CHAPTER NINE

Links between Object Categorization and Naming

Origins and Emergence in Human Infants

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INFANTS ACROSS THE WORLD'S COMMUNITIES are raised in vastly different environments, surrounded by different objects, different customs, and different languages. Yet despite these differences, there are striking similarities in the most fundamental aspects of infant cognitive and language development. Within their first two years, infants develop two uniquely human capacities: they naturally establish rich and flexible repertoires of object categories, and they spontaneously acquire their native language. Each of these capacities, considered on its own, is a remarkable feat. But perhaps even more remarkable is the fact that even before they begin to produce words on their own, infants' conceptual and linguistic advances are powerfully and implicitly linked. These early links foster the acquisition of a stable set of object categories, guide the acquisition of the early lexicon, and serve as a foundation for the evolution of the finely tuned links between language and conceptual organization that characterize the mature system.

This chapter focuses on the origin and unfolding of these links between language and conceptual organization. I will argue that from the onset of acquisition, object naming and object categorization are linked. Infants across the world begin the task of word learning equipped with a broad, universal expectation that directs them to link novel words to commonalities among objects. This initial link supports the rapid acquisition of the increasingly sophisticated language and conceptual systems that are the hallmark of human development. And over the course of early acquisition, this initial link becomes fine-tuned, in accordance with the structure of the native language under acquisition.

This developmental proposal has several distinct advantages. First, it embraces the importance of considering both (1) any expectation(s) that the infant may bring to the task of acquisition and (2) any influence of the infant's environment in shaping those expectations. On this view, early acquisition is at once sufficiently *constrained* to permit infants to form rich categories of objects and to learn words to express them; it is also sufficiently *flexible* to accommodate systematic cultural and linguistic variation in categorization and naming patterns. Second, this developmental proposal is a dynamic one, in which any initial expectation(s) held by infants is not rigidly fixed throughout development but rather will evolve over the course of development, becoming fine-tuned in accordance with the regularities observed in the language under acquisition. Third, this developmental proposal assumes a bidirectional relation between language and conceptual organization. The conceptual system serves up several candidate concepts that may (or may not) be expressed in the native language under acquisition. The linguistic system also exerts an influence on conceptual structure, with words serving as invitations to form new categories and concepts and to discover the deep, often unobservable, relations among members of the same concept (Brown, 1956; Gelman & Coley, 1991; Waxman & Markow, 1995).

Early Milestones in Conceptual and Linguistic Organization

During their first year, infants form categories that capture both the similarities and differences among the objects they encounter, and they represent these categories in a stable fashion over time. Most of these early object categories will be at the basic level (i.e., *dog*) and the more inclusive global level (i.e., *animal*) (see chap. 3; Mandler, 1992). Infants use these early object categories as an inductive base to support inferences about novel members. They also begin to relate categories to one another on the basis of taxonomic (e.g., dogs are a kind of animal), thematic (e.g., dogs chase tennis balls), functional (e.g., dogs can pull babies on sleds), and other relations among them. In forming these early categories and relations among categories, infants attend flexibly to features of the objects, as well as to the (often transient) functions and actions in which these objects are engaged. Thus, early categories provide a core of conceptual continuity that endures from infancy through adulthood.

Concurrent with these conceptual advances, infants make remarkable strides in acquiring language. Well before they begin to comprehend or produce the words of their native language, infants show a special interest in speech sounds, as compared to other forms of auditory input. Later, by 6 months, infants become perceptually attuned to the distinct prosodic, morphologic, and phonologic elements of their native language (chap. 2; Jusczyk & Kemler Nelson, 1996; Kemler Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989; Morgan & Demuth, 1996; Shi, Werker, & Morgan, 1999; Werker, Lloyd, Pegg, & Polka, 1996). By their first birthdays, infants typically begin to produce their first words. These early words tend to refer to salient individuals (e.g., "Mama"), categories of objects (e.g., "cup," "doggie"), social routines

(e.g., "bye-bye"), and actions (e.g., "up"). Infants in this period reveal a "noun advantage"; with words (e.g., nouns) that refer to salient (e.g., basic-level) object categories (e.g., cup, dog) being by far the predominant form (Au, Dapretto, & Song, 1994; for a different interpretation see Bloom, 1993; Choi & Gopnik, 1995; Gentner, 1982; Gentner & Boroditsky, 2001; Gleitman, 1990; Goldin-Meadow, Seligman, & Gelman, 1976; Huttenlocher & Smiley, 1987; Nelson, Hampson, & Shaw, 1993; Saah, Waxman, & Johnson, 1996; Tardif, 1996). By their second birthdays, most infants have mastered hundreds of words from various grammatical forms (e.g., nouns, verbs, adjectives) and have begun to combine these to form short phrases that conform broadly to the syntactic and semantic properties of their native language.

Thus, in addition to forming categories to capture commonalities and differences among the myriad objects and events that they encounter, infants rapidly and naturally learn words to express them. A review of the developmental literature reveals that during this early period of acquisition, there are powerful, implicit links between infants' conceptual and linguistic advances, and these links guide acquisition even before infants produce their first words.

Word Learning: At the Crossroad of Language and Conceptual Organization

Perhaps more than any other developmental achievement, word learning stands at the very crossroad of the conceptual and linguistic realms. What does it take to learn a word? At its most fundamental level, word learning depends on the learner's ability to establish a mapping between the linguistic entities that we call *words* and the actual entities to which they correspond in the *world.* What is the conceptual consequence of establishing this word-to-world mapping? And how do infants discover that the very same entity (e.g., the family dog) can be named flexibly, using different types of words, including proper nouns ("Magic"), count nouns ("dog," "pet," "puppy"), and adjectives ("frisky," "sleek," "fast"), and that these different types of words refer to different aspects (e.g., the individual object, a category of objects, or a property of the object)?

What Does It Take to Learn a Word?

The entrance into word learning is dramatic. "[M]y teacher placed my hand under the spout. As the cool stream gushed over one hand she spelled into the other the word *water,* first slowly, then rapidly. I stood still, my whole attention fixed upon the motions of her fingers. Suddenly I felt a misty consciousness as of something forgotten—a thrill of returning thought; and somehow the mystery of language was revealed to me. I knew then that 'w-a-t-e-r' meant the wonderful cool something that was flowing over my hand. That living word awakened my soul, gave it light, hope, joy, and set it free! . . . Everything had a name, and each name gave birth to a new thought" (Keller, 1904, pp. 22–23).

This passage conveys the conceptual power of establishing a word-to-world correspondence. To be sure, Keller's entrance into word learning differed in important

ways from the more typical circumstances in which infants' first words are acquired. Normally developing infants begin producing their first words at approximately 1 year of age, but Keller acquired "w-a-t-e-r" when she was approximately 7 years of age.[1] Second, although in some cultures and some circumstances names are deliberately "taught," this practice is emphatically not universal. In some cultures (e.g., Western, well-educated communities), caretakers deliberately provide names for their infants, often even before the infants themselves can even speak. But in other communities, (e.g., Kahluli, see Ochs & Schieffelin, 1984), caretakers refrain from speaking directly to infants until the infants themselves begin to speak. Because infants from these communities acquire language on roughly the same timetable, it is clear that successful word learning does not depend on direct tutoring.

Third, in the typical course of events, words are seldom presented in isolation in the way that Annie Sullivan presented *w-a-t-e-r*. Instead, words tend to be embedded in a fluent stream of continuous speech. How do infants succeed in these cases? At a most general level, it helps that infants devote special attention to human speech; this serves them in good stead as they begin to single out the novel words (chap. 2; Jusczyk & Kemler Nelson, 1996). Another advantage is that caretakers tend to use infant-directed speech, or "motherese," when addressing infants and young children. The exaggerated pitch contours and phrase boundaries of this speech register facilitate the identification of distinct words and phrases in the continuous speech stream (Gleitman & Wanner, 1988). We also know that infants as young as 8 months of age are especially attentive to words that receive stress, particularly those at the end of a sentence or phrase boundary (e.g., "See the *water*?") (Fernald, 1992; Jusczyk & Aslin, 1995). In many languages (e.g., English, Spanish, French), nouns tend to occupy this privileged phrase-final position; in others (e.g., Mandarin Chinese [Tardif, 1996], Korean [Au et al., 1994; Choi & Gopnik, 1995; Kim, McGregor, & Thompson, 2000], and apparently Tzeltal and Itzaj Maya), this is less often the case. Despite these variations, infants across the world begin to produce their first words at roughly the same age, and the composition of their early lexicons are roughly comparable, with nouns (that is, words that are classified as nouns in the adult language) being the predominant early form (Au et al., 1994; Gentner, 1982; Gentner & Boroditsky, 2001; Gleitman, 1990; Goldin-Meadow et al., 1976; Huttenlocher & Smiley, 1987; Nelson et al., 1993; Saah et al., 1996; Tardif, 1996).

Fourth, although Annie Sullivan made sure that the referent of the word was available for Helen's inspection throughout the duration of the naming episode, this is not representative of the more typical word-learning scenario, in which infants must identify the referent (e.g., the family dog) amid an ever-changing current of events. In many cases, the referent is absent entirely (e.g., "Let's find the dog," uttered as the parent wakes the infant from a nap). In other cases, the referent may make only a fleeting appearance (e.g., "There goes the dog again!" uttered as Magic makes a fleeting appearance in the infant's room). Perhaps most perplexing, even if the referent is present throughout the naming episode, there is no guarantee that the infant will attend to it at the time that the novel word is introduced (e.g., "Go kiss Magic," uttered in an effort to pull the infants' attention away from a sleeping sibling).

The Puzzle of Word Learning

In the best of all scenarios, word learning takes place as one speaker (say, an adult) points toward an object or scene (say, an animal running across the yard) and utters a phrase ("Voilà, un chien" [in French], or "Look, a dog" [in English]). To successfully learn the word, the listener must (1) parse the relevant word (*chien* or *dog*) from the ongoing stream of speech, (2) identify the relevant entity (the dog) in the ongoing stream of activity in the world, and (3) establish a word-to-world correspondence. To put matters more formally, successful word learning rests on an ability to discover the relevant linguistic units, the relevant conceptual units, and the mappings between them.

Parsing the Relevant Word By approximately 9 to 10 months, infants have become increasingly sensitive to the morphologic, phonetic, and prosodic cues that mark word and phrase boundaries (chap. 2; Jusczyk & Aslin, 1995; Kemler Nelson et al., 1989). Recent work reveals that infants' growing sensitivity to these cues permits them to distinguish between two very broad classes of words: *open class* words (or *content* words, including nouns, adjectives, verbs) and *closed class* words (or *function* words, including determiners and prepositions) (Shi et al., 1999). By 9 to 10 months, infants prefer to listen to open class, as compared to closed class, words.

This preference is likely related to perceptual salience: open class words typically receive greater stress and entail more interesting melodic contours than closed class words. Since this preference for open class words exists well before infants begin to map words systematically to meaning, it is reasonable to assume that it is not tied specifically to the domain of language, per se, or to the establishment of meaning. Nonetheless, this (presumably) perceptually based early preference represents an important first step on the road to word-learning, for it ensures that infants attend to just those words (the open class, content words) that are required if they are to anchor their first word-to-world mappings (Jusczyk & Kemler Nelson, 1996; Morgan & Demuth, 1996; Werker et al., 1996).

Identifying the Relevant Entity Word learning also depends on the learner's ability to identify discrete objects in the environment, to notice relations among these objects, and to attend to the commonalities and distinctions among them that support categorization. Recent research has revealed that prelinguistic infants have considerable knowledge about objects (Baillargeon, 2000; Spelke, 2000) that serves to organize an impressive repertoire of concepts. Some of these prelinguistic concepts are focused around richly structured, conceptual relations (e.g., bottle; animal); others are focused around primarily perceptual relations (e.g., red; soft); most concepts incorporate both conceptual and perceptual factors (see chap. 3; Waxman & Markow, 1995). Since infants' ability to form concepts appears before the advent of word learning, it is reasonable to assume that at least some concepts are formed independently of language.

Establishing a Word-to-World Mapping This is a monumental accomplishment. It is predicated on infants' ability to grasp the referential power of words and to infer

the goals and intentions of others. By 10 months, infants appear to have made such connections (Baldwin & Baird, 1999; Guajardo & Woodward, 2000). Moreover, a successful mapping depends on the infants' ability to store in memory the sound of the new word and the mapping between that word and its intended referent. This aspect of word learning, sometimes known as "fast mapping," is evident when a child applies a word (*e.g., dog*) to the same individual that was named by her caregiver (e.g., a pet dog named Magic).

This represents an important step, but successful word-learning requires more. It requires infants to go beyond this *word-to-object* mapping to establish a more abstract *word-to-category* mapping (Waxman & Booth, 2000b). For example, the acquisition of a count noun (e.g., dog) requires infants to extend a new word beyond the particular individual on which it was introduced, making an inferential leap, from an individual (Magic) to a category or kind (dog). Infants' spontaneous naming behavior reveals that they make such leaps. Rather than (merely) mapping words to the individuals on which they were introduced, infants extend these words systematically, and these extensions are guided by the grammatical form of the word itself.

Different Kinds of Words Highlight Different Aspects of the Same Scene A fundamental feature of human language is that different kinds of words highlight different aspects of the same observed scene and support a unique pattern of extension. For example, in English, count nouns ("Look, it's a dog") typically refer to the named object itself and are extended to other members of the same object kind (other dogs); proper nouns ("Look, it's Magic") also refer to the named individual, but these are not extended further; although adjectives can also be applied correctly to that individual ("Look, it's furry"), they do not refer to the individual itself but to a property of the named individual, and they are extended to other objects sharing that property.

Recent research has documented that by 2½ to 3 years of age, children are sensitive to many of these links between kinds of words and kinds of relations among objects. Moreover, children recruit these links in the process of word learning (for a review, see Waxman, 1998). For example, they expect proper nouns to refer to individual objects (Hall, 1991, 1999; Jaswal & Markman, 2001), count nouns to refer to categories of objects (Waxman, 1999; Waxman & Markow, 1995), and adjectives to refer to properties of objects within basic level kinds (Waxman & Klibanoff, 2000; Waxman & Markow, 1998). Links like these could provide powerful support in word learning, particularly if presenting a novel word in its grammatical context permits the learner to narrow the range of possible interpretations.

How Do Infants Acquire These Word-to-World Links?

But which of these links, if any, are available to infants at the very onset of lexical acquisition? And how are these shaped over the course of development? There are three logically possible solutions to this question.

Possibility 1 First, consider the possibility that early lexical acquisition is guided by an a priori set of expectations, linking each distinct grammatical form (e.g., noun,

adjective, verb) to a distinct type of meaning (e.g., object categories, object properties, actions). Implicit in this view is an assumption that a great deal of structure is built into the mind of the human infant, that this structure is specific to the domain of language, and that the expectations held by infants at the onset of word learning approximate those of adults, once the particular grammatical forms can be identified in the input.[2]

This possibility requires some further specification. For while it is certainly possible that links between *some* grammatical forms and their meaning may be available at the outset of lexical acquisition, it would be an oversimplification to posit that this is the case for all, or even most, such links. The cross-linguistic literature delineates some important boundary conditions on the range of potential "a priori" links. For example, the grammatical form *noun* enjoys considerable cross-linguistic stability. Across languages, this grammatical form is universally represented, and a core function of this grammatical form is to refer to individual objects (e.g., Agamemnon) and to categories of objects (e.g., tapir; mammal; animal). In contrast, other grammatical forms (particularly the predicates, including adjectives, prepositions, spatial terms) are much more variable in both the extent to which they are represented in various languages and the ways these forms are recruited to express meaning (Bowerman, 1996; Haryu & Imai, 1999; Imai & Gentner, 1997; Regier & Carlson, in press; Waxman, Senghas, & Benveniste, 1997).

This cross-linguistic variability is directly related to questions of early acquisition, for it reveals that infants' expectations linking these grammatical forms to their associated meanings cannot be fixed from the outset. Thus, although some links may indeed be universal and may be available at the very onset of word learning, other links (and in particular those involving the predicate system) must emerge later as infants *discover* (1) whether a particular grammatical form is realized in the language under acquisition and (2) how each form maps to meaning.

Possibility 2 A radically different possibility is that infants begin the task of word learning as tabulae rasae, equipped with no a priori expectations to guide the process of acquisition. Implicit in this view is a strong assumption that any expectations regarding word-to-world mappings must be learned, and that this process of learning is no different than any other kind of learning. The claim, sometimes described as a claim that word learning is the result of "dumb attentional mechanisms" (Smith, 1999) is that infants' first words, indeed first scores of words, are acquired without the guidance of any expectations. On this view, it is only once infants have established a sufficiently large lexicon that they will begin to notice correlations between types of words and their associated meanings. Thus, the claim is that any expectations linking lexical and conceptual organization become available only *after* the establishment of a sufficiently sizeable lexicon, and certainly after the onset of word learning. In recent work, Smith and her colleagues have proposed that the first evidence of any such expectations emerges only after infants have acquired 150 words in their productive lexicons. It follows, then, on this domain-general view, that the process of word learning at the very onset of lexical acquisition (when no links have yet been established) is qualitatively different in nature from later acquisition (when the lexicon has been established and can serve

as a basis for creating these links). This position has been argued forcefully (Smith, 1999; chap. 11).

However, a review of the developmental literature casts serious doubt on this possibility. There is now ample evidence (reviewed hereafter) that infants do not approach the initial steps of word learning as tabulae rasae, but instead harbor powerful expectations linking words with concepts (Balaban & Waxman, 1997; Waxman & Markow, 1995; Xu, 1999). The fact that these nascent expectations are in place in advance of word learning constitutes strong evidence against the possibility that expectations linking lexical and conceptual organization (1) emerge after the onset of word learning or (2) must be induced bottom-up, from infants' existing lexicons.

Possibility 3 The shortcomings of these first two possibilities have led me to argue for a third possibility—that infants embark on the task of word learning equipped with a broad, universally shared expectation, linking words to commonalities among objects, and that this initially broad expectation is itself subsequently fine-tuned in accordance with the form-to-meaning mappings that are realized in the native language under acquisition.

The claim is that infants begin the process of lexical acquisition not as tabulae rasae but with an initial, broad expectation regarding word-to-world mappings already in place. This expectation serves to guide lexical acquisition from the start. There is growing evidence for this view. For example, novel words (independent of their grammatical form) highlight commonalities among named objects (Balaban & Waxman, 1997) in infants as young as 9 months of age. This early expectation linking words to commonalities among objects appears to be supported by several domain-general principles, including (1) a perceptual preference for listening to novel (open class) words over other auditory stimuli, and (2) a capacity to notice similarities and differences among objects. However, the expectation itself—linking words to commonalities—appears to be specific to word learning, for it applies to novel words but not to other auditory signals (e.g., tones, as described later).

This broad initial link serves (at least) three essential functions. First, because words direct attention to commonalities, this link facilitates the formation of an expanding repertoire of categories and concepts. In this way, words serve as invitations to form categories. Second, this initially broad expectation supports infants' first efforts to establish symbolic reference, to form a set of stable "word-to-world" mappings—in short, to establish a rudimentary lexicon. Finally, and perhaps most radically, this initially broad expectation sets the stage for the evolution of the more precise expectations linking particular grammatical forms (e.g., nouns, adjectives, verbs) to particular types of relations among objects (e.g., object categories, object properties, actions) in the native language under acquisition (Waxman, 1999).

How might this evolution come about? Infants' early expectation (that words refer broadly to commonalities) directs their attention to just the sorts of regularities (among objects and among grammatical forms) that will promote the rapid discovery of the distinct grammatical forms that are present in the input. As infants begin to identify the distinct grammatical forms in the input, they first tease apart the nouns (from among the other open class grammatical forms)[3] and map these specifically to object categories (from among the other types of commonalities, including

property-based or action-based commonalities). Any subsequent linkages will build on this fundamental referential base and will be fine-tuned as a function of experience with the specific correlations between particular grammatical forms and their associated meanings in the native language.

Adjudicating among These Possibilities To adjudicate among these possibilities, we must be able to ascertain, first, whether prelinguistic infants harbor any expectations regarding word-to-world mappings, and second, whether and how infants' expectations are shaped in the course of acquiring a native language. Both developmental and cross-linguistic evidence are relevant here. For example, developmental evidence documents that by 2½ to 3 years of age, children reveal very specific expectations linking particular grammatical forms to particular types of meaning. (For evidence regarding a link between proper nouns and individuals, see Hall, 1999; for evidence regarding a link for adjectives, see Klibanoff & Waxman, 2000; for evidence regarding a link between count nouns and object categories, see Waxman, 1998, for a review; Waxman et al., 1997.) Moreover, cross-linguistic evidence reveals that some of these expectations are more likely than others to be powerfully shaped by the structure of the native language that the child is in the process of acquiring (Waxman & Guasti, 2002; Waxman et al., 1997). For example, when it comes to mapping novel count nouns to meaning, children acquiring a range of languages (English, French, Spanish, Italian) share an expectation that novel nouns direct attention specifically to categories of objects (e.g., dog, animal) (Markman & Hutchinson, 1984; Waxman & Gelman, 1986). This outcome is consistent with cross-linguistic evidence regarding the stability of the grammatical form *noun* and with the possibility that a noun-to-category mapping may be a universal feature of human language (Dixon, 1982; Gentner, 1982; Waxman, Senghas, & Benveniste, 1997). In contrast, children's expectations for novel adjectives vary systematically as a function of the language they are acquiring. For children acquiring English and French, novel adjectives direct attention specifically to property-based commonalities among objects (e.g., color; texture). Adjectives do not direct attention to category-based commonalities. However, children acquiring Italian and Spanish show a very different pattern, mapping adjectives to both categories and properties of objects. This pattern is consistent with that observed in the adult grammar. This cross-linguistic and developmental variation in the adjective system suggests that the mappings for adjectives must be learned (Waxman & Guasti, 2002; Waxman et al., 1997), while leaving open the possibility that a broader initial expectation linking words to commonalities among objects may exist in advance of word learning.

These results, coupled with converging evidence from other paradigms (Bloom, 2000; Hall & Graham, 1999; Landau, 1994; Waxman & Hall, 1993) document clearly that preschool-aged children have the *linguistic* capacity to distinguish among the relevant grammatical forms (count noun vs. adjective), the *conceptual* or *perceptual* ability to appreciate different kinds of relations among objects (category- vs. property-based), and a tacit expectation that these linguistic and conceptual abilities are interwoven. These results also reveal that children's expectations for at least some grammatical forms (here, the adjectives) are shaped by the structure of the native language under acquisition. To discover which linkages (if any) guide acqui-

sition from the outset, and how these are shaped by experience, we go on to consider infants on the very threshold of language acquisition.

An Initially General Link between Words and Concepts Exists in Advance of Lexical Acquisition

By the end of their first year, infants are well on their way to solving several key elements in the puzzle of word learning. They identify novel words in the input, detect likenesses and differences among objects, and take advantage of the rich social and pragmatic cues in which novel words are introduced. These accomplishments are impressive, but they do not, in themselves, provide evidence that naming has any consequences for prelinguistic infants' conceptual organization and categorization behavior. What remains to be seen is whether naming influences conceptual organization before the onset of productive language.

Cognitive Consequences of Naming in Prelinguistic Infants

Naming has important cognitive consequences, even in infants who have not yet begun to produce words on their own. First, by 10 months, infants devote more attention to objects that have been named than to objects that have been presented in silence (Baldwin & Markman, 1989). This effect appears to be specific to the domain of language. The evidence reveals that infants' increased attention stems specifically from the presentation of words and not from the attention-engaging functions of auditory stimulation more generally (Balaban & Waxman, 1997). Moreover, and perhaps more striking, the consequences of naming extend beyond the named individual. Balaban and Waxman (1997) documented these effects by comparing the effect of novel words versus tone sequences in 9-month-old infants. During a familiarization phase, infants saw a series of nine slides, each depicting a different member of a basic-level category (e.g., nine rabbits). Infants were randomly assigned to either a *Word* or a *Tone* condition. For infants in the *Word* condition, a naming phrase (e.g., "a rabbit!") accompanied the familiarization trials. For infants in the *Tone* condition, a sine-wave tone (matched to the naming phrase in amplitude, duration, and pause length) accompanied the familiarization trials. The familiarization phase was immediately followed by a test trial, in which infants in both conditions saw (1) a new member of the now-familiar category (e.g., another rabbit) and (2) an object from a novel category (e.g., a pig). Test trials were presented in silence.

If words focus attention on commonalities among objects, then infants hearing words during familiarization should notice the commonalities among the familiarization objects and should reveal a preference for the novel test object (e.g., the pig). If this effect is specific to words, and not to auditory stimulation more generally, then infants hearing tone sequences during familiarization should be less likely to notice the category-based commonalities and consequently less likely to reveal a novelty preference at test. The results echoed these predictions precisely. Only infants in the *Word* condition revealed a novelty preference at test. We therefore conclude that as early as 9 months of age, there is indeed something special about words,

as opposed to a more general facilitative effect of auditory input. In addition, the cognitive consequence of naming extends beyond the named individual(s) to highlight commonalities among named individuals and to promote the formation of object categories.

Naming has other key consequences for cognition during this period as well. In particular, naming appears to support infants' ability to trace the identity of individual objects over time and place. Recent evidence suggests that 10-month-old infants often find it difficult to track the unique identity of two distinct objects (e.g., a ball and a duck) (Xu & Carey, 1996). However, this difficulty decreases dramatically if each of the objects is introduced in conjunction with a distinct name ("Look, a ball!)" (Xu, 1999).

Together, these results reveal that naming has powerful cognitive consequences, even in prelinguistic infants. Naming distinct objects with the *same* name highlights their commonalities and promotes the formation of object categories (Balaban & Waxman, 1997). Naming distinct objects with *distinct* names (e.g., *ball, duck*) highlights their differences and promotes the process of object individuation (Xu, 1999). Thus, even before infants themselves begin to name objects, naming supports the establishment of a stable repertoire of object categories and provides infants with a means of tracing the identity of individuals within these categories. These core conceptual abilities are facilitated by naming, and the links between naming and conceptual organization appear before the advent of productive language.

Cognitive Consequences of Naming in Infants Just Beginning to Establish a Lexicon

In this section, I begin to trace the evolution of infants' expectations regarding word-to-world mappings as they cross over an important developmental threshold and begin producing words on their own. Together with several of my colleagues, I have designed experiments to uncover the influence of naming on categorization in infants ranging from 11 to 24 months of age (Booth & Waxman, in press; Waxman, 1999; Waxman & Booth, 2000a; Waxman & Booth, in press; Waxman & Booth, 2001; Waxman & Markow, 1998).

Some Methodological and Design Issues

Each experiment in this section is essentially an object categorization task, which compares infants' categorization of objects in "neutral" conditions (involving no novel words) with their categorization in the context of hearing a novel word. If naming facilitates categorization, then infants hearing novel words should categorize more successfully than infants in *No Word* control conditions. Because our goal is to examine an abstract linkage between naming and conceptual organization, we introduce novel words (e.g., *fauna*) rather than familiar ones (e.g., *animal*) in an effort to ensure that words we introduce have no established associations for the infants. Because we are also interested in tracing infants' emerging sensitivity to distinct grammatical forms, we vary the syntactic frame in which the novel words are embedded. In all conditions, infants hear short, simple constructions that are charac-

teristic of infant-directed speech and that provide unambiguous structural evidence of the word's grammatical form. To introduce a novel word as a noun, we say, for example, "This is a *blicket.*" We can also present the same word as an adjective by presenting it within a different frame, saying, for example, "This is a *blick-ish* one." (See Gerken & McIntosh, 1993, and Waxman & Markow, 1995, 1998, for evidence that infants are sensitive to these distinct frames.) In the *No Word* control conditions, we introduce no novel words but offer the same strong social and pragmatic support as in the experimental conditions. We point out the objects, saying, for example, "Do you like this?" or "Look at this." Performance in this *No Word* control condition assesses how readily infants form the various categories presented in our tasks (e.g., dog, animal, purple things). Performance in the *Noun* and *Adjective* conditions assesses the role of naming in this important endeavor. Including these two conditions permits us to test the specificity of the relation between grammatical form and meaning.

Naming and Category-Based Commonalities

We began by adapting the standard novelty preference task to examine the influence of novel words on object categorization in 12- to 14-month-old infants (see Waxman & Markow, 1995, for a complete description). (See fig. 9.1 for a sample set of stimuli and introductory phrases.) During a familiarization phase, an experimenter offered an infant four different toys from a given category (e.g., four animals) one at a time, in random order. This was immediately followed by a *test phase*, in which the experimenter simultaneously presented both (1) a new member of the now-familiar category (e.g., another animal) and (2) an object from a novel category (e.g., a fruit). Each infant completed this task with four different sets of objects. Two involved basic-level categories (e.g., horses vs. cats); two involved more abstract superordinate-level categories (e.g., animals vs. fruit). Infants manipulated the toys freely, and their total accumulated manipulation time served as the dependent measure.

To identify any influence of novel words on categorization, we randomly assigned infants to one of three conditions. Infants in all conditions heard infant-directed speech. The conditions differed only in the experimenter's comments during familiarization. In the *No Word* condition (control), she said, "Look at this" as she introduced each object; in the *Noun* condition, she said, for example, "This one is a *blicket.*" In the *Adjective* condition, she said, for example, "This one is *blick-ish.*" In the test phase, infants in all conditions heard precisely the same phrase ("See what I have?").

If infants detect the presence of the novel word, and if novel words direct infants' attention to object categories, then infants who hear novel words in conjunction with the objects presented during familiarization should be more likely than those in the *No Word* condition to form object categories. Including both a *Noun* and *Adjective* condition permitted us to test the specificity of infants' initial expectation. If this expectation is initially general, as I have proposed, then infants in either the *Noun* and *Adjective* conditions should be more likely than those in the *No Word* condition to detect the category-based commonalities.

	Familiarization Phase				Test Phase	
	Trial 1	Trial 2	Trial 3	Trial 4		
Animal Set:						
	yellow duck	green raccoon	blue dog	orange lion	red cat	red apple
Noun	This one is. a(n) X	This one is a(n) X	See what I have?	This one is a(n) X	See what I have?	
Adjective	This one is X-ish	This one is X-ish	See what I have?	This one is X-ish	See what I have?	
No Word	Look at this.	Look at this.	See what I have?	Look at this.	See what I have?	

Figure 9.1. A schematic presentation of introductory phrases from Waxman & Markow (1995) and an example of a single stimulus set.

The results provided support for these predictions. First, infants reliably detected the novel words presented in fluent speech, and these novel words (both adjectives and nouns) promoted the formation of object categories. Second, in this experiment, and in several others in our laboratory, we find that the facilitative effect of novel words is most powerful on superordinate level sets. Infants in all three conditions noticed the category-based commonalities on the basic-level sets and therefore demonstrated reliable novelty-preferences. However on superordinate level sets, where the category-based commonalities were more difficult to detect,[4] infants in the *No Word* control condition failed to detect the commonalities among the familiarization objects and failed to reveal novelty preferences at test. Yet when the same superordinate-level familiarization objects were introduced in conjunction with novel words (either count nouns or adjectives), infants successfully detected the commonalities among them and revealed reliable novelty preferences at test. Thus, although infants had difficulty detecting the category-based commonalities on superordinate level sets in the absence of a novel word, there was a clear facilitative effect of novel words at this hierarchical level. We therefore conclude that novel words highlighted category-based commonalities and facilitated infants' formation of superordinate level categories.

Infants' successful formation of (superordinate-level) categories in the *Noun* and *Adjective* conditions, and their failure to do so in the *No Word* conditions, stands as clear evidence that a link between word learning and conceptual organization is in place. Following Roger Brown (1956), we interpret this as evidence that words serve as invitations to form categories. This invitation has several dramatic consequences. Novel words invited infants to assemble together objects that were otherwise perceived as disparate and supported the discovery of commonalities that otherwise went unnoticed (for related evidence, see Gentner & Namy, 1999; Gentner & Waxman, 1994). Naming may also have dramatic consequences in situations in which infants have already formed groupings and noticed (some of) the commonalities among

objects. For example, although infants in this series successfully formed basic-level object categories (whether or not they were introduced to novel words), we know that their knowledge about these categories is not on a par with that of an older child or adult (Gelman, 1996; Keil, 1994). Despite this relative lack of information, children seem to expect that members of named object categories share deep, nonobvious commonalities. Indeed, children depend on these to support inference and induction. In our view, novel words serve as invitations, motivating infants and young children to discover the deeper commonalities that underlie our richly structured object categories (Barsalou, 1983; Gelman, 1996; Gelman, Coley, & Gottfried, 1994; Gelman & Medin, 1993; Kalish & Gelman, 1992; Keil, 1994; Landau, 1994; Landau, Smith, & Jones, 1988; Lassaline & Murphy, 1996; Macnamara, 1994; Markman, 1989; Medin & Heit, in press).

Naming and Property-Based Commonalities

In the next series of experiments, our goal was to capture more precisely the scope of this early expectation linking object naming and categorization. At issue is whether infants embark on the process of lexical acquisition with an expectation linking novel words specifically to category-based commonalities (e.g., *flamingos, animals*), or to a wider range of groupings, including, for example, property-based commonalities (e.g., color: *pink things*; texture: *soft things*) as well. To answer this question, we retained the logic and design of Waxman and Markow's (1995) original paradigm but shifted the focus from category-based commonalities (e.g., *flamingo, animal*) to property-based commonalities (e.g., *pink things, soft things*). This approach is predicated in the assumption that a principled psychological distinction can be made between object categories and object properties. Most current theorists distinguish object categories (also known as *kinds* or *sortals*) from other types of groupings (e.g., *pink 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; Gelman & Medin, 1993; Kalish & Gelman, 1992; Macnamara, 1994; Medin & Heit, in press; 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 (Gelman, 1996; Keil, 1994).

We focused on two properties—color and texture—because infants find these properties perceptually salient and because groupings based on these properties (e.g., *purple things*) readily cut across category boundaries (to include, e.g., a lollipop, a t-shirt, and a tricycle).[5] As in the previous experiment, infants were familiarized to four distinct objects. However, this time, the commonality among the familiarization objects was not category based; it was property based (either color, e.g., purple cat, purple plate, purple spatula, purple bottle, or texture, e.g., rough cup, rough ball, rough hat, rough boot). At test, all infants were presented with both (1) a new object embodying the now-familiar property (e.g., a purple horse) and (2) an object embodying a contrasting property (e.g., a blue horse). Infants were randomly as-

signed to either a *Noun*, *Adjective*, or *No Word* condition. As before, these conditions differed only in the instructions presented to the infants during familiarization (see fig. 9.2).

This design permitted us to ask whether infants link novel words (e.g., count nouns, adjectives) specifically to the commonalities underlying object categories from the start, or whether words might also direct infants' attention to the property-based commonalities presented in this task. The design also permitted us to ascertain whether infants distinguish between novel words presented as count nouns versus adjectives. Recall that in the previous series, infants treated these two grammatical forms identically with respect to object categorization (Waxman & Markow, 1995). Both nouns and adjectives directed infants' attention toward category-based commonalities (Waxman & Markow, 1995). However, whether infants distinguish between these grammatical forms in other contexts, and whether this distinction has consequences on the formation of groupings other than object categories, remains very much an open question.

We reasoned as follows. If infants attended to the property-based commonalities among the familiarization objects, then they should reveal a preference for the object with the novel property at test (e.g., the blue horse). If they attended to the category-based commonalities among the familiarization objects, then they should reveal no novelty preferences. The only commonality among familiarization objects was property based (e.g., color or texture; see fig. 9.2). Thus, infants attending to category-based commonalities should reveal no consistent preferences at test.

The results clarify the scope of infants' initial expectations regarding object naming and categorization. Infants in this series distinguished between novel words presented as count nouns versus adjectives. Infants hearing novel adjectives directed their attention primarily to the property-based commonalities among the familiarization objects, and revealed reliable preferences at test for the object with the new contrastive properties (e.g., the blue horse). In contrast, infants hearing novel nouns revealed

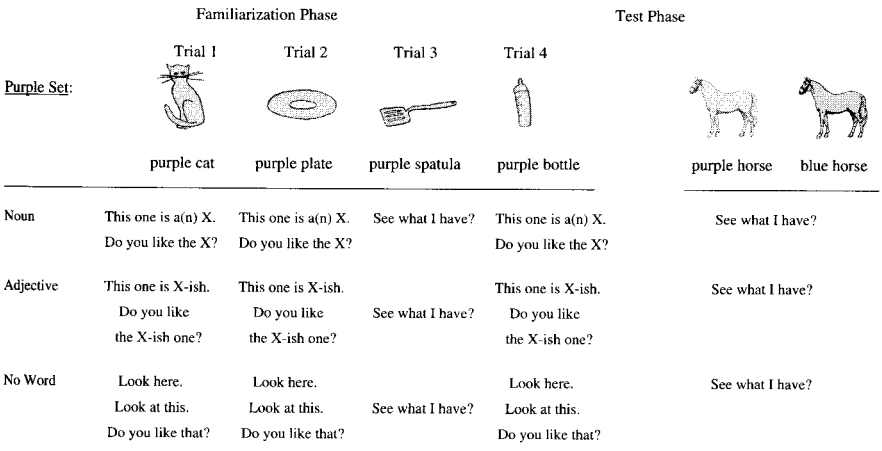

Figure 9.2. A schematic presentation of introductory phrases from Waxman (1999) and an example of a single stimulus set.

no consistent preferences at test. This, coupled with the infants' performance in the *No Word* control condition, suggests that nouns actually drew infants' attention away from the property-based commonalities.

Together, these two series of experiments offer some insight into infants' expectations regarding word-to-world mappings at the onset of lexical acquisition. By 13 months, infants appear to be sensitive to at least some grammatical form distinctions, and this sensitivity has consequences for their object categorization. Novel nouns directed infants' attention specifically to category-based commonalities (as in Waxman & Markow, 1995) but away from property-based commonalities (as in Waxman, 1999). Novel adjectives had a more general influence, highlighting both category-based commonalities (as in Waxman & Markow, 1995) and property-based commonalities (as in Waxman, 1999).

What are the implications of this outcome? First, these results call into question the possibility (possibility 1) that early lexical acquisition is guided by an a priori set of expectations, linking each distinct grammatical form (e.g., noun, adjective, verb) to a distinct type of meaning (e.g., object categories, object properties, actions), for infants do not make as fine a set of distinctions as do more mature speakers (as is evident from infants' apparently general expectation for adjectives). Second, these results challenge the claim (possibility 2) that infants begin the task of word learning equipped with no expectations to guide the process of acquisition, for even novel words have a clear effect on the categorization of objects.

These results favor the possibility (possibility 3) that infants begin the task of lexical acquisition equipped with a general expectation linking words (independent of grammatical form) to commonalities among objects. The results also suggest that by 13 months of age, infants have already begun to refine this initially general expectation. At this developmental moment, infants' expectation for novel words presented as count nouns appears to be more finely tuned than their expectations for adjectives. Clearly, the infants' grammatical form distinctions are not as well defined as those of more mature speakers. And clearly, their repertoire of knowledge about individual objects, categories of objects, and properties of objects is not as rich as those of their elders. Yet by 13 months, infants do appear to share with their elders a deep insight—that there are different types of words (here, count nouns and adjectives) and that these draw attention to different types of commonalities among objects (here, category- and property-based commonalities). If this is the case, then infants have begun to make the transition from an initially general expectation linking words (in general) to commonalities (in general), and have begun to develop a more specific set of expectations for the various grammatical forms. Because this is such a powerful claim, and because it has such powerful implications for theories of acquisition, we have gone on to submit this claim to rigorous empirical test.

Fine-tuning an Initially General Expectation

The primary goal of this series was to trace the proposed developmental trajectory from an initially general expectation linking novel open class words (either count nouns or adjectives) broadly to commonalities among objects (either category- or property-based) to a more specific set of expectations. We therefore examined the

influence of novel nouns and adjectives on infants from 11 to 14 months of age. We expected that 11-month-olds would reveal a very general expectation and that the older infants would have begun to transition to a more specific set of expectations. At each age, we asked (1) whether infants could construe the very *same* set of objects (e.g., four purple animals) either as members of an *object category* (animals) or as embodying an *object property* (purple), and (2) whether their construal was influenced as a function of naming.

This is important because in previous work, the evidence that naming promotes attention to object categories was documented with one set of materials and the link between naming and attention to object properties with another. For example, in experiments documenting the contribution of naming to infants' attention to category-based commonalities (Balaban & Waxman, 1997; Fulkerson & Haaf, 1998; Waxman & Markow, 1995), the only consistent relation among the familiarization objects was category based (e.g., animals). In experiments demonstrating the effect of naming on infants' attention to object properties (Waxman, 1999), the only consistent relation shared by the familiarization and test objects was property based (e.g., purple things). By introducing infants to a set of objects (e.g., purple animals) that share both an *object category* (animals) and an *object property* (purple), we can discover whether their attention to category-based and property-based commonalities is affected by naming, and more specifically, whether it is systematically affected by the grammatical form of the name provided.

A third goal of this series is methodological. Virtually all of the evidence reviewed thus far regarding infants' expectations in word learning has been based entirely on one measure: the novelty-preference task. It remains to be seen whether infants' expectations are sufficiently strong to support performance beyond this task. Therefore, in the current series, we asked whether infants' expectations would influence performance in a word extension task. Our goal here was to bridge a longstanding methodological gap between research with infants and preschoolers. From the onset of word learning, infants advance from producing single-word utterances (at approximately 9 to 12 months) to creating rich multiword expressions (at approximately 24 months). We have proposed that in the intervening period, infants' initially general expectation (that words, in general, highlight commonalities among objects, in general) become fine-tuned as infants develop the more specific expectations characteristic of their native language (that nouns refer to category-based, but not property-based, commonalities and that adjectives refer to property-based, but not category-based, commonalities, etc.). But our view of this critical transition period has been clouded, at least in part, by the difficulties of accommodating the very different behavioral capacities of individuals at either end. Novelty-preference tasks have been successful with infants, but beyond 18 months of age, infants lose interest in such tasks. Word-extension tasks have been successful with toddlers and preschoolers but lack sensitivity with infants under 18 months, who have difficulty choosing systematically among objects in forced-choice tasks.

To bridge this methodological gap, we developed a new method that weds features of the novelty-preference procedure with those of the word-extension paradigms. The procedure involved three distinct phases (see fig. 9.3 for a schematic

	Familiarization		Contrast	Test	
	Trial 1	Trial 2		Category	Property
Purple Animal Set:					
	bear lion	elephant dog	red apple	purple horse vs. purple chair	purple horse vs. blue horse
Noun	These are blickets. This one is a blicket & This one is a blicket	These are blickets. This one is a blicket & This one is a blicket	Uh-oh, this one is not a blicket!	Can you give me the blicket?	Can you give me the blicket?
Adjective	These are blickish. This one is blickish & This one is a blickish	These are blickish. This one is blickish & This one is a blickish	Uh-oh, this one is not blickish!	Can you give me the blickish one?	Can you give me the blickish one?
No Word	Look at these. Look at this one & Look at this one	Look at these. Look at this one & Look at this one	Uh-oh, look at this one!	Can you give one?	Can you give me one?

Figure 9.3. A schematic presentation of introductory phrases from Waxman & Booth (1999) and an example of a single stimulus set.

description of the procedure and a summary of the instructions presented in each condition).

In the familiarization phase, the experimenter introduced infants in all conditions to four objects, all drawn from the same object category (e.g., four horses or four animals) and embodying the same object property (e.g., purple). These were presented in pairs, and infants manipulated them freely. During the *Contrast phase*, the experimenter presented a new object (e.g., a brown rolling-pin), drawn from a contrastive object category and embodying a contrastive object property. She shook her head solemnly, and said either, for example, "Uh oh! This one is not a *blicket*" (*Noun* condition), "Uh oh! This one is not *blickish*" (*Adjective* condition), or "Uh oh! Look at this one" (*No Word* condition). She then re-presented a target object drawn from the original set of familiarization objects (e.g., a purple horse) and happily exclaimed, for example, "Yay, this one is a *blicket*" (*Noun* condition), "Yay, this one is *blickish*," or "Yay, look at this one" (*No Word* condition). She placed this target object in front of the infant and outstretched her palm, asking, for example, "Can you give me the *blicket*?" (*Noun* condition), "Can you give me the *blickish* one?" (*Adjective* condition) or "Can you give me that one?"(*No Word* condition).

In the *Test phase*, half of the infants in each condition received *Category* test trials (e.g., a purple horse vs. a purple chair). The remaining infants received *Property* test trials (e.g., a purple horse vs. a blue horse). Each infant was permitted to play freely with the test pair for 20 seconds. We have found that when infants are permitted to play with both test objects briefly before testing, they are more likely to select between these two objects when presented with a forced-choice test. After the 20 seconds had elapsed, the experimenter retrieved the test pair.

To assess *word-extension*, she presented a target object, drawn from the set of familiarization objects (e.g., a purple horse), and drew attention to it by pointing. She then presented the two test objects, placing them easily within the infant's reach, and asked the infant to choose one. (See fig. 9.3 for the precise instruction used in

each condition.) Each infant completed this entire procedure four times, with four different sets of objects, two representing basic level object categories and two representing superordinate level categories.

If infants begin the process of lexical acquisition with a general expectation linking words (in general) to commonalities among objects (in general), then at 11 months, both nouns and adjectives should highlight both category-based (e.g., animal) and property-based (e.g., purple things) commonalities among the familiarization objects. If this initial expectation is subsequently refined, as infants discover the more precise links between particular grammatical forms and their associated meaning, then for more advanced learners, a more specific pattern should emerge. If a specific expectation for nouns is first to emerge from the initially general expectation, then infants should extend count nouns specifically to category-based commonalities but should continue to extend adjectives broadly to both category- and property-based commonalities.

The results, which are depicted in table 9.1, provided strong support for these predictions. At 11 months, infants hearing novel words (both nouns and adjectives) performed differently from those in the *No Word* condition. Infants extended both novel nouns and adjectives consistently to the familiar test object (e.g., the purple horse) on both category and property trials. This confirms that at the very onset of building a lexicon, (1) novel words direct infants' attention broadly to both category- and property-based commonalities among named objects, and (2) this link is sufficiently strong to support the infants' extension of novel words. This constitutes evidence in support of the proposal that infants on the very threshold of word learning harbor a general expectation linking words (both nouns and adjectives) broadly to commonalities (both category- and property-based) among objects.

The results from the 14-month-old infants also support the prediction that once word learning is underway and infants have established a modest lexicon, a more specific pattern of expectations should emerge. Based on our previous work (Waxman, 1999; Waxman & Booth, 2000a), we expected that at 14 months, infants would

TABLE 9.1. Means and Standard Deviations of the Proportion of Word-Extension Test Trials on Which the Familiar Object Was Chosen

	14-month-olds (Waxman & Booth, in press-b)		11-month-olds (Waxman & Booth, in press-a)	
	M	*SD*	*M*	*SD*
Noun				
Category	.68*	.13	.57	.24
Property	.44	.15	.55	.14
Adjective				
Category	.50	.18	.59	.24
Property	.52	.17	.58	.15
No word				
Category	X	X	.46	.15
Property	X	X	.49	.09

*$p < .05$ versus chance of .50.

begin to distinguish count nouns (from among the other grammatical forms) and to map these specifically to category-based commonalities. We expected that 14-month-olds' expectations for adjectives would still be quite general and that words from this grammatical form would direct their attention broadly toward commonalities (be they category or property based). In support of this aspect of our proposal, we found that by 14 months, infants were more likely to extend novel nouns to the familiar object (e.g., purple horse) on category trials (e.g., purple horse vs. purple plate) than on property trials (e.g., purple horse vs. blue horse) (M = .68 vs. .44, respectively). This suggests that they expect nouns to refer to category-based, rather than to property-based, commonalities among objects. However, infants' expectations regarding the extension of novel adjectives were more general. Infants hearing adjectives were equally likely to select the familiar object on both types of test trials (M = .50 vs. .52, respectively). This result has now been replicated (Waxman, 1999; Waxman & Booth, 2000a), using various other properties (e.g., color, texture).

Clearly, by 14 months of age, infants are sensitive to (at least some of) the relevant cues that distinguish count nouns from adjectives, and they recruit these distinctions in the task of word learning. This is consistent with the view that as infants begin to refine their initially general expectation for word-to-world linkages, they first tease apart the nouns from among the other grammatical forms, and map them specifically to category-based commonalities. During this transition from general to more specific expectations, infants' expectation for adjectives remains more general, with adjectives highlighting both category- and property-based commonalities. The more specific expectations linking adjectives to their associated types of meaning is a subsequent developmental accomplishment, one that appears to depend on infants' prior establishment of the link between count nouns and object categories, and one that is shaped by the semantic and syntactic properties of adjectives in the language under acquisition. (See Waxman et al. [1997] for evidence that this expectation for adjectives is indeed sensitive to cross-linguistic variation.)

The Evidence in Review

Bolstered by the current evidence, I return to a question I posed earlier: what expectations, if any, do infants recruit in the process of mapping their first word-to-world mappings, and how do these evolve over development? I have argued (1) that infants begin the task of word learning with a broad initial expectation that links novel words (independent of their grammatical form) to commonalities among named objects, and (2) that this initial expectation is subsequently fine-tuned as infants gain experience with the specific correlations between particular grammatical forms and their associated meanings in the native language (Waxman, 1999; Waxman & Booth, 2001; Waxman & Markow, 1995).

Our results are entirely consistent with this proposal. Eleven-month-olds begin the task of lexical acquisition with a general expectation linking novel words (in general) to commonalities among objects (in general). More specific expectations linking particular kinds of words to particular types of meaning (e.g., linking nouns

to object categories) begin to emerge later, once the process of word learning is well under way. These more specific expectations, which begin to appear in infants close to 14 months of age (Waxman, 1999; Waxman & Booth, in press-b; Waxman & Markow, 1995), do not emerge all of a piece. Instead, some expectations (e.g., linking nouns to object categories) appear earlier than others (e.g., linking adjectives to properties).

The Three Possibilities Revisited

In full view of these results, reconsider the three possibilities raised earlier. First, there is the possibility that early acquisition is guided by an a priori set of expectations, linking each type of word (e.g., noun, adjective, verb) to a particular type of meaning (e.g., object categories, object properties, actions). The evidence reported here does not support this possibility in its strongest form. As has been shown, infants appear to begin the task of word learning with a link that is considerably more general than that of the more mature language user. We therefore conclude that infants' specific expectations linking particular grammatical forms to their meaning are not fixed from the outset. Instead, infants seem to discover how the various grammatical forms (and in particular, the predicates) are mapped to meaning in the language under acquisition.

One caveat is in order here. Based on my review of the adult cross-linguistic literature, I suggested that *some* links between particular grammatical forms and meaning may indeed be universal. In particular, the noun-category link enjoys considerable cross-linguistic stability. This is also the link that is first to emerge from a more general expectation. For most other grammatical forms, there is considerable cross-linguistic variability in the mappings to meaning (Bowerman, 1996; Haryu & Imai, 1999; Imai & Gentner, 1997; Regier & Carlson, in press; Waxman et al., 1997). This link also appears to emerge later in acquisition, and may indeed be predicated on the prior establishment of the noun-category linkage. This caveat is relevant to my own proposal (possibility 3) and will therefore be discussed more fully later.

Second, there is the possibility that infants begin the task of word learning as tabulae rasae, equipped with no expectations to guide early acquisition (Smith, 1999). We find no support for this possibility, particularly because infants as young as 9 to 12 months of age reveal a powerful, albeit general, expectation linking words with concepts (Balaban & Waxman, 1997; Waxman & Markow, 1995; Xu, 1999). The fact that this nascent expectation is in place in advance of word learning undermines Smith's claim that infants' expectations (1) must emerge after the onset of word learning or (2) must be induced on the basis of an extensive existing lexicon.

Third, I offered a developmental proposal, suggesting that (1) infants embark on the task of word learning equipped with a broad, universally shared expectation that links novel words (independent of their grammatical form) broadly to a wide range of commonalities among named objects, and that (2) this initial expectation is subsequently fine-tuned as infants gain experience with the particular grammatical forms in their native language and their links to meaning. The results of our experiments fit well with this proposal.

I have suggested that the initially general expectation, which appears at 11 months before the advent of productive language, is universally available and provides the foundation for infants' early establishment of symbolic reference and lexical acquisition. It also sets the stage for the evolution of the more specific expectations, which are calibrated in accordance with the observed correlations between particular grammatical forms and their associated meanings in the language under acquisition (Waxman, 1999; Waxman & Booth, 2000a; Waxman & Markow, 1995). The evidence summarized in this chapter supports this aspect of the proposal. By 14 months, infants' expectations have indeed become more fine-tuned than those that emerged at 11 months. The evidence goes one step further to reveal that as infants develop this more specific set of expectations, they first distinguish the count nouns (as compared to other grammatical forms) and map them specifically to category-based, but not property-based, commonalities among objects.

Why Is the Noun-Category Link the First Specific Link to Emerge?

On the basis of the current evidence, we cannot be certain why this is the case. This new result fits well within the framework of several different theoretical alternatives. For example, it is consistent with the possibility that a link between count nouns and object categories, which is a universal feature in the design of human languages, is innate. Across languages, the grammatical form *noun* is always represented, and a core semantic function of this grammatical form is to pick out individual objects and categories of objects. In contrast, there is substantially more cross-linguistic variation in the extent to which the grammatical form *adjective* is represented, and there is considerably more variation in the types of meaning associated with this form (Dixon, 1982). It is therefore possible that although an expectation linking nouns to object categories might be "there from the start," it is clear that any specific expectation regarding adjectives instead would emerge later, as infants come to identify the adjectives in the input and to discover how these map to meaning in the particular language under acquisition.

On the other hand, this noun-category link, though universal, may itself be learned. Gleitman and her colleagues (Fisher, Hall, Rakowitz, & Gleitman, 1994; Gillette, Gleitman, Gleitman, & Lederer, 1999; Snedeker & Gleitman, 1999) have provided a demonstration proof that learners successfully map nouns to concrete objects and categories of objects (e.g., dog, animal) by observing the word-to-world pairings that are available in the input (ongoing scenes of events and maternal input). Other types of words require additional structural, linguistic information, and this information can only become available once infants have acquired a repertoire of concrete nouns. An examination of infants' early lexicons is also consistent with the experimental evidence that I have offered concerning the early emergence of the noun-to-category link, and with the possibility that this link is learned. Recall that nouns constitute the greatest proportion of words in infants' early lexicons. Because these words refer predominantly to individual objects and categories of objects, it is possible that a link between nouns and object categories happens to be the one that is most readily discovered by infants.

Whatever its origins—induced or innate—the early emergence of a noun-category linkage is probably universal. This interpretation accords well with most current theories of language acquisition, which assume that the learner must be able to identify the nouns in the input and map them to entities in the world if they are to discover the other grammatical forms and their links to meaning (Dixon, 1982; Gentner, 1982; Gleitman, 1990; Grimshaw, 1994; Huttenlocher & Smiley, 1987; Maratsos, 1998; Pinker, 1984; Talmy, 1985; Waxman, 1999; Wierzbicka, 1986). Indeed, the argument is that the acquisition of these other grammatical forms must be grounded in the prior acquisition of nouns.

Conclusions

The goal of this chapter has been to articulate a developmental account of the powerful relation between word learning and conceptual organization. I proposed that (1) infants begin the task of word learning equipped with a broad, initial, and universally available expectation linking novel words (independent of their grammatical form) to a wide range of commonalities among named objects; (2) this initially general expectation sets the stage for the evolution of more specific expectations, calibrated in accordance with the correlations between particular grammatical forms and their associated meanings in the language under acquisition; and (3) these expectations support the rapid acquisition of increasingly sophisticated language and conceptual systems that are the hallmark of human development (Waxman, 1999; Waxman & Booth, 2000a; Waxman & Markow, 1995).

This developmental account has several distinct strengths. First, it embraces both the importance of the expectations imposed by the learner and the shaping role of the environment. The power of adopting this integrative approach to questions of acquisition has been recognized across disciplines. It can be seen in the elegant work of Marler (1991) on the acquisition of birdsong, of Held and Hein (1963) on the acquisition of depth perception in kittens, of Baillargeon (1993) and Spelke (1993) on the acquisition of physical knowledge about objects in human infants, and of R. Gelman (1991) on the acquisition of number concepts. Although each of these research programs considers very different domains of knowledge, they are all committed to considering carefully the relative contributions of both (1) the amount and type of information present in the environment, and (2) the structure or constraints imposed by the learner when characterizing the rapid acquisition of complex, sophisticated systems. (See Gallistel, Brown, Carey, Gelman, & Keil, 1991, for an extended discussion of this topic.)

In the case of word learning, this interplay between factors inherent in the child and factors within the environment is essential. Infants across the world will encounter different objects, will acquire different languages, and will be provided with different types of language input and training (Cole, Gay, Glick, & Sharp, 1971; Laboratory of Comparative Human Cognition, 1983). I have offered a proposal in which early acquisition is sufficiently constrained to permit infants to form fundamental categories of objects and to learn the words to express them, and sufficiently flexible to accommodate the systematic variations in the word-to-world

mappings that occur across languages. In my view, infants' initial general expectation, or constraint, is available from the start, and it serves to direct the infant's attention toward precisely the sorts of information and regularities that will support the rapid acquisition of complex systems of knowledge, including the acquisition of words and the flexible formation of rich object categories (Gelman & Williams, 1999).

I conclude by articulating the cognitive consequences of infants' initially broad expectation linking word learning and conceptual organization. First, it guides infants in building a lexicon and establishing reference. Second, words serve as invitations to form categories. Providing a common name to a diverse set of objects directs infants' attention to the commonalities (perceptual or conceptual) among them. In this way, word learning supports the early establishment of object categories that figure largely in conceptual tasks and reasoning from infancy through adulthood. Third, words promote inductive inference. Providing a common name initiates a search for deeper, perhaps nonobvious commonalities among named entities. This promotes induction and permits rapid learning about categories of objects. Third, words promote object individuation. Applying unique names to unique individuals highlights the distinctions (perceptual or conceptual) among them and provides infants with a means for tracing the identity of those individuals over time. Fourth, early word learning is the foundation for subsequent language acquisition. Infants' initial expectations support the establishment of a stable lexicon and a stable repertoire of object categories. This provides a foundation for identifying the more specific grammatical form categories and discovering how these map to meaning in the native language.

Notes

1. Note that this was, in fact, Keller's second language. She had begun to acquire English before becoming deaf and blind.

2. There have been two distinct formulations of this possibility, syntactic bootstrapping (Gleitman, 1990) and semantic bootstrapping (Pinker, 1987), as well as an in-principle resolution of these formulations (Grimshaw, 1994).

3. We suspect that infants' discovery of grammatical form is aided by cues that are perceptually available in the input. For instance, we suspect that infants will notice which words tend to be stressed or inflected, which tend to be preceded consistently by (unstressed) closed class words, which tend to occur in particular positions (initial, final) within phrases, and so on. These cues, which are perceptually available in the input, are also integral cues to grammatical form.

4. This pattern is consistent with evidence regarding the salience of basic-level categories in early development (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) but is at odds with Mandler's claim for a developmental precedence of global over basic-level categories (chap. 5). For a full discussion of this issue, see Waxman (in press).

5. In contrast, an object's shape may be more centrally related to category membership, particularly for simple artifacts and for animate objects (Waxman & Braig, 1996).

References

Au, T. K., Dapretto, M., & Song, Y. K. (1994). Input vs. constraints: Early word acquisition in Korean and English. *Journal of Memory and Language, 33*(5), 567–582.

Baillargeon, R. (1993). The object concept revisited: New direction in the investigation of infants' physical knowledge. In C. Granrud (Ed.), *Visual perception and cognition in infancy: Carnegie-Mellon Symposia on Cognition* (pp. 265–315). Hillsdale, NJ: Erlbaum.

Baillargeon, R. (2000). How do infants learn about the physical world? In D. Muir & A. Slater (Eds.), *Infant development: The essential readings. Essential readings in development psychology* (pp. 195–212). Malden, MA: Blackwell.

Balaban, M. T., & Waxman, S. R. (1997). Do words facilitate object categorization in 9-month-old infants? *Journal of Experimental Child Psychology, 64*(1), 3–26.

Baldwin, D. A., & Baird, J. A. (1999). Action analysis: A gateway to intentional inference. In P. Rochat (Ed.), *Early social cognition: Understanding others in the first months of life* (pp. 215–240). Mahwah, NJ: Erlbaum.

Baldwin, D. A., & Markman, E. M. (1989). Establishing word-object relations: A first step. *Child Development, 60*(2), 381–398.

Barsalou, L. W. (1983). Ad hoc categories. *Memory & Cognition, 11*(3), 211–227.

Bhatt, R. S., & Rovee-Collier, C. (1997). Dissociation between features and feature relations in infant memory: Effects of memory load. *Journal of Experimental Child Psychology, 67*(1), 69–89.

Bloom, P. (1993). Overview: Controversies in language acquisition. In P. Bloom (Ed.), *Language acquisition: Core readings* (pp. 5–48). Cambridge, MA: MIT Press.

Bloom, P. (2000). *How children learn the meanings of words.* Cambridge, MA: MIT Press.

Booth, A. E., & Waxman, S. R. (in press). Object functions and object names: Effects on categorization in 14-month-old infants. *Developmental Psychology.*

Bowerman, M. (1996). The origins of children's spatial semantic categories: Cognitive versus linguistic determinants. In J. J. Gumperz & S. C. Levinson (Eds.), *Rethinking linguistic relativity* Studies in the social and cultural foundations of language, No. 17 (pp. 145–176). Cambridge: Cambridge University Press.

Brown, R. (1956). The original word game. In J. S. Bruner, J. J. Goodnow, & G. A. Austin (Eds.), *A study of thinking* (pp. 247–312). New York: Wiley.

Choi, S., & Gopnik, A. (1995). Early acquisition of verbs in Korean: A cross-linguistic study. *Journal of Child Language, 22*(3), 497–529.

Cole, M., Gay, J., Glick, J. A., & Sharp, D. W. (1971). *The cultural context of learning and thinking.* New York: Basic Books.

Dixon, R. M. W. (1982). *Where have all the adjectives gone?* Berlin: Mouton.

Fernald, A. (1992). Meaningful melodies in mothers' speech to infants. In H. Papousek, U. Jurgens, & M. Papousek (Eds.), *Nonverbal vocal communication: Comparative and developmental approaches: Studies in emotion and social interaction* (pp. 262–282). New York: Cambridge University Press.

Fisher, C., Hall, G., Rakowitz, S., & Gleitman, L. (1994). When it is better to receive than to give: Syntactic and conceptual constraints on vocabulary growth. *Lingua, 92*, 333–376.

Fulkerson, A. L., & Haaf, R. A. (1998, April). *New words for new things: The relationship between novel labels and twelve-month-olds' categorization of novel objects.* Paper presented at the International Conference on Infant Studies, Atlanta, GA.

Gallistel, C. R., Brown, A. L., Carey, S., Gelman, R., & Keil, F. C. (1991). Lessons from animal learning for the study of cognitive development. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition. The Jean Piaget Symposium series* (pp. 3–36). Hillsdale, NJ: Erlbaum.

Gelman, R. (1991). Epigenetic foundations of knowledge structures: Initial and transcendent constructions. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition [Jean Piaget Symposium series]* (pp. 293–322). Hillsdale, NJ: Erlbaum.

Gelman, R., & Williams, E. M. (1998). Enabling constraints for cognitive development and learning: domain-specificity and epigenesis. In W. Damon (Series Ed.) and D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language,* (5th ed., pp. 575–630). New York: Wiley.

Gelman, S. A. (1996). Concepts and theories. In R. Gelman & T. Kit-Fong (Eds.), *Perceptual and cognitive development: Handbook of perception and cognition* (2nd ed., pp. 117–150). San Diego: Academic Press.

Gelman, S. A., & Coley, J. D. (1991). Language and categorization: The acquisition of natural kind terms. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on language and thought: Interrelations in development* (pp. 146–196). New York: Cambridge University Press.

Gelman, S. A., Coley, J. D., & Gottfried, G. M. (1994). Essentialist beliefs in children: The acquisition of concepts and theories. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 341–365). New York: Cambridge University Press.

Gelman, S. A., & Medin, D. L. (1993). What's so essential about essentialism? A different perspective on the interaction of perception, language, and conceptual knowledge. *Cognitive Development, 8*(2), 157–167.

Gentner, D. (1982). Why nouns are learned before verbs: Linguistic relativity versus natural partitioning. In S. Kuczaj (Ed.), *Language development: Language, thought, and culture* (Vol. 2, pp. 301–334). Hillsdale, NJ: Erlbaum.

Gentner, D., & Boroditsky, L. (2001). Individuation, relativity, and early word learning. In M. Bowerman & S. Levinson (Eds.), *Language acquisition and conceptual development.* (pp. 215–256). Cambridge: Cambridge University Press.

Gentner, D., & Namy, L. (1999). Comparison in the development of categories. *Cognitive Development, 14,* 487–513.

Gentner, D., & Waxman, S. R. (1994, June). *Perceptual and conceptual bootstrapping in early word meaning.* Paper presented at the meeting of the International Conference on Infancy Studies, Paris.

Gerken, L., & McIntosh, B. J. (1993). Interplay of function morphemes and prosody in early language. *Developmental Psychology, 29*(3), 448–457.

Gillette, J., Gleitman, H., Gleitman, L., & Lederer, A. (1999). Human simulations of vocabulary learning. *Cognition, 73*(2), 135–176.

Gleitman, L. (1990). The structural sources of verb meanings. *Language Acquisition: A Journal of Developmental Linguistics, 1*(1), 3–55.

Gleitman, L. R., & Wanner, E. (1988). Current issues in language learning. In M. H. Bornstein & M. E. Lamb (Eds.), *Developmental psychology: An advanced textbook* (2nd ed. pp. 297–356). Hillsdale, NJ: Erlbaum.

Goldin-Meadow, S., Seligman, M. E., & Gelman, R. (1976). Language in the two-year-old. *Cognition, 4*(2), 189–202.

Grimshaw, J. (1994). Minimal projection and clause structure. In B. Lust & M. Suner (Eds.), *Syntactic theory and first language acquisition: Cross-linguistic perspectives* (Vol. 1, pp. 75-83). Hillsdale, NJ: Erlbaum.

Guajardo, J. J., & Woodward, A. L. (2000, July). *Using habituation to index infants' understanding of pointing.* Paper presented at the 12th biennial meeting of the International Society for Infant Studies, Brighton, UK.

Hall, D. G. (1991). Acquiring proper nouns for familiar and unfamiliar animate objects: Two-year-olds' word-learning biases. *Child Development, 62*(5), 1142–1154.

Hall, D. G. (1999). Semantics and the acquisition of proper names. In R. Jackendoff, P. Bloom, & K. Wynn (Eds.), *Language, logic, and concepts: Essays in memory of John Macnamara* (pp. 337–372). Cambridge, MA: MIT Press.

Hall, D. G., & Graham, S. A. (1999). Lexical form class information guides word-to-object mapping in preschoolers. *Child Development, 70*(1), 78–91.

Haryu, E., & Imai, M. (1999). Controlling the application of the mutual exclusivity assumption in the acquisition of lexical hierarchies. *Japanese Psychological Research, 41*(1), 21–34.

Held, R., & Hein, A. (1963). Movement-produced stimulation in the development of visually guided behavior. *Journal of Comparative and Physiological Psychology, 56*(5), 872–876.

Huttenlocher, J., & Smiley, P. (1987). Early word meanings: The case of object names. *Cognitive Psychology, 19*(1), 63–89.

Imai, M., & Gentner, D. (1997). A cross-linguistic study of early word meaning: Universal ontology and linguistic influence *cognition, 62*, 169–200.

Jaswal, V. K., & Markman, E. M. (2001). Learning proper and common names in inferential versus ostensive contexts. *Child Development, 72*(3), 768–786.

Jusczyk, P., & Aslin, R. N. (1995). Infants' detection of the sound patterns of words in fluent speech. *Cognitive Psychology, 29*(1), 1–23.

Jusczyk, P. W., & Kemler Nelson, D. G. (1996). Syntactic units, prosody, and psychological reality during infancy. In J. L. Morgan & K. Demuth (Eds.), *Signal to syntax: Bootstrapping from speech to grammar in early acquisition* (pp. 389–408). Mahwah, NJ: Erlbaum.

Kalish, C. W., & Gelman, S. A. (1992). On wooden pillows: Multiple classification and children's category-based inductions. *Child Development, 63*(6), 1536–1557.

Keil, F. C. (1994). The birth and nurturance of concepts by domains: The origins of concepts of living things. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 234–254). New York: Cambridge University Press.

Keller, H. (1904). *The story of my life.* New York: Doubleday, Page.

Kemler Nelson, D. G., Hirsh-Pasek, K., Jusczyk, P. W., & Cassidy, K. W. (1989). How the prosodic cues in motherese might assist language learning. *Journal of Child Language, 16*(1), 55–68.

Kim, M., McGregor, K. K., & Thompson, C. K. (2000). Early lexical development in English- and Korean-speaking children: Language-general and language-specific patterns. *Journal of Child Language, 27*(2), 225–254.

Klibanoff, R. S., & Waxman, S. R. (2000). Basic level object categories support the acquisition of novel adjectives: Evidence from preschool-aged children. *Child Development, 71*(3), 649–659.

Laboratory of Comparative Human Cognition. (1983). Culture and cognitive development. In P. Mussen (Ed.), *Handbook of child psychology: History, theory, and methods* (Vol. 1, pp. 295–356). New York: Wiley.

Landau, B. (1994). Object shape, object name, and object kind: Representation and development. In D. L. Medin (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 31, pp. 253–304). San Diego: Academic Press.

Landau, B., Smith, L. B., & Jones, S. S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3*(3), 299–321.

Lassaline, M. E., & Murphy, G. L. (1996). Induction and category coherence. *Psychonomic Bulletin & Review, 3*(1), 95–99.

Lyons, J. (1977). *Semantics.* New York: Cambridge University Press.

Macnamara, J. (1994). Logic and cognition. In J. Macnamara & G. E. Reyes (Eds.), *The logical foundations of cognition.* [Vancouver studies in cognitive science] (Vol. 4, pp. 11–34). New York: Oxford University Press.

Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review, 99*(4), 587–604.

Maratsos, M. (1998). The acquisition of grammar. In W. Damon (Series Ed.) and D. Kuhn & R. S. Siegler (Vol. Eds.), *Handbook of child psychology:* Vol. 2. *Cognition, perception, and language* (5th ed., pp. 421–466). New York: Wiley.

Markman, E. M. (1989). *Categorization and naming in children: Problems of induction.* Cambridge, MA: MIT Press.

Markman, E. M., & Hutchinson, J. E. (1984). Children's sensitivity to constraints on word meaning: Taxonomic versus thematic relations. *Cognitive Psychology, 16*(1), 1–27.

Marler, P. (1991). The instinct to learn. In S. Carey & R. Gelman (Eds.), *The epigenesis of mind: Essays on biology and cognition.* Hillsdale, NJ: Erlbaum.

Medin, D. L., & Heit, E. (Eds.). (in press). *Categorization.* San Diego: Academic Press.

Morgan, J. L., & Demuth, K. (Eds.). (1996). *Signal to syntax: Bootstrapping from speech to grammar in early acquisition.* Mahwah, NJ: Erlbaum.

Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92*(3), 289–316.

Nelson, K., Hampson, J., & Shaw, L. K. (1993). Nouns in early lexicons: Evidence, explanations and implications. *Journal of Child Language, 20*(1), 61–84.

Ochs, E., & Schieffelin, B. (1984). Language acquisition and socialization. In R. Shweder & R. LeVine (Eds.), *Culture theory.* Cambridge: Cambridge University Press.

Pinker, S. (1984). *Language learnability and language development.* Cambridge, MA: Harvard University Press.

Pinker, S. (1987). The bootstrapping problem in language acquisition. In B. MacWhinney (Ed.), *Mechanisms of language aquisition* (pp. 399–441). Hillsdale, NJ: Erlbaum.

Regier, T., & Carlson, L. (in press). Grounding spatial language in perception: An empirical and computational investigation. *Journal of Experimental Psychology: General.*

Rosch, E., Mervis, C. B., Gray, W. D., Johnson, D. M., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*(3), 382–439.

Saah, M. I., Waxman, S. R., & Johnson, J. (1996, April). *The composition of children's early lexicons as a function of age and vocabulary size.* Paper presented at the International Conference on Infancy Studies Providence, RI.

Shi, R., Werker, J. F., & Morgan, J. L. (1999). Newborn infants' sensitivity to perceptual cues to lexical and grammatical words. *Cognition, 72*(2), B11–B21.

Smith, L. B. (1999). Children's noun learning: How general learning processes make specialized learning mechanisms. In B. MacWhinney (Ed.), *The emergence of language* (pp. 277–303). Mahwah, NJ: Erlbaum.

Snedeker, J., & Gleitman, L. (1999, November). *Knowing what you know: Metacognitive monitoring and the origin of the object category bias.* Paper presented at the 24th annual Boston University Conference on Language Development, Somerville, MA.

Spelke, E. S. (1993). Object perception. In A. I. Goldman (Ed.), *Readings in philosophy and cognitive science* (pp. 447–460). Cambridge: MIT Press.

Spelke, E. S. (2000). Nativism, empiricism, and the origins of knowledge. In D. Muir & A. Slater (Eds.), *Infant development: The essential readings. Essential readings in development psychology* (pp. 36–51). Malden, MA: Blackwell.

Talmy, L. (1985). Lexicalization patterns: Semantic structure in lexical forms. In T. Shopen (Ed.), *Language typology and syntactic description* (Vol. 3, pp. 249–291). San Diego: Academic Press.

Tardif, T. (1996). Nouns are not always learned before verbs: Evidence from Mandarin speakers' early vocabularies. *Developmental Psychology, 32*(3), 492–504.

Waxman, S. R. (1998). Linking object categorization and naming: Early expectations and the shaping role of language. In D. L. Medin (Ed.), *The psychology of learning and motivation* (Vol. 38, pp. 249–291). San Diego: Academic Press.

Waxman, S. R. (1999). Specifying the scope of 13-month-olds' expectations for novel words. *Cognition, 70*(3), B35–B50.

Waxman, S. R., & Booth, A. E. (2000a). Distinguishing count nouns from adjectives: Evidence from 14-month-olds' novelty preference and word extension. In S. C. Howell, S. A. Fish, & T. Keith-Lucas (Eds.) *Proceedings of the 24th Annual Boston University Conference on Language Development.* Somerville, MA: Cascadilla Press.

Waxman, S. R., & Booth, A. E. (2000b). Principles that are invoked in the acquisition of words, but not facts. *Cognition, 77*(2), Netherlands: Elsevier.

Waxman, S. R., & Booth, A. E. (2001). Seeing pink elephants: Fourteen-month-olds' interpretations of novel nouns and adjectives. *Cognitive Psychology, 43*(3), 217–242.

Waxman, S. R., & Booth, A. E. (in press). The origins and evolution of links between word learning and conceptual organization: New evidence from 11-month-olds. *Developmental Science.*

Waxman, S. R., & Braig, B. (1996, April). *Stars and starfish: How far can shape take us?* Paper presented at the International Conference on Infancy Studies, Providence, RI.

Waxman, S. R., & Gelman, R. (1986). Preschoolers' use of superordinate relations in classification and language. *Cognitive Development, 1*(2), 139–156.

Waxman, S. R., & Guasti, M. T. (2002). Cross-linguistic differences in children's extensions of novel count nouns and adjectives: Evidence from Italian. Unpublished manuscript.

Waxman, S. R., & Hall, D. G. (1993). The development of a linkage between count nouns and object categories: Evidence from fifteen- to twenty-one-month-old infants. *Child Development, 64*(4), 1224–1241.

Waxman, S. R., & Klibanoff, R. S. (2000). The role of comparison in the extension of novel adjectives. *Developmental Psychology, 36*(5), 571–581.

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29*(3), 257–302.

Waxman, S. R., & Markow, D. B. (1998). Object properties and object kind: Twenty-one-month-old infants' extension of novel adjectives. *Child Development, 69*(5), 1313–1329.

Waxman, S. R., Senghas, A., & Benveniste, S. (1997). A cross-linguistic examination of the noun-category bias: Its existence and specificity in French- and Spanish-speaking preschool-aged children. *Cognitive Psychology, 32*(3), 183–218.

Werker, J. F., Lloyd, V. L., Pegg, J. E., & Polka, L. (1996). Putting the baby in the bootstraps: Toward a more complete understanding of the role of the input in infant speech processing. In J. L. Morgan & K. Demuth (Eds.), *Signal to syntax: Bootstrapping from speech to grammar in early acquisition* (pp. 427–447). Mahwah, NJ: Erlbaum.

Wierzbicka, A. (1986). Does language reflect culture? Evidence from Australian English. *Language in Society, 15*(3), 349–373.

Xu, F. (1999). Object individuation and object identity in infancy: The role of spatiotemporal information, object property information, and language. *Acta Psychologica, 102*(2–3), 113–136.

Xu, F., & Carey, S. (1996). Infants' metaphysics: The case of numerical identity. *Cognitive Psychology, 30*(2), 111–153.

Younger, B. A., & Cohen, L. B. (1986). Developmental change in infants' perception of correlations among attributes. *Child Development, 57*(3), 803–815.