirely novel concepts, comprised of entirely novel objects (P. Bloom, 2001; Booth & Waxman, 2002a; Fulkerson & Haaf, 2003; Gopnik, Sobel, Schulz, & Glymour, 2001; Maratsos, 2001; Nazzi & Gopnik, 2001). Moreover, this invitation has considerable conceptual force: Although novel words were presented only during the familiarization phase, their influence extended beyond the named objects, directing infants' attention to the new—and unnamed—objects present at test.

### Specificity of the Initial Link

This demonstration of a broad initial link between words and concepts attracted considerable attention and raised several further questions, especially concerning the specificity of this phenomenon. On the linguistic side, researchers have asked whether infants' early expectation is specific to words, or whether it is apparent with sounds more generally. This question bears on issues of domain

specificity. On the conceptual side, researchers have explored whether the invitation is specific to the kinds of commonalities that underlie object categories or whether it also applies to a broader range of candidate meanings (e.g., property-based, event-related commonalities).

### *Words or Sounds?*

A key question is whether the facilitative effect of novel words on infants' categorization stems specifically from the presentation of novel words or whether this might be the consequence of a more general, attention-engaging function associated with any auditory stimuli. To address this issue, several research programs have compared the effects of novel words to the effects of nonlinguistic stimuli (e.g., tones, melodies, mechanical noises produced by simple toys). The results are somewhat mixed. On the one hand, at 9 to 12 months of age, when infants have just begun to reliably parse words from the speech stream, novel words promote categorization, but novel tones (matched precisely to the naming phrase in amplitude, duration, and pause length) and other, more complex nonlinguistic stimuli (e.g., repetitive, nonlinguistic mouth sounds; a brief melodic phrase) fail to do so (Balaban & Waxman, 1997). This suggests that there is indeed something special about words at this early developmental moment (but see Gogate et al., 2001; Sloutsky & Lo, 1999).

This is not to say that nonlinguistic stimuli have no effect on object categorization. Under certain circumstances, nonlinguistic sounds (e.g., whistles, melodic phrases), gestures, and even pictograms appear to promote object categorization in infants and toddlers. But the key finding is that they do so only in certain restricted experimental contexts, and in particular when an experimenter makes it clear that her intention is to treat these nonlinguistic stimuli as object names. For example, if nonlinguistic stimuli are presented within familiar naming routines or if they are produced intentionally by an experimenter who is interacting directly with the infant and a salient object, then these nonlinguistic stimuli can promote object categorization (Fulkerson, 1997; Fulkerson & Haaf, 2003; Namy & Waxman, 1998, 2000, 2002; Woodward & Hoyne, 1999). In contrast, when these social and pragmatic cues are stripped away, nonlinguistic elements fail to support object categorization (Balaban & Waxman, 1997; Campbell & Namy, 2003; Fulkerson & Haaf, 2003).

This pattern of results is consistent with the position that infants take advantage of several kinds of cues to dis-

cover word meaning (Hall & Waxman, 2004; Hollich, Hirsh-Pasek, et al., 2000). When the cues converge with sufficient strength, nonlinguistic elements can be interpreted as "names for things." Absent these cues, nonlinguistic elements fail in this regard. Moreover, infants' willingness to accept nonlinguistic elements as names decreases over the course of the 2nd year of life, as they become aware that although nonlinguistic stimuli (including gestures) certainly augment spoken language, they do not typically function as category names (for a review of gesture, see Goldin-Meadow, Chapter 8, this *Handbook*, this volume; Namy, Campbell, & Tomasello, 2004). Thus, from the earliest stages of word learning, there appears to be something special about words. Infants interpret words, but not other sounds or gestures, as inherently connected to meaning.

### *Object Categories or a Broader Range of Concepts?*

In addition to gaining clarity on what counts as a word at this early juncture, researchers have also explored more broadly the evidence on the conceptual side, asking whether infants initially link novel words exclusively to category-based commonalities (e.g., rabbits, animals), or whether this early link might encompass a wider range of commonalities, including property-based commonalities (e.g., color: pink things; texture: soft things) and event-based commonalities (e.g., flying; rolling).

Notice, however, that in all the experiments reviewed thus far, the only candidates for word meaning were individual objects or categories of objects. Yet, object categories represent only a small portion of the concepts that infants entertain and that words can denote. Therefore, to better characterize the scope of infants' initial expectation, it is necessary to examine a broader range of candidate meanings in word-learning experiments. With this goal in mind, Waxman and Booth (2001) went one step further, asking whether novel words highlight property-based commonalities (e.g., color, texture) as well as category-based commonalities among objects. The design of this series of experiments is described fully in the Acquisition of Nouns section later in this chapter. For the moment, we simply highlight one result from that series indicating that infants begin word learning with a broad expectation for candidate meanings. At 11 months of age, novel words (presented as either nouns or adjectives) directed infants' attention broadly to both category- and property-based commonalities.

This is an important finding because, thus far, only a handful of experimental studies have documented suc-

successful word learning in infants at this age (Balaban & Waxman, 1997; Fulkerson & Haaf, 2003; Welder & Graham, 2001; Woodward, Markman, & Fitzsimmons, 1994). But even more important, the results revealed that infants begin the task of bona fide word learning equipped with a broad expectation that links content words (including both nouns and adjectives) to a broad range of candidate meanings (allowing for either category- or property-based commonalities).

### *Advantages of a Broad Initial Link*

From the perspective of the learner, this general expectation offers an important developmental advantage. Because different languages make use of different sets of grammatical categories and because they use these to carve up semantic space in slightly different ways, it is to the learner's advantage to begin with only the most general expectations that highlight a range of commonalities and enable the learner to break into the system of word learning in the first place.

This broad initial link serves (at least) three essential functions. First, because words initially direct attention to a broad range of commonalities, they facilitate the formation of an expanding repertoire of concepts, and help to focus infants' attention on concepts that may otherwise have gone undetected. Second, this broad initial link between words and concepts provides infants with a means to establish a stable rudimentary lexicon. Finally, this initially broad expectation sets the stage for the evolution of the more precise expectations found in their native language.

## **LATER STEPS INTO WORD LEARNING: MORE SPECIFIC LINKS BETWEEN KINDS OF WORDS AND KINDS OF CONCEPTS**

Our goal in this section is to ask how infants advance beyond an initially general expectation for words, how they establish a more precise set of expectations, and how they tease apart the distinct grammatical forms and discover their links to meaning.

Facing the linguistic domain, the question is when (and under what circumstances) infants begin to distinguish among the major grammatical forms (e.g., noun, adjective, verb) that are represented in their language. Facing the conceptual domain, the question is when they begin to map these grammatical forms to distinct kinds of meaning (e.g., category, property, actions, relations).

### **The Acquisition of Nouns**

The evidence indicates that infants first tease out the nouns from among the other grammatical forms and map them specifically to category-based commonalities. We consider the conceptual consequences of this noun-to-category link, as well as the linguistic and conceptual forces supporting its emergence.

### *The Evolution of a Link between Nouns and Object Categories*

The first evidence for the evolution of a more precise link between kinds of words and kinds of meaning comes from infants at roughly 13 to 14 months of age. Retaining the logic of the novelty-preference task described earlier, Waxman and Booth (2001, 2003) shifted the focus to include objects (e.g., purple animals) that shared both category-based commonalities (e.g., animal) and property-based commonalities (e.g., color: purple things). This design feature permitted them to examine infants' conceptual flexibility as well as the influence of novel words on conceptual organization. More specifically, they asked (a) whether infants could construe the very *same* set of objects (e.g., four purple animals) flexibly, either as members of an *object category* (e.g., animals) or as embodying an *object property* (e.g., color: purple), and (b) whether infants' construals were influenced systematically by novel words. For a discussion of the psychological distinction between category- versus property-based commonalities, see Waxman, 1999; Waxman & Booth, 2001; S. A. Gelman & Kalish, Chapter 16, this *Handbook*, this volume.<sup>6</sup>

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<sup>6</sup>This approach is predicated on the assumption that there is, indeed, a principled psychological distinction between categories versus properties of objects. Most current theorists distinguish object categories (also known as *kinds* or *sortals*) from other types of groupings (e.g., *purple things*, *things to pull from a burning house*) on at least three (related) grounds: Object categories (1) are richly structured, (2) capture many commonalities, including deep, nonobvious relations among properties (as opposed to isolated properties), and (3) serve as the basis for induction (Barsalou, 1983; Bhatt & Rovee-Collier, 1997; S. A. Gelman & Medin, 1993; Kalish & Gelman, 1992; Macnamara, 1994; Medin & Heit, 1999; Murphy & Medin, 1985; Younger & Cohen, 1986). Although infants and children have less detailed knowledge about many object categories than do adults, they clearly expect named object categories to serve these functions (S. A. Gelman, 1996; Keil, 1994; Waxman, 1999; Welder & Graham, 2001).

This experiment consisted of three phases. Each infant completed the entire procedure four times, using four different sets of objects. In the *familiarization phase*, infants in all conditions viewed four distinct objects (e.g., four different purple animals), all drawn from the *same object category* (e.g., animal) and embodying the *same object property* (e.g., purple). These objects were presented two at a time, and the experimenter's comments when she presented them varied as a function of the infant's condition assignment. In the noun condition, she presented the two objects saying, for example, "These are *blickets*. This one is a *blicket* and this one is a *blicket*." In the adjective condition, she said, "These are *blickish*. This one is *blickish* and this one is *blickish*." In the no-word control condition, she said, "Look at these. Look at this one and look at this one."

In the *test phase*, they saw a category match (e.g., a blue horse; same category as familiarization objects, but new property) pitted directly against a property match (e.g., a purple spatula; same property as familiarization objects, but a new category). To assess *novelty-preference*, the experimenter placed the test pair easily within the infant's reach, saying, "Look at these." No labels were provided, and infant's attention to the objects was recorded. Next, to assess *word-extension*, the experimenter presented a target object (one of the original familiarization objects, e.g., a purple elephant), and pointed to it saying, "This one is a *blicker*" (noun condition), "This one is *blickish*" (adjective condition) or "Look at this one" (no-word condition). She then presented the two test objects, placing them easily within the infant's reach, saying, "Can you give me the *blicket*?" (noun condition), "Can you give me the *blickish* one?" (adjective condition) or "Can you give me one?" (no-word condition). By assessing both novelty-preference and word-extension, these researchers were able to ask whether infants' early expectations, previously evident in novelty-preference tasks only, are sufficiently robust to influence performance in the more active word-extension task.

Infants at 11 months revealed evidence for a broad initial expectation: They mapped novel words (either nouns or adjectives) to commonalities among objects (either category- or property-based commonalities; Waxman & Booth, 2003). In contrast, by 14 months, infants distinguished novel nouns from adjectives. They mapped novel nouns specifically to category-based (but not to property-based) commonalities among objects. Yet, at this same developmental moment, their mapping

for novel adjectives remained more general. As was the case at 11 months, 14-month-old infants typically tended to map novel adjectives broadly, either to category- or property-based commonalities. Although in some tasks, infants showed a more advanced pattern, mapping novel adjectives specifically to property-based (and not category-based) commonalities, this was a fragile effect, evident only under certain circumstances (Waxman & Booth, 2001).

In an independent line of research using the preferential-looking procedure, Echols has documented a similar developmental pattern (Echols & Marti, 2004). Focusing on infants' expectations for nouns and verbs, these researchers provide converging evidence that the link between nouns and object categories is first to emerge from a more general expectation. Infants in this task faced two video monitors. In the *familiarization phase*, infants watched as a novel object (e.g., an anteater) produced a novel action (e.g., opening/closing a cup). The infants saw this event first on one screen, then on the other, and then finally on both screens simultaneously. In the *test phase*, the scenes that were depicted changed, with one screen depicting the now-familiar object engaged in a novel action (e.g., the anteater spinning the cup) and the other depicting a novel object engaged in the now-familiar action (e.g., a manatee opening/closing the cup).

To identify whether the grammatical form of the novel word influenced infants' construal of these scenes, infants were randomly assigned to either a novel noun, novel verb, or no-word control condition. In the novel noun condition, infants heard, for example, "That's a *gep*; it's a *gep*." Those in the novel verb condition heard "It is *gepping*; it *geps*." At test, infants heard either "Look at the *gep*!" or "Look at it *gepping*" in the novel noun and novel verb conditions, respectively. If infants can distinguish novel nouns from verbs, and if they use grammatical form to infer novel words meanings, then infants hearing nouns should prefer the scene with the familiar object, and those hearing verbs should prefer the scene with the familiar action. And if infants' expectations regarding nouns emerges first, then infants hearing nouns should prefer the scene with the novel action, but infants hearing verbs should show no preference. This result would run parallel to those described earlier for nouns and adjectives (Waxman & Booth, 2001, 2003).

The results were consistent with the hypothesis that the link between nouns and object categories is the first to emerge in acquisition. At 13 months, infants in the

novel noun condition revealed a reliable preference for the familiar object, but those in the novel verb condition revealed no preference, looking equally to the two test screens. By 18 months, infants had acquired a more specific expectation for verbs. At this point, they mapped the novel nouns specifically to the familiar objects *and* the novel verbs specifically to the familiar actions (for related evidence, see Casasola & Cohen, 2000; Forbes & Poulin-Dubois, 1997).

Taken together, this research suggests that by 13 to 14 months, infants are sensitive to (at least some of) the relevant cues that distinguish among the grammatical forms, and they recruit these distinctions actively. At this developmental moment, they map nouns rather specifically to object categories, but their expectations for adjectives and verbs remain somewhat broad. Infants' sensitivity to the more specific expectations mapping these latter grammatical forms to their associated range of meanings represents a subsequent developmental achievement.

Summarizing to this point, we have argued that infants' broad initial expectations in word learning serve as a foundation for two discoveries: that there are distinct kinds of words (grammatical categories) in their language, and that there are correlations between these grammatical categories and the types of meaning that they convey. We suspect that these two discoveries go hand-in-hand, each adjusting gradually to the other, in a process akin to Quine's now-classic example of the child scrambling "up an intellectual chimney, supporting himself against each side by pressure against the others." (Quine, 1960, p. 93). We suspect that infants discover that there are distinct grammatical forms when they begin to notice the distinct patterns or grammatical frames in which distinct (kinds of) words occur (e.g., that some tend to be inflected or stressed, that some tend to be preceded consistently by (unstressed) closed class words, that some tend to occupy particular positions within phrases; Brent & Cartwright, 1996; Maratsos, 1998; Mintz, 2003; Mintz, Newport, & Bever, 2002).

Moreover, we have argued that as infants begin to scramble up the chimney of lexical acquisition, they first identify the nouns (from among the other grammatical forms) and map these specifically to object categories (from among the other types of commonalities, including property-based or action-based commonalities). Subsequent links (e.g., those for adjectives and verbs) will build on this fundamental base and will be fine-tuned as a function of experience with the specific correlations

between particular grammatical categories and their associated meanings in the language being acquired.

### *Further Evidence Concerning Nouns*

The evidence for the early emergence of a link between nouns and object categories makes contact with an impressive array of literature focusing on the acquisition of nouns and their relation to object categories (see Woodward & Markman, 1998 for an excellent review; also see P. Bloom, 2000; Golinkoff et al., 2000; Hirsh-Pasek et al., 2004). Decades of devoted research on this topic have led to several important insights. Several research programs have focused on how children map *particular* nouns to their *particular* meaning. In this arena, researchers have discovered in infants and young children a strong tendency to interpret a novel noun (e.g., *dog*), applied to an individual object, as referring to a category of objects at the basic level within a conceptual hierarchy (Hall & Waxman, 1993; Markman & Hutchinson, 1984; Markman & Jaswal, 2004; Mervis, 1987; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Schafer & Plunkett, 1998; Waxman, 1990). Only after having established a name for the basic level category do children go on to interpret novel nouns as referring to categories at other hierarchical levels of abstraction (e.g., terrier, mammal, animal), or to individuals (e.g., Rover). This priority for naming objects at the basic level, which appears to be evident broadly across languages and cultures (Berlin, 1992; Berlin, Breedlove, & Raven, 1973), likely facilitates the process of word learning: This conceptual priority to name at the basic level effectively narrows the range of candidate meanings. Having established a basic level name, infants and children then go on to add names for categories at other hierarchical levels and to coordinate those names within semantic space (Diesendruck, Gelman, & Lebowitz, 1998; Diesendruck & Shatz, 2001; Imai & Haryu, 2004; Waxman & Senghas, 1992).

Other research has focused on how children discover the various *types* of nouns that are represented in their language (e.g., count nouns, mass nouns, proper nouns, generic nouns) and how these types map to meaning (Hall & Lavin, 2004; Markman & Jaswal, 2004; Prasada, 2000). Central to this endeavor has been an examination of cross-linguistic evidence, since languages differ in whether and how these distinctions are made within the nominal system (Bowerman & Levinson, 2001; Gathercole & Min, 1997; Gathercole, Thomas, & Evans, 2000; Imai, 1999; Imai & Gentner, 1997; Imai &

Haryu, 2004; Lucy & Gaskins, 2001; Wierzbicka, 1984). Current evidence with English-acquiring infants suggests that these distinctions among types of nouns may emerge toward the end of the 2nd year (Belanger & Hall, in press), at roughly the same time as the expectations for adjectives and verbs (Echols & Marti, 2004; Waxman & Booth, 2003).

Because the very rich research documenting an early talent for mapping nouns to meaning has been reviewed ably and elegantly elsewhere (P. Bloom, 2000; Gentner & Boroditsky, 2001; Golinkoff et al., 2000; Hall & Waxman, 2004; Woodward & Markman, 1998), we leave these issues aside to focus on newer advances.

### *The Noun Advantage*

The evidence previously reviewed, documenting the early emergence of a link between nouns and categories of objects, resonates with the long-held observation that early word learning is characterized by an abundance of nouns relative to words from other grammatical categories (Caselli et al., 1995; Gentner & Boroditsky, 2001; Huttenlocher, 1974; Woodward & Markman, 1998; and see Bornstein et al., 2004 for an excellent cross-linguistic review). This observation has been the subject of some controversy. A number of researchers have claimed that this noun advantage is not universal, and have focused on the relative frequency of nouns versus verbs in the speech of children learning languages like Korean (Choi, 1998, 2000; Choi & Gopnik, 1995; Gopnik & Choi, 1995; Gopnik, Choi, & Baumberger, 1996) and Mandarin (Tardif, 1996; Tardif, Gelman, & Xu, 1999; Tardif, Shatz, & Naigles, 1997) in which verbs may be more salient in the input (Slobin, 1985; see also Sandhofer, Smith, & Luo, 2000). Others, however, have focused primarily on the relative frequency of nouns and verbs in mothers' reports of their children's speech, and have argued that children acquiring a wide variety of languages, including Dutch, French, Hebrew, Italian, Japanese, Kaluli, Korean, Mandarin, Navajo, Spanish, and Turkish, show an advantage for nouns over verbs, mirroring that reported for English-learning children (Au, Dapretto, & Song, 1994; Bassano, 2000; L. Bloom, Tinker, & Margulis, 1993; Camaioni & Longobardi, 2001; Fernald & Morikawa, 1993; Gentner, 1982; Goldfield, 2000; Kim, McGregor, & Thompson, 2000).

Despite these controversies, one conclusion is clear: Although the strength of the noun advantage may vary across languages and across vocabulary measures, there are no reported cases in which verb learning outstrips

noun learning. This early noun advantage calls for an explanation, and three have been put forth, each of which may account for some portion of the data.

The natural partitions/relational relativity hypothesis (Gentner, 1982; Gentner & Boroditsky, 2001; Gentner & Namy, 2004) argues that the noun advantage is a consequence of a conceptual or perceptual advantage in identifying objects in the world over relations among them. On this view, because objects come in tidy preindividuated packages, they are easy to identify and therefore serve as good candidates for word meaning. Because relational concepts (even for concrete, observable actions) are more nebulous, they are harder to identify. As a consequence, terms that refer to these relational meanings are learned later and are more variable across languages (Papafragou, Massey, & Gleitman, 2002). The natural partitions/relational relativity position, which focuses heavily on the conceptual and perceptual requirements of word learning, has been influential. However, it does not take into account that most nouns, even those concrete nouns that predominate in the early lexicon, do not refer to individual objects, but are instead extended quite spontaneously beyond the individuals on which they were learned. This observation is very important, because it means that infants' early words point to rather abstract concepts and not to tidy preindividuated packages (Waxman & Markow, 1995). This being the case, the question is whether *object concepts* are in some sense simpler than *relational concepts*, an issue that has yet to be resolved (Chierchia & McConnell-Ginet, 2000; Heim & Kratzer, 1998; Moltmann, 1997).

A second explanation for the noun advantage focuses more directly on cultural and linguistic factors. In brief, the claim is that the noun advantage may be related to cultural factors that make objects more salient than relations among them. On this view, cultural factors work in concert with other acoustic, prosodic, or syntactic factors that make nouns more salient than other grammatical forms in speech to children (S. A. Gelman & Tardif, 1998; Lavin, Hall, & Waxman, in press).

A third explanation for the noun advantage, to which we have already alluded, highlights the differences in the linguistic requirements underlying the acquisition of nouns compared with other grammatical categories (Fisher, Hall, Rakowitz, & Gleitman, 1994; Fisher & Tokura, 1996; Gillette, Gleitman, Gleitman, & Lederer, 1999; Gleitman, 1990; Mintz & Gleitman, 2002). Because adjectives and verbs are predicates that require arguments for their meaning, and because it is the nouns

that serve as these arguments, the acquisition of these grammatical forms and their links to meaning must be grounded in the prior acquisition of at least some nouns. Because nouns typically have fewer linguistic prerequisites, they can be learned first, and can then be used as a foothold for the subsequent acquisition of words from other grammatical categories.

### *More Than “Names for Things”: Consequences of Early Noun Learning*

In recent years, researchers have begun to explore more broadly the *consequences* of acquiring nouns on infants’ conceptual and linguistic representations. A growing body of evidence, based on several experimental paradigms, has converged to suggest that when infants acquire their first words, they acquire more than names for things. Noun learning engages and supports some of the most fundamental logical and conceptual capacities of the human mind, including the processes of object individuation, object categorization, and inductive inference. Infants’ efficiency in identifying and processing nouns in the input also increases rapidly in infancy.

**Conceptual Consequences: Individuation** Object individuation, or the ability to track the identity of distinct individuals over time and place (Macnamara, 1982), is a fundamental conceptual and logical capacity. It permits us to know whether, for example, the dog we see now is the same dog we saw previously, or whether these are two different individuals. Under certain circumstances, infants have difficulty tracking the identity of two distinct objects (e.g., a ball and a duck; Van de Walle, Carey, & Prevor, 2000; Wilcox & Baillargeon, 1998; Xu, 1999; Xu & Carey, 1996). This was demonstrated in a series of experiments in which infants, seated before a stage with a small screen, watched as one object (e.g., a ball) emerged from one side of the screen and then returned. Next a different object (e.g., a duck) emerged from the other side of the screen and returned. After several such appearances and disappearances, the screen was lowered to reveal either one or two objects. If infants were able to track the identity of the two distinct objects, they should look longer on test trials revealing one object (the unexpected outcome) than on those revealing two (the expected outcome). Although 12-month-olds succeeded, 10-month-olds had difficulty tracking identity in this complex task (but see Wilcox, 1999; Wilcox & Baillargeon, 1998, for evidence that they succeed in simpler tasks).

However, Xu (1999) went on to examine the effect of naming each object as it appeared, and in so doing, documented a powerful role for naming in object individuation. Ten-month-old infants who were introduced to the same name for the two appearing and disappearing objects (e.g., “It’s a toy!”) continued to have difficulty in this object individuation task. In contrast, those who heard distinct names for each object (e.g., “It’s a ball. . . . It’s a duck!”) succeeded. Apparently, then, providing distinct names for distinct objects highlights their uniqueness (rather than their commonalities) and supports very young infants’ ability to trace their identity over time.

Converging evidence for this view comes from infants’ performance in object categorization tasks. When objects (e.g., four different animals) are introduced with *distinct* (rather than common) names, infants fail to form categories (Graham, Kilbreath, & Welder, 2004; Waxman & Braun, 2005). It therefore appears that even for infants as young as 10 to 12 months of age, the conceptual consequences of word learning is nuanced. Providing the same name for a set of distinct individual objects highlights their commonalities and supports the formation of object categories, but does not support individuation. In contrast, providing *distinct* names for each individual highlights distinctions among them and promotes the process of object individuation (Van de Walle et al., 2000; Wilcox, 1999; Wilcox & Baillargeon, 1998; Xu, 1999). Thus, naming not only supports the establishment of a stable repertoire of object categories, but also provides infants with a means of tracing the identity of individuals within these categories.

**Conceptual Consequences: Induction.** One of the reasons that object categories have figured so largely in cognitive psychology, cognitive development, and cognitive science is that they have considerable inductive force. If we discover a property (e.g., bites if you pull its tail) that is true of one individual (e.g., Fido), we can infer that this property is also true of other members of the same object category (e.g., dogs). This is important because it permits us to extend our knowledge powerfully and systematically, taking us beyond our firsthand experience with distinct individuals and supporting category-based inferences. This inductive capacity is especially powerful when it comes to acquiring knowledge about nonobvious properties of objects.

There is now considerable evidence that, for adults and preschool-age children, naming strongly supports

category-based induction. Naming permits us to go beyond the perceptible commonalities that we can observe firsthand, and points us toward the deeper, perhaps hidden commonalities that characterize some of our most fundamental concepts (see Diesendruck, 2003; S. A. Gelman & Kalish, Chapter 16, this *Handbook*, this volume). More recent research reveals that naming may also support inductive inference in infants.

In an ingenious line of experimental work, Graham and her colleagues (Graham et al., 2004; Welder & Graham, 2001) have documented the role of naming in infants' inductive inference. In their tasks, an experimenter introduced 13-month-old infants to a target object. For half the infants, the experimenter named the target object with a novel noun; for the remaining infants, no names were provided. All infants then witnessed the experimenter perform an action with the object. Crucially, this action revealed a property of the object that was not available by visual inspection alone (e.g., that it made a particular noise when shaken). Infants were then provided with an opportunity to explore a series of other objects; no names were provided for these objects. The results were striking. In the absence of naming, infants generalized the hidden property narrowly, trying to elicit it only with test objects that strongly resembled the target object. In the novel noun condition, however, infants revealed a very different pattern. They now generalized the "hidden" property of the target object more broadly to other members of the object category, even if they did not bear as strong a perceptual resemblance to the target object (Booth & Waxman, 2002a; Gopnik & Sobel, 2000; Graham et al., 2004; Nazzi & Gopnik, 2001; Welder & Graham, 2001).

Thus, for infants as young as 13 months of age, nouns do more than merely support the establishment of object categories; they also lend inductive force and advance the acquisition of category-based knowledge.

**Processing Consequences.** In another exciting line of new research, investigators have begun to examine with precision the time-course underlying infants' processing of spoken words in real time. Although infants as young as 9 to 12 months of age can learn the meanings of (some) words, the efficiency with which they are able to process the words that they hear improves dramatically over the 2nd year of life (Fernald, McRoberts, & Swingley, 2001a; Fernald, Pinto, Swingley, Weinberg, & McRoberts, 1998; Swingley & Aslin, 2000; Swingley, Pinto, & Fernald, 1999). Swingley and Fernald (2002)

demonstrated this phenomenon in a series of innovative experiments. Infants in their experimental paradigm are presented with visual images of two familiar objects (e.g., a ball and a shoe). These are presented simultaneously, on two sides of a screen, while an experimenter directs the infant's attention to one of the objects by naming it (e.g., "Where is the ball?"). The likelihood that an infant will happen to be looking at the appropriate object at the moment that the experimenter mentions the noun is 50%. But the focus in this technique is on those infants who happen to be looking at the unnamed object when the naming event occurs (e.g., the shoe, in our example). Swingley and Fernald reasoned that if these infants understand the meaning of the noun, then they should switch their attention from the unnamed to the named object. They further reasoned that the latency of infants' switches could serve as an index of the infants' processing time for these familiar nouns. Analyses of infants' latency to switch revealed that their processing of familiar nouns increased markedly in the 2nd year of life. Moreover, they documented that infants begin to process words even as the words are being uttered. That is, they use partial information (e.g., the first half of a word) to begin to map that word to meaning (Fernald, Swingley, & Pinto, 2001b).

We suggest that infants' rapid gains in processing efficiency for familiar nouns is likely to facilitate several additional aspects of word learning as well. In particular, their increasing facility in recognizing familiar nouns should also help them to detect those circumstances in which a novel word has been uttered. This in turn will permit them to devote their resources (both conceptual and linguistic) toward identifying the meaning of that word. Infants' gains in processing efficiency for familiar nouns should also support their ability to notice the relations among words within an utterance, and to use these relations to establish the meaning of a novel word. In a clever demonstration, Goodman and her colleagues (J. C. Goodman, McDonough, & Brown, 1998) presented infants with sentences that contained a novel noun (e.g., "Mommy feeds the ferret"). Their results revealed that 2-year-olds successfully discovered the meaning of the novel nouns (e.g., ferret) based on their semantic and syntactic relations to the familiar words in the sentence.

Infants' increasing efficiency in processing spoken words may be related to other changes in word learning during the 2nd year of life. Recent evidence reveals that during this period, as infants become more proficient word learners, their patterns of neural activation in re-

response to familiar words shifts from a bilateral to a left-lateralized response (Mills, Coffey-Corina, & Neville, 1997). This suggests that they become more efficient in processing words. This increased efficiency facilitates word learning in general, and may be especially helpful in their efforts to assign distinct meanings to words that are close phonological neighbors (Hollich, Jusczyk, & Luce, 2000; Schafer, Plunkett, & Harris, 1999; Werker, Cohen, Lloyd, Casasola, & Stager, 1998; Werker & Fennell, 2004; Saffran et al., Chapter 2, this *Handbook*, this volume) and to words whose referents are absent.

### **Conclusions about Nouns**

Infants as young as 13 months of age have already begun to discover some precise links between kinds of words and kinds of meaning. As they move from the broad initial link, they first tease apart the nouns from among the various other grammatical forms (e.g., adjectives, verbs) and map them specifically to objects and object categories (and not to object properties, including color, texture). This conclusion raises two (related) points.

First, the developmental advantage for acquiring nouns converges well with the view that learners must first identify the nouns and map them to entities in the world if they are to discover the other grammatical forms and their links to meaning (Fisher & Gleitman, 2002; Maratsos, 1998; Snedeker & Gleitman, 2004; Talmy, 1985; Wierzbicka, 1984). In addition to the conceptual and processing advantages conferred by the acquisition of nouns, there are important linguistic consequences of noun learning. In particular, the acquisition of nouns provides a gateway into the discovery of other grammatical categories and their mappings to meaning. More specifically, acquiring nouns enables the learner to build a rudimentary syntactic structure that contributes to the identification of other grammatical categories.

Second, it is now apparent that nouns are not the paradigm case for word learning. Their developmental trajectory and informational requirements differ markedly from those of the other major grammatical categories. Therefore, it is important to consider carefully the developmental trajectories of these other grammatical forms. Accordingly, we turn our focus to two such forms: adjectives and verbs.

### **The Acquisition of Adjectives**

Although theoretical and empirical interest in the acquisition of the grammatical form *adjective* has lagged far

behind that of nouns (and even verbs), recent years have witnessed an increase in interest. The evidence thus far makes it clear that at least some of the processes underlying the acquisition of adjectives differ substantially from those underlying the acquisition of nouns. As discussed, substantially more developmental and cross-linguistic variation is associated with adjectives than with nouns (see the first section for cross-linguistic evidence pertaining to adjectives). Adjectives tend to appear later than nouns in the early lexicon, and the specific link between adjectives and properties of objects emerges later than the link between nouns and categories. In essence, then, the link between adjectives and properties of objects is elusive.

This developmental picture is somewhat surprising. After all, adjectives are prevalent in infant-directed speech and even from the first months of life, infants are exquisitely sensitive to the concepts marked by adjectives (e.g., sensory and perceptual properties, including color, size, texture, temperature). This being the case, the mappings from adjectives to properties of objects should be straightforward. This was the conclusion expressed by John Locke, who claimed, "Thus the same colour being observed to-day in chalk or snow, which the mind yesterday received from milk, it considers that appearance alone, makes it a representative of all of that kind; and having given it the name *whiteness*, it by that sound signifies the same quality wheresoever to be imagined or met with." (Locke, 1690/1975, Bk. II, chaps. xi, p. 9).

Yet, Locke's account fails to capture the developmental process. Although infants certainly detect many properties that are named by adjectives, and although they rely on these properties when reasoning about objects and events (Needham & Baillargeon, 1998; Wilcox, 1999), they somehow do not consider such properties to be primary candidates for word meaning. In fact, when presented with a novel adjective (*white*) in the context of a novel object (a white llama), infants and toddlers tend to interpret that adjective as a name for the object category (e.g., llama) rather than to a property (e.g., its color). This robust finding has been documented in children up to 3 years of age (Hall & Lavin, 2004; Markman & Jaswal, 2004). This interpretive error is telling, because children at this age certainly distinguish nouns from adjectives. Moreover, we know that they already have established a link between adjectives and object properties because when they are presented with familiar objects (objects for which they have

already acquired noun labels), they readily map novel adjectives to object properties rather than to categories. It is when they are presented with objects for which they have not yet acquired a noun label that they persist in mapping adjectives to categories, instead of to properties. Thus, children's interpretation of a novel adjective varies with the familiarity of the noun that it modifies. Further, their interpretive error (mapping a novel adjective to a category- rather than property-based commonality when the noun label for the category is unknown) suggests that there is a conceptual or linguistic priority for lexicalizing an object's category (and in particular, its basic level category) before any of its properties or parts (Hall & Waxman, 1993; Hall, Waxman, & Hurwitz, 1993; Imai & Haryu, 2004; Markman, 1989; Markman & Hutchinson, 1984).

To complicate developmental matters still further, even when they succeed in mapping an adjective to a property of an object, infants do not follow Locke's optimistic program. Instead of extending novel adjectives freely and liberally (e.g., extending *white* from cats to milk, snow, and mittens), their initial tendency is to extend adjectives very narrowly, only to other members of the same basic level category that share that property (e.g., extending *white* from one cat to another; Klibanoff & Waxman, 2000; Mintz & Gleitman, 2002; Waxman & Markow, 1998).

Why is the mapping from adjectives to object properties so elusive? In the following section, we address this question. We focus primarily on the early acquisition of adjectives referring to color and texture, because most of the recent developmental work has been centered here. However, not all adjectives are created equal. Some adjectives (e.g., *big* versus *small*) refer primarily to the poles of an entire dimension (e.g., size), whereas others pick out a range of values (e.g., *red*, *orange*, *yellow*) along the entire dimension (e.g., color; Landau & Gleitman, 1985). Although we will not treat this issue directly here, we point out that factors like these will probably have consequences for patterns of acquisition for most property terms.

### **Developmental Work**

Several different approaches have been adopted to capture the developmental processes underlying infants' and young children's acquisition of adjectives (Gasser & Smith, 1998; Hall & Belanger, in press; Hall, Quantz, & Persoage, 2000; Mintz & Gleitman, 2002; Prasada, 1997; Waxman & Markow, 1998). These approaches

share some key design elements. To maximize the likelihood that infants will map the novel word to an object property, most experiments (a) introduce objects for which infants have already acquired a basic level noun label, (b) use properties that infants find salient (e.g., color; texture),<sup>7</sup> and (c) present the novel adjectives within short syntactic frames, using the intonational contours of infant-directed speech. Yet despite these design features, infants and toddlers reveal an intriguing difficulty establishing the mappings for adjectives, and when they do succeed, their interpretations appear to depend on the nouns that they modify.

**Linking Adjectives to Object Properties.** Although there are slight hints suggesting that infants as young as 14 months have begun to map adjectives to object properties, the earliest systematic evidence comes from infants at 21 months. This is also the point at which infants begin to produce adjectives on their own (Fenson et al., 1994; Waxman & Markow, 1998). In a forced-choice task, infants were introduced to a single target (e.g., a yellow object) and asked to choose between two test objects. The matching test object shared a property-based commonality with the target (e.g., it was yellow). The contrasting test object embodied a contrasting value along that dimension (e.g., it was red). For half of the infants, the target (e.g., a yellow snake) and test objects (e.g., another yellow snake; a red snake) were members of the same basic level category. For the others, the target (e.g., a yellow dog) and test objects (e.g., a yellow snake, a red snake) were from different basic level categories. If infants map adjectives specifically to object properties, then infants hearing the target labeled with a novel adjective ("This is a(n) X one") should reveal a

<sup>7</sup>Most investigations include texture (e.g., soft versus hard) because these property terms emerge fairly early in the lexicon (Fenson et al., 1994) and color (e.g., yellow versus green). Color represents an interesting case. Although color terms are almost universally marked as adjectives (Dixon, 1982; Wetzler, 1992), and although infants' color perception is remarkably similar to that of adults (Bornstein, Kessen, & Weiskopf, 1976), young children nonetheless appear to have a curious difficulty mapping specific color terms to their meaning (Bornstein, 1985a; Landau & Gleitman, 1985; Rice, 1980; Sandhofer & Smith, 1999, 2001; Soja, 1994). Most of the evidence has suggested that color terms emerge late, relative to other property terms, and that the initial mappings for color terms tend to be inconsistent (Bornstein, 1985b; but see Macario, 1991; Shatz, Behrend, Gelman, & Ebeling, 1996).

preference for the matching test object. If this effect is specific to adjectives, then infants hearing the target labeled with a novel noun (e.g., “This is an X”) or with no novel word (e.g., “Look at this one”) should reveal no such preference.

The results revealed clear competences as well as limitations. At 21 months, when the target and test objects were all drawn from the same familiar basic level category (e.g., all snakes), infants successfully extended novel adjectives (but not nouns) specifically to the test object sharing the same property. This indicates that they had distinguished adjectives from nouns and mapped them specifically to property-based commonalities. In sharp contrast, when the target (e.g., a dog) and test objects (e.g., snakes) were drawn from different basic level categories, infants were unable to accomplish this mapping.

**Basic Level Categories as an Entry Point.** This reliance on basic level object categories is not a fleeting phenomenon, evident only in very young word learners, or only with a small set of adjectives. It has also been documented in 3-year-olds performing word-extension tasks (Hall & Lavin, 2004; Klibanoff & Waxman, 2000; Markman & Jaswal, 2004), in adults performing online processing tasks (Alloppenna, Magnuson, & Tanenhaus, 1998; Half, Ortony, & Anderson, 1976; Medin & Shoben, 1988; Pechmann & Deutsch, 1982) and in connectionist models (Gasser & Smith, 1998). These findings are consistent with the observation that the precise meaning of a given adjective is influenced by the noun it modifies.

To see why this might be the case, consider a property term like *soft* or *red*. *Soft* slippers and *soft* ice-cream do not have the same texture; *red* hair and *red* Corvettes are not really the same color. This reflects that most adjectives must be related to a standard of comparison, and this standard is typically determined by the noun that the adjective modifies (Graff, 2000; Kennedy, 1997; Kennedy & McNally, in press; Rotstein & Winter, in press).<sup>8</sup>

Moreover, cross-linguistic evidence suggests that the semantic, syntactic, morphological, and lexical dependencies of adjectives on nouns may be universal. In languages that mark grammatical gender or number, ad-

jectives must agree with the nouns they modify. This linguistic fact, coupled with the conceptual primacy of basic level categories, suggests that basic-level *nouns* may serve as an entry point for the acquisition of adjectives.

**Moving beyond the Basic Level.** Although novel adjectives may initially be interpreted within the context of familiar basic level categories, they are eventually extended more broadly. Children learn to extend *wet* to diapers, grass, finger-paintings; and *red*, to balloons, apples, shoes. What factors motivate this advance? The evidence suggests that to accomplish this task, infants integrate information from a wide range of sources, including cognitive, pragmatic, and linguistic cues. The importance of these additional cues is especially clear for infants acquiring languages (e.g., Japanese, Mandarin) where there are scant grammatical cues to distinguish nouns (count, mass, and proper nouns) from adjectives (Imai & Haryu, 2004). In such languages, where the grammatical cues are relatively weak, learners must depend more heavily on these additional sources of evidence if they are to assign words to grammatical categories and map them to meaning.

Current evidence suggests that several general cognitive processes are instrumental in discovering these mappings. The process of comparison operates in conjunction with naming to support children’s ability to extend adjectives across diverse basic level categories (Waxman & Klibanoff, 2000). Three-year-old children succeed in mapping novel adjectives beyond the basic level if they are first provided with an opportunity for comparison. For example, if they are permitted to compare two members of the same basic level category that differ only in the property of interest (e.g., a red versus a blue car), and if they are told that one is *blickish* and the other is not, children readily home in on the inference that *blickish* refers to the property and they go on to extend it broadly to other red objects, from a range of different basic level categories (Au, 1990; Heilbeck & Markman, 1987; Waxman & Booth, 2001; Waxman & Klibanoff, 2000). Similarly, if they are permitted to compare two members of different basic level categories that share a particular property (e.g., a red car and a red cup), and if they are told that each is *blickish*, they infer that *blickish* refers to the property and extend it broadly to objects bearing that property from various basic level kinds (Mintz & Gleitman, 2002; Waxman & Klibanoff, 2000). In fact, it turns out that mothers provide just this kind of information when they are instructed to teach

<sup>8</sup>The standard of comparison for adjectives can also be set by context. For example, “my Fiat is a big car” may be true in the context of a discussion of Italian cars, but false in the context of a discussion of American cars.

their infants and toddlers the meaning of a novel adjective (Hall, Burns, & Pawluski, 2003; Manders & Hall, 2002). General cognitive processes may also help infants and children discover how reference to a particular dimension, like color or texture, is reflected in the lexicon (Sandhofer & Smith, 1999).

Pragmatic cues also facilitate adjectival mappings. Consider a scenario in which a novel animate object is introduced, saying, "This is *daxy*." This phrase is ambiguous, because *daxy* could be a proper noun, mass noun, or an adjective (Hall & Belanger, 2001; Hall & Lavin, 2004; Haryu & Imai, 2002; Imai & Haryu, 2004). Hall and his colleagues (Hall & Belanger, in press) demonstrated that 3-year-old children acquiring English resolve the ambiguity by attending to the number of individuals to which the word is applied. If it is applied only to a single novel animal (e.g., a llama), they restrict the word to that individual, suggesting that they interpreted it as a proper noun. However, if the word is applied to two different animals, then children extend it to other animals that share that property, suggesting that they interpreted it as an adjective. Imai and Haryu (2001, 2004) demonstrated that children acquiring Japanese show an overwhelming preference to interpret a novel word in an ambiguous phrase as referring to the basic level category. Once a basic level category term has been acquired, they go on to interpret a novel word in that same phrase as referring to a property of the object.

Finally, linguistic factors also contribute to the use of basic level categories as an entry point for adjectival acquisition. Mintz and Gleitman (2002) noted that in constructions like "This is a *blickish* one," the term *one* refers to an (unspecified) object category. Because in experimental tasks, this term is typically applied to a single individual (e.g., a dog), and because basic level object categories are so salient, such constructions are likely to support the extension of the novel adjective within, but not across, that (unspecified) basic level category. If this is the case, then replacing the unspecified pronoun *one* with a lexically specific head noun (e.g., "This is a *blickish* dog. Can you give me a *blickish* car?") should support a broader range of adjectival extension. The results revealed that in such cases, 2-year-olds successfully extended novel adjectives beyond the limits of basic level categories (Klibanoff & Waxman, 2000; Mintz & Gleitman, 2002). Providing the lexically specific head noun essentially blocked a basic level interpretation of the adjective because this noun provides explicit information indicating that a broader range of

extension (one that includes both a dog and a car) for the novel adjective is required.

Summarizing to this point, we have shown that in the absence of explicit (linguistic, pragmatic, or conceptual) evidence to the contrary, basic level kinds serve as the entry point for assigning meaning to a novel adjective (see Goldvarg-Steingold, 2003 for evidence that higher level categories may also serve this function). By enriching the conceptual, pragmatic, or linguistic information available, infants and children move beyond this entry point to extend adjectives broadly and appropriately across basic level kinds.

### *Cross-Linguistic Work*

We have argued that cross-linguistic and developmental observations suggest (a) that the link between nouns and object categories, which emerges early in infants, may be a universal phenomenon, and (b) that the specific link between adjectives and their associated meaning, which emerge later in development, vary systematically as a function of the structure of the language under acquisition.

Empirical support for this position comes from recent research comparing monolingual children acquiring English, French, Italian, or Spanish (Hall, Waxman, Bredart, & Nicolay, 2003; Waxman, Senghas, & Benveniste, 1997). Although these languages are closely related, they provided an interesting set of cross-linguistic comparisons, primarily because of differences in the syntactic contexts and semantic functions associated with the grammatical form *adjective*. These differences permit us to examine how expectations for *adjectives* are shaped by the language being acquired.

To get a flavor for these differences, consider a cupboard holding several different coffee cups. Speakers of English and French distinguish the cups linguistically using a determiner, an adjective, and an overt noun (e.g., "a *blue* cup" or "the *blue* one"). In Italian and Spanish, although such constructions are sometimes apt, whenever the referent of the noun (cup) is recoverable from the context, it is omitted obligatorily from the surface of the sentence, leaving the determiner and adjective alone (e.g., "uno *azul*" or "a *blue*"). That is, in contexts where English speakers would say "the blue one," Spanish and Italian speakers allow the noun to be elided.

These constructions, known to linguists as *det-A* constructions, are ubiquitous in Italian and Spanish. Although *det-A* constructions also appear in English and French, they do so under highly restricted circum-

stances. Moreover, although *det-A* constructions are permissible in a slightly broader range of circumstances in French than in English, in both languages, this construction is relatively rare, and appears to be learned on a case-by-case basis rather than emerging as the product of a productive grammatical rule, as in Italian and Spanish (see Gathercole & Min, 1997, for other semantic/syntactic factors in Spanish and English, and their relation to acquisition; and Waxman et al., 1997, for a more detailed treatment of the *det-A* construction in these languages). Snyder et al. (2001) documented that Spanish-speaking children as young as 2 years of age produce *det-A* constructions broadly and spontaneously (see also, MacWhinney & Snow, 1990).

There are two important features to notice about the adjectives in *det-A* constructions. First, the adjectives in these constructions appear in syntactic contexts that appear to be identical to those where count nouns typically occur.<sup>9</sup> Second, adjectives in these constructions appear to adopt a semantic function that is customarily associated with count nouns. *Det-A* constructions can refer to the named object *qua* object and can be extended to include other members of its object category, if these members also share the named property. Importantly, then, in Italian and Spanish there is considerable overlap in both the surface syntactic contexts and the semantic extensions for nouns and adjectives.

Does experience with these different languages lead to different outcomes in the expectations concernin the grammatical form *adjective*? As a first step in examining this hypothesis, Waxman and her colleagues (Waxman et al., 1997) conducted a cross-linguistic investigation involving preschool-age monolingual children acquiring either English, French, Italian, or Spanish. Each child “read” through a picture book with an experimenter (a native speaker of the child’s language). On each page, there were five pictures: a target (e.g., a cow), two category-based alternatives (e.g., a fox and a zebra), and two thematically related alternatives (e.g., a barn and milk). Children were assigned to one of three conditions. In the no-word condition, the experimenter pointed to the target and said, “See this? Can you find another one?” In the novel noun condition, she said, for example, “See this *fopin*? Can you find another *fopin*?”

In the novel adjective condition, she said, “See this *fopish* one? Can you show me another one that is *fopish*?”

The predictions were straightforward. (a) If a link between nouns and object categories is universal, then all children should extend the novel nouns to the category-based test objects; (b) If cross-linguistic differences regarding the grammatical form *adjective* have consequences on acquisition, then children’s extensions of the novel adjectives should vary as a function of native language. In Italian and Spanish, where adjectives are permitted to adopt some of the syntactic and semantic features associated with nouns, children may extend novel adjectives (like nouns) to other members of the same category. In contrast, in English and in French, where this nominal interpretation of novel adjectives is not available, children should fail to extend novel adjectives to category members and should perform at chance levels.

The results were consistent with these predictions. Children from each language community consistently extended the novel nouns to the category-based alternatives. But performance in the *novel adjective* condition varied systematically as a function of language. As predicted, children acquiring French and English performed at the chance level, while those acquiring Italian and Spanish extended novel adjectives (like novel nouns) to the category-based alternatives. Although this taxonomic inclination was less pronounced for adjectives than for nouns, it was quite robust, holding up in children ranging from 3 to 7 years of age. Perhaps most striking, these children extended novel adjectives to the category-based alternatives not only when they were presented in *det-A* phrases (and therefore could have been either nouns or adjectives), but also when they were presented in phrases incorporating an overt noun (e.g., *cosa*). Thus, even when the syntactic contexts were unambiguously adjectival and fully comparable to those in English and French, Italian- and Spanish-speaking children extended the novel adjectives on the basis of category membership.

These results suggest that children’s expectations for adjectives are tailored by features of the particular language being acquired. For children acquiring English or French, languages in which nouns (but not adjectives) can refer to objects and can be extended to other category members, children build an expectation that nouns (but not adjectives) can take on this semantic function. For children acquiring Italian and Spanish, experience steers the acquisition process along a slightly different

<sup>9</sup>The adjectives in these *det-A* phrases retain their syntactic status as adjectives (see Kester, 1994; Snyder, 1995; and Waxman et al., 1997, for the relevant diagnostics).

developmental course, permitting children to build an expectation that both nouns and adjectives can be extended on the basis of category membership.

This suggests one way in which language-specific experience shapes the acquisition of the predicate forms. In future work, it will be important to examine these effects in a wider range of languages and to explore the developmental implications of this distributional overlap for infants' ability to distinguish nouns from adjectives.

### *Conclusions about Adjectives*

We have conveyed several insights into the acquisition of adjectives. Although adjectives are plentiful in the input that children hear, and although even infants are sensitive to the properties that are typically encoded by early adjectives (e.g., color, texture, size, temperature, temperament), mapping adjectives to their associated meaning is surprisingly elusive. The mapping for adjectives emerges later than that for nouns and varies as a function of the structure of the ambient language. Moreover, there is a linguistic or conceptual priority to name an object's kind (and especially its basic level category) before marking its properties, however salient those properties may be.

The acquisition of the grammatical form *adjective* appears to rest on the prior acquisition of (at least some) nouns and to require a richer set of linguistic and conceptual cues than nouns (Mintz & Gleitman, 2002; Waxman & Klibanoff, 2000). Moreover, the interpretation of any particular adjective appears to depend (at least in the initial stages of acquisition) on the particular noun that it modifies. These observations have led to the conclusion that early noun learning serves as a gateway for the acquisition of adjectives. We also suggest that noun learning serves as a gateway for the acquisition of verb meaning.

### **The Acquisition of Verbs**

Because not all words share the same grammatical and conceptual requirements, we expect to find differences in the information that learners use to acquire different kinds of words. Most nouns are not argument taking but most verbs are; it may therefore be the case that identifying a verb requires prior identification of the phrases that serve as its arguments. Noun phrases serve this function by helping the learner identify the event denoted by the verb from the extralinguistic context. From

this perspective, early noun learning sets the stage for the subsequent acquisition of other grammatical categories like verbs (Gleitman, 1990). Learning the nouns enables the learner to project noun phrases in the syntax. These noun phrases represent the scaffolding on which infants assemble a rudimentary representation of the structure of the native language (Fisher et al., 1994; Fisher & Tokura, 1996; Naigles, 2002) and this, in turn, provides a foundation for the acquisition of the other essential grammatical forms. The critical idea is that a learner who can identify the nouns in a sentence can build noun phrases, which then serve as the arguments of the verb. Identifying the arguments of the verb leads to a rudimentary syntactic structure which, in turn, is informative of the meaning of the verb. On this view, verb learning is dependent on syntactic structure, which can be partially identified through the identification of the nouns in the sentence.

### *Informational Differences between Nouns and Verbs*

One of the strongest pieces of evidence that the informational requirements for learning verbs are steeper than those for nouns comes from experiments with adult participants in a simulated word-learning environment (Gillette et al., 1999; Snedeker & Gleitman, 2004). Adults were presented a series of videotaped scenes depicting the visual context of a parent uttering a word to their child, but with the sound removed. The participants' task was to identify the word that was uttered by the parent. Participants were divided into several conditions that differed by how much information they received about the linguistic context of the utterance. Participants experienced either (a) just the visual scene, (b) the scene plus the nouns that co-occurred with the novel word, (c) the syntactic frame with nonsense words replacing all the content words, (d) the syntactic frame with co-occurring nouns, or (e) all this information together. Crucially, the proportion of words that were correctly identified and the type of words that were identifiable changed significantly as a function of information type. When presented with no information beyond the visual scene, participants correctly identified nouns more often than they correctly identified verbs. Although participants were least successful at identifying verbs when only the visual scene was presented, they improved as the amount of syntactic information increased. Syntactic information was more effective than the co-occurring nouns in leading participants to the right answer, and the combination of these cues was

more effective than either of these alone. These results lend support to the idea that successful verb learning requires information beyond the observation of extralinguistic context. In particular, syntactic argument structure and the co-occurrence of known nouns serving as syntactic arguments were crucial to adults' success in identifying the missing verbs.

### *Children's Use of Syntax to Learn Verb Meanings*

In addition to these simulations with adult learners, there is by now a wealth of evidence identifying the crucial role of syntax in helping children identify the meanings of novel verbs. Naigles (1990) used the preferential looking paradigm to investigate this issue. Two-year-olds saw a videotaped scene depicting the following two actions simultaneously: A duck forces a rabbit to squat by pushing on its head, while the duck and rabbit each wheel their free arm in a circle. Notice that there is a causal interpretation of the observed event ("to force to squat") and a noncausal interpretation ("to rotate one's arm"). While both interpretations involve two participants, only under one of these interpretations are the two in a causer-to-caused relation. While watching this scene, half the infants heard a disembodied voice say "The duck is biffing the bunny" while the other half heard "The duck and the bunny are biffing." Each utterance thus mentions two entities, but only in the first one do the two entities show up in two different argument positions ("the duck and the bunny" is a single complex noun phrase occupying one argument position; namely, the subject position). This video was then removed and the voice said, "Find biffing now!" Two new videos now appeared, one displayed to the left of the watching child, the other to the right. In one, the duck was shown forcing the rabbit to squat but without arm-wheeling. In the other, the duck and rabbit were shown standing side by side wheeling their arms. Infants attended longest to the scene that matched the syntax. When the novel verb was presented as a transitive verb ("the duck is biffing the bunny"), infants took that verb to refer to the causative event in which the duck causes the bunny to squat. When the novel verb was presented as an intransitive ("the duck and the bunny are biffing"), they looked longest at the noncausative action in which the characters were wheeling their arms. Evidently the syntactic structure was decisive in cueing which aspect of the complex initial scene was relevant to the interpretation of *biffing* (Naigles, 1990; see also Fisher et al., 1994; Naigles,

1996; Naigles & Kako, 1993). This work demonstrates that 2-year-olds can use the syntax to assign a meaning to a novel verb.

Bunger and Lidz (2004) used the preferential looking paradigm to show that syntax can be useful not only in distinguishing which of two simultaneously occurring events is labeled by a novel verb, as in Naigles' studies, but also in distinguishing which aspect of a single internally complex event is so labeled. The relevant case also involved causative events that, although typically expressed as one lexical unit (e.g., *kill*, *roll*), can be decomposed into two subevents (Dowty, 1979; Hale & Keyser, 1993; Jackendoff, 1990; Levin & Rappaport-Hovav, 1995; McCawley, 1968). The conceptual structure of a causative event can be represented as in (2), with open argument positions to be filled by the causer of the event and the affected entity:

- (2) [[X DO SOMETHING] CAUSE [Y BECOME STATE]].

The first subpart of this structure [X DO SOMETHING] specifies the causing subevent, or the means, and the second subpart [Y BECOME STATE] specifies the resulting change of state. For example, a verb like *bounce* (a) can be represented as in (b):

- (3) a. The girl bounced the ball.  
b. [[The girl HITS THE BALL] CAUSE [the ball BECOME BOUNCING]]

Bunger and Lidz (2004) asked three questions. First, do young children have internally complex representations like (2) for the concepts labeled by causative verbs? Second, can different syntactic structures differentially direct children's attention to these subevents (thereby influencing their interpretation of a novel verb used to describe the event). Third, are children limited to using syntax to distinguish between multiple distinct events in the world as in Naigles (1990), or can they also use it to parse single events that are internally complex.

To answer these questions, they conducted a preferential looking study in which 2-year-old children saw internally complex causative events labeled by a novel verb occurring in distinct syntactic structures. Children were first familiarized to an event of direct causation (e.g., a girl bouncing a ball) described by a novel verb. The syntactic frame in which the novel verb was presented varied across children in four ways: control ("Look at that"), transitive ("The girl is pimming the ball"),

unaccusative<sup>10</sup> (“The ball is pimming”), or multiple frame (transitive + unaccusative: “The girl is pimming the ball.” “Do you see the ball pimming?”). This training phase was followed by a test phase, identical for all conditions, in which children heard the novel verb (“Where’s pimming now?”) while they saw, on opposite sides of the screen, the separate subevents depicting the means (the girl patting a ball, but no bouncing) and the result (the ball bouncing with the girl standing idly by) of the complex causative presented during training.

Because the unaccusative variant of a causative verb labels the result subevent without making reference to the means, Bungler and Lidz (2004) predicted that children in the unaccusative and multiple-frame conditions would be more likely than children in the transitive and control conditions to interpret the novel verb as referring to the result subevent. This prediction was borne out. At test, children in the control and transitive conditions showed no significant preference for either subevent. Crucially, however, children in the unaccusative and multiple-frame conditions demonstrated a significant preference for the result subevent. Thus, the syntactic context in which novel verbs were presented guided children’s interpretations of those verbs, even when the verbs referred to subparts of internally complex events.

In an interesting refinement, Fisher and her colleagues (Fisher et al., 2004; Fisher & Tokura, 1996) asked whether these kinds of syntactic bootstrapping effects result from the syntax per se, or whether they might result from children’s knowledge of the meanings of the co-occurring nouns. Her method was to provide children with structural cues without providing contentful noun phrases. Two- and three-year-old children saw two same-gender individuals participating in a single event. For example, a woman was being twirled in a swivel chair by another woman, by the stratagem of pulling on a long ribbon attached to the former woman’s waist. The children were asked to “Show me the one who’s pilking around” or “Show me the one who’s pilking her around” by pointing to one of the depicted women. These children used the number and position of noun phrases in the sentence to determine which of the two women was being referred to, even though these

noun phrases were just pronouns. When they heard the transitive sentence, they picked the woman doing the twirling; that is, they interpreted the two-noun phrase sentence as describing the causal aspect of the observed event; symmetrically, when they heard the intransitive sentence, they picked the woman being twirled. Thus, we see that although the identification of nouns can help to build a syntactic structure, it is this structure, and not only the semantic information contained in the nouns, that guides children’s acquisition of novel verbs. This conclusion does not mean that verb learning is independent of noun learning. Rather, to the extent that learning nouns leads to learning verbs, this support is mediated through the projection of syntactic structure.

An additional kind of evidence for children’s use of syntax to guide verb learning comes from their interpretations of known verbs in novel syntactic contexts (Lidz, 1998; Naigles, Fowler, & Helm, 1992; Naigles & Kako, 1993). In these experiments 2-, 3-, and 4-year-old children used objects from a Noah’s ark playset to act out sentences presented to them by an experimenter. Some of the sentences were grammatical, whereas others were ungrammatical in English, but represented structures that are possible in some language. Some sentences added an argument to an intransitive verb, as in “the zebra comes the giraffe to the ark,” while others subtracted a required argument from a transitive verb, as in “the zebra brings to the ark.” While children uniformly provided accurate enactments of the grammatical sentences, their behavior in response to the ungrammatical sentences was crucial in providing a window into the learning process. For these sentences, children essentially had two choices. They could ignore the additional or missing argument, relying on their knowledge of the verb. Alternatively, they could integrate the novel structure into their interpretation, modifying their interpretations of these known verbs. These children adopted the latter strategy. When presented with a sentence like “The zebra comes the giraffe to the ark,” children acted out a scene in which the zebra brings the giraffe to the ark, showing that the extra argument is interpreted as a causal agent. By the same token, “The giraffe brings to the ark” was acted out with the giraffe coming to the ark, with no causal agent.

These studies show that children use the number of noun phrase arguments to broaden the scope of the events that they think a known verb refers to. Although *come* expresses only motion toward a location in the adult language, if this verb is presented with an additional syntactic argument, children who have not yet set-

<sup>10</sup>The term “unaccusative” refers to an intransitive verb whose subject behaves in some ways like an object, as in pairs like “the navy sank the boat” versus “the boat sank” (see Burzio, 1986; Levin & Rappaport-Hovav, 1995; Perlmutter & Postal, 1984, for discussion).

tled on a fixed representation of the verb's meaning will take that additional syntactic argument as evidence that the verb can also express caused motion. These studies provide clear evidence for the power of syntax in licensing inferences about verb meaning. Moreover, they enable us to ask whether children are constrained in how they extend known verbs into novel contexts. We now turn to this question.

### ***Cross-Linguistic Evidence and Constraints on Verb Learning***

The fact that children can use syntax as one source of information in learning novel verbs allows us to ask questions not only about how children learn verbs but also about the existence of constraints on verb learning. We can ask whether children are limited in their verb learning by the kinds of constraints that appear to hold across diverse languages. The research strategy is to look for cross-linguistically stable generalizations and then ask whether children's learning reflects those generalizations. The idea behind this strategy is that linguistic universals derive from principled constraints on what a possible human language is. Thus, to the extent that these constraints can be found in verb learners, we add to the evidence in support of them. From another perspective, cross-linguistically stable generalizations provide us with hypotheses about constraints on verb learning that can then be tested on children who are developing a lexicon. Moreover, to the extent that a property of verb meaning or linking can vary cross-linguistically, we expect to find that property to be highly sensitive to aspects of the linguistic environment, since it will depend not on principled constraints from the learner, but on the observation of the particular language being learned (the linguistic input).

#### **Syntactic and Semantic Types of Arguments.**

The method of testing children's extensions of known verbs to novel contexts has been used to investigate children's knowledge of the connection between syntactic and semantic types of arguments and the range of possible verb meanings (Lidz, Gleitman, & Gleitman, 2004). The rationale for this manipulation is based on the observation that some aspects of the mapping from event participants to syntactic categories are universal, while other aspects are more variable both within and across languages. A propositional argument can be realized as a tensed clause (*John thinks that Mary will win*) or an infinitival clause (*John expects Mary to win*) but not as a noun phrase referring to an in-

dividual (*\*John thinks the winner*).<sup>11</sup> The choice of tensed or untensed clause, however, is subject to lexical variability and must be learned on a verb-by-verb basis. Similarly, some change-of-state verbs that can occur with one argument (*the vase dropped*) can also occur with two (*I dropped the vase*), while others do not allow this alternation (*the vase fell*; *\*I fell the vase*). But, verbs in this class never have their arguments realized as sentential complements (*\*John falls that it is Bill*; *\*John drops Bill to be here*).

Given the existence of principled constraints on the syntax-semantics mapping (e.g., that verbs denoting relations between individuals and propositions can take clausal arguments), as well as lexically specific constraints (e.g., that *think* takes a tensed sentence complement but not an infinitival complement), we can ask whether children are limited in the ways that they are willing to extend known verbs in accordance with these constraints. To do this, Lidz et al. (2004) examined 3-year-old children's understanding of known verbs in syntactic contexts that are permitted by language, but not by the language they happen to be learning (*the zebra falls the giraffe*; *the zebra thinks the giraffe to go to the ark*) and compared this with their understanding of known verbs in syntactic contexts that are not permitted by any language (*\*the zebra falls that the giraffe goes to the ark*; *\*the zebra thinks the giraffe*). The reasoning behind this manipulation was the following: If children are constrained to allow only those mappings that are allowed by language in general, then they should distinguish these two types of extensions. Children should be willing to extend verbs in ways that are possible in principle, but happen not to occur for those particular verbs in their language. They should be unwilling to extend verbs in ways that are in conflict with the principles of syntax-semantics mapping that are found across all languages.

This expectation was met. Lidz et al. (2004) found that children relied on the syntactic structure to guide their enactments only when the novel verb-sentence pairing was a possible pairing in principle (although not in English). In the cases in which the novel syntactic structure would violate principles of syntax to semantic mapping (like *\*the zebra falls that the giraffe goes to the ark*), children performed actions that relied more heavily on what they already knew about the verb. In other words, children accepted extensions of known verbs into

<sup>11</sup> The asterisk (\*) is used to indicate that a sentence is grammatically anomalous.

new syntactic frames only when the verb-frame pairing was one that might have been possible. This finding suggests that children's knowledge of the syntax-semantics mapping guides their acquisition of novel verbs even when their lexical representations for certain verbs have not yet solidified. Some aspects of the syntax to semantics mapping do not have to be learned but rather guide learners' hypotheses from the start.

**Universals in the Expression of Causativity.** The domain of causation, because it has some universal components and some cross-linguistically variable components, has provided another opportunity to isolate the relative contributions of linguistic constraints and linguistic experience. As noted, many change-of-state verbs (e.g., *break*) have both a transitive and intransitive use that differ with respect to causativity. The transitive version (4a) includes an argument to play the role of causer, whereas the intransitive version (4b) does not:

- (4) a. Kim broke the vase.  
b. The vase broke.

This relation between transitivity and causativity is found in all languages (Comrie, 1985; Haspelmath, 1993, among others). One thing that does vary cross-linguistically is whether the alternation is morphologically marked. In many languages, the intransitive variants are basic, and an additional causative morpheme is used to indicate causation. In other languages, the transitive variants are basic and an additional anticausative morpheme indicates the lack of causation. In still other languages, both strategies exist for different verbs. Thus, the addition and subtraction of arguments is used universally to mark causative status, whereas the use of verbal affixes to mark causative status varies both cross-linguistically and within a language.

This state of affairs presents an interesting research question—whether children use argument number as a cue to causativity because this cue is reliably present in their language or because they are predisposed to do so. Lidz, Gleitman, and Gleitman (2003) pitted the universal property of argument number against the cross-linguistically variable property of morphology in Kannada, a language with causative morphology, to distinguish the effect of inherent constraints on the learner from the effect of the language environment. Do children use argument number as a cue to causal verb meaning as a result of observing this relationship in the input? Or is this

relationship in the input because all language learners expect their language to express it?

Kannada is an appropriate probe language because of its abundant use of the morphological cue to causativity. In Kannada, any verb can be made causative through the addition of a causative morpheme. Moreover, whenever this morpheme is present, the causal interpretation is entailed. Finally, in Kannada, as in all languages, many verbs with two arguments are not interpreted causally. Given this pattern of facts, the causative morpheme is a more reliable cue for causation than is the number of arguments.

Because the presence of the causative morpheme guarantees a causal interpretation but the presence of two arguments is only probabilistically associated with causal interpretation, Kannada can offer some insight into the origins of the connection between argument number and causal interpretation.

Lidz et al. (2003) used the Noah's ark methodology described earlier with 3-year-old children learning Kannada as their first language. Children were presented with known verbs with either one or two noun phrase arguments and either with or without the causative morpheme. The predictions were as follows. If children use the most reliable cues in their language input to determine the syntax to semantics mapping, we would expect children learning Kannada to rely more heavily on the causative morpheme as an expression of causativity than on the number of arguments. On the other hand, if children are guided by expectations about the syntax-semantics mapping that are based on the universal grammatical principles, they should rely more heavily on argument number than causative morphology. In the latter case, children would be expected to override the most reliable cue in the input in favor of the less reliable cue determined by inherent grammatical constraints.

The data were clear. Three-year-old Kannada-learning children treated argument number but not morphology as an indication of causativity, despite the fact that the latter is the more reliable cue in their language. In sum, children acted out two-noun-phrase sentences as causative and one-noun-phrase sentences as noncausative, independent of the presence or absence of the causative morpheme.

In effect, these children ignored the more reliable morphological cue to verb meaning and instead relied on the syntactic cue (noun phrase number). This result provides evidence for the priority of the principle aligning noun phrases with semantic participants. The observation that learners discarded the best cue in favor of a

weaker one reveals the active role that learners play in acquiring verb meanings. Learners use argument number as a cue to verb meaning not because it is there in the input, but because they expect to find it there.<sup>12</sup>

**Universals and Constraints on Locative Verbs.**

Yet another source of evidence for inherent constraints on syntax semantics mapping comes from studies of locative verbs—verbs expressing the movement of some object (the figure) to a location (the ground). Verbs that describe the manner of motion (*pour, spill, shake*) require the figure to occur as the direct object, whereas verbs that describe a change of state (*fill, cover, decorate*) require the ground to occur as the direct object (Rappaport & Levin, 1988):

- (5) a. Edward poured water into the glass.  
(figure frame)
- b. \*Edward poured the glass with water.  
(ground frame)
- c. \*Edward filled water into the glass.  
(figure frame)
- d. Edward filled the glass with water.  
(ground frame)

Studies of the acquisition of these verbs find that children use this syntax-semantics mapping to guide their interpretations and productions (Gropen, Pinker, Hollander, & Goldberg, 1991a, 1991b; Pinker, 1989). However, it has also been observed that children make some errors in production in this domain. Bowerman (1982) found evidence of children using the figure frame inappropriately with change of state verbs in their spontaneous productions. This effect was replicated by Gropen et al. (1991a) and Kim, Landau, and Phillips (1999) in elicited production studies.

Importantly, however, in none of these studies were children reported to have made errors in which they used manner of motion verbs with the ground frame. This asymmetry is important because it mirrors the cross-linguistic variation in this domain. Kim et al. (1999) exam-

ined a wide range of unrelated languages and found that locative change of state verbs vary cross-linguistically in whether they can occur in the figure frame. However, no language was found in which manner of motion verbs can occur in the ground frame. Thus, children’s errors are limited to the places where languages can vary. In cases where there are universal constraints on linking patterns, children obey those constraints throughout acquisition. In cases where there are no such constraints, children must rely on their input to guide acquisition.

**The Role of Input in Verb Learning**

We have seen (a) that children use syntax to guide their acquisition of novel verbs, and (b) that inherent constraints guide children’s use of syntax in this regard. However, we also expect to find children showing a sensitivity to the input exactly when inherent constraints from the learner do not exist. In determining a division of labor between the child’s internally generated constraints and the child’s experience with the language environment, we expect to find sensitivity to the input just in those cases in which the child has no internally generated expectations about verb meaning and verb syntax. This is what we find.

One study showing children’s sensitivity to the input in verb learning involved the verb extension methodology discussed earlier. Naigles et al. (1992) examined 2- to 5-year-old children’s extensions of motion verbs like *come, go, bring, and take* into syntactic frames where these verbs do not occur. As in the studies previously discussed, these authors found that children, but not adults, adjusted their meanings of these verbs to fit the syntactic context. Thus, when *come* was presented transitively (*the zebra comes the giraffe to the ark*), children treated it as expressing the causal event in which the zebra brings (= cause to come) the giraffe to the ark. Adults on the other hand seemed to interpret the sentence as an error and repaired the syntax, acting out a noncausal scenario (e.g., *the zebra and the giraffe come to the ark*). Interestingly, the transition to adult behavior varied as a function of age and, most importantly, as a function of verb frequency. In particular, intransitive *bring* and *take* were repaired earlier than transitive *come* and *go*. This finding is important because the intransitive (ungrammatical) variants of *bring* and *take* express the same meanings as the intransitive (but grammatical) variants for *come* and *go*. Likewise, the transitive (ungrammatical) variants of *come* and *go* express the same meanings as the transitive (grammatical) variants of

<sup>12</sup> Kannada-speaking adults eventually do acquire this special (“language specific”) feature of their language. To say that they did not would mean that the Kannada language had changed. So it is reassuring to find, as we did, that Kannada adults show sensitivity both to argument number and to the causative morpheme when they participate in the Noah’s ark experiment.

*bring* and *take*. Thus, the learner at some point should recognize that these verbs represent suppletive pairs (e.g., *come* = *bring*; and *go* = *take*, modulo the difference in causation) and stop allowing the intransitives to be used transitively and vice versa. But, importantly, what Naigles et al. found was that the repairs did not all begin at the same time. Instead, the more frequent verbs (*come* and *go*) were repaired later than the less frequent verbs (*bring* and *take*). This can be understood as the effect of frequency on suppletion. The higher frequency items allow children to build stable lexical representations earlier. Thus, these representations block the use of other words to express those same meanings. *Bring* is disallowed as an intransitive because the child has learned that *come* expresses that meaning. Experience with a given verb determines the learner's willingness to accept other verbs as expressing that same meaning. Most importantly, from the present perspective, the effect of experience appears here because there are no expectations or constraints from children to tell them whether a verb like *come* can or cannot be used transitively. This must come from experience.

Other studies also highlight the importance of children's sensitivity to the input in verb learning (e.g., Childers & Tomasello, 2002; Naigles & Hoff-Ginsberg, 1998; Snedeker & Trueswell, in press; Tomasello, 1992, among others). These studies tell us that for properties of verb representation that can vary within a language, children are extremely sensitive to the frequency of occurrence of those representations. As expected, when there are no constraints from the child on what the verb's representation should be like, the linguistic environment exerts a strong influence.

### **Conclusions about Verbs**

We have conveyed several messages about the state of the art in verb learning. First, because verbs have complex representations that depend on the prior acquisition of certain other linguistic properties (minimally, the recognition of syntactic arguments), they are acquired later than nouns. Second, by paying attention to the details of how verbs are represented in the minds of adult speakers and whether these details can and cannot vary across languages, we can develop very clear predictions about the kinds of constraints on verb learning that we should find in children. In cases where cross-linguistic evidence suggests that a linking may be universal, we suspect that inherent constraints may be at play and therefore that we should be able to see these constraints

in experimental manipulations with young learners. Where properties of representation can vary, however, we expect to find little evidence of inherent constraints. Instead, we expect to see a strong influence of the linguistic environment. As we have argued throughout this chapter, the important question in language acquisition and in word learning is not whether there are inherent constraints on learners. Rather, the crucial questions are where we expect to see the effects of constraints, where we expect to see the effects of experience, and how constraints interact with experience to guide acquisition.

### **THE FUTURE OF WORD-LEARNING RESEARCH**

The study of word learning must take into account the variety of word types found in natural languages. In this chapter, we have focused on the acquisition of the major grammatical categories—noun, adjective, and verb—highlighting that nouns tend to emerge first in language acquisition and serve as the foundation for the discovery of the other grammatical forms and their meanings.

The kinds of words that we have examined, however, only scratch the surface of those found in natural languages. Languages include words that quantify over individuals (*a*, *the*, *every*, *two*), words that compare sets of individuals (*most*, *more*, *less*), words that refer back to previously mentioned entities (*he*, *she*, *one*, *herself*), words that quantify over events (*always*, *sometimes*), words that describe the manner of an event (*quickly*, *repeatedly*), and so on. As we have suggested, each kind of word points to a restricted range of concepts. Moreover, the relation between linguistic and conceptual structure is bidirectional. Distinct grammatical forms highlight distinct kinds of meaning; but at the same time, linguistic structure is in many ways derived from the meaning of the words involved. Differences in meaning therefore lead to differences in syntax. Consequently, examining the role of syntax in word learning is crucial, as the syntax provides a surface cue that the learner can use to infer the meaning of the word and that the developmental researcher can use to infer what might count as knowledge of the word.

We have also underscored the argument that the field of word learning must be sensitive to cross-linguistically stable and cross-linguistically variable properties of words and grammatical categories. Cross-linguistic research can be instrumental in developing hypotheses

both about the kinds of structures within the learner that guide acquisition and about the kinds of linguistic input that shape word learning. A maximally general theory of word learning must still be constrained enough to explain the speed with which children grow a lexicon and flexible enough to allow this growth to occur in a wide range of linguistic environments. By placing word learning firmly within the context of development and of comparative linguistics, we have provided a foundation for future research in which we consider the full range of words represented in human language and the full range of concepts to which these apply. Current word-learning research reveals that learners exhibit some general sensitivities and expectations at the onset of acquisition that later become tuned to the child's particular language environment.

We began this chapter with a reference to Janus, the god of gateways and transitions. We have argued throughout this chapter that word learning resides on the boundary between conceptual and linguistic knowledge and that word learning represents a doorway through which constraints from the learner interact with the vagaries of linguistic environment. We end with a final reference to Janus. Word-learning research now stands at an important threshold, having reached a point where a focus on noun learning can be replaced with a broader, more inclusive, conception of the range of concepts and grammatical knowledge involved in word learning. Crossing this threshold will require the field to continue to integrate ideas, methods, and generalizations from developmental psychology, cognitive psychology, and comparative linguistics.

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BOOK REVIEWS 511. Handbook of Clinical Child Psychology. Edited by C.Eugene Walker and Michael C. Roberts. New York:John Wiley & Sons, 1983, 1397 pp., \$64.95.Â The four chapters of Section One cover the area ofnormal and abnormal child development, integratingtheory, philosophical foundations, and clinical impli-cations. Rune J. Simeonsson's chapter is not only agood introductory review of various theories of devel-opment, it is also interesting and helpful to the expe-rienced clinician who wishes to better organize andsynthesize this information along dimensions whichorient him or her to the relevant implications forclinical practice.