

LINKING OBJECT CATEGORIZATION AND NAMING: Early Expectations and the Shaping Role of Language

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I. Introduction

This chapter addresses fundamental issues of early conceptual development, language development, and the relation between them. Infants across the world's communities are raised in enormously rich environments populated with novel objects and events. Because this diversity would be overwhelming if each object were treated as unique, an essential developmental task is to form *categories* that capture the commonalities among objects and to learn *words* to express them. I will argue that these developmental tasks are not independent. On the contrary, from the earliest stages of word learning, there are powerful, implicit expectations linking object categorization and naming. For infants on the brink of word learning, novel words (both count nouns and adjectives) highlight commonalities among objects and, in this way, foster the formation of object categories. This initial expectation serves three fundamental functions. First, it guides infants in their earliest efforts to establish object reference. Second, it promotes the establishment of a stable conceptual system that promotes the organization of object categories and the acquisition of additional information about category members. Third, this initial expectation sets the stage for the acquisition of more specific expectations linking particular types of words (count nouns versus adjectives) to particular types of relations among ob-

jects (object categories versus object properties) (Waxman & Markow, in press). These latter expectations are shaped by the structure of the native language under acquisition, and become more entrained with age (Waxman, Senghas, & Benveniste, 1997).

The overarching goal of this chapter is to underscore the vital interaction between the child's expectations and the shaping role of the environment in this process (Waxman, in press). I gather together recent developmental and crosslinguistic evidence to illustrate the origin and scope of infants' early expectations, and to discover how these are shaped over the course of development.

II. The Developmental Process: A Dynamic Interplay between the Constraints in the Learner and the Amount and Information Present in the Environment

A portrait can capture beautifully an individual at any one moment in time, but no matter how finely it is drawn, it cannot reveal the dynamic processes and influences that have shaped the individual. Similarly, detailed analyses of ecosystems can catalog exhaustively the elements, life-forms, and relations among them at one point in time, but cannot capture the original state of the system or the pressures motivating its changes over time. To discover the origins of any system and the mechanisms responsible for its unfolding, a developmental approach is required. Evidence regarding the acquisition of any complex system sheds light on the mature state and on the processes underlying its evolution.

The significance of adopting a developmental approach to questions of acquisition and change has now been widely recognized across a range of disciplines. See, for example, Marler (1991) on the acquisition of birdsong in the white-crowned sparrow, Held and Hein (1963) on the acquisition of depth perception in kittens, Baillargeon (1993) and Spelke (1993) on infants' acquisition of physical knowledge about objects, and R. Gelman (1991) on the acquisition of number concepts in humans. Although these research programs focus on vastly different topics, they share a commitment to characterizing the rapid acquisition of complex systems by considering the interplay between the structural constraints imposed by the learner and the amount and type of information present in the environment. (See Gallistel, Brown, Carey, Gelman, & Keil (1991) for an extended discussion.)

I have adopted a similar strategy to examine the relation between object categorization and naming. Together with my colleagues, I have argued for a *dynamic* account that embraces both the expectations held by the child and the shaping role of the environment. I have also argued for a

continuous view of development, in which infants' and young children's considerable perceptual and conceptual abilities are recruited early in the fundamental task of forming object categories and mapping words to their meanings. In our view, early development is guided by general, broad initial constraints or expectations that direct the infant's attention toward precisely the sort of regularities in the environment that will facilitate the rapid acquisition of complex systems of knowledge, including the acquisition of word meaning and object categories (Gelman & Williams, 1998). These broad initial expectations are themselves fine-tuned over the course of development.

This interplay between factors within the child and factors within the environment (including the objects the child encounters and the structure of the native language under acquisition) is essential. Children raised in different cultures will encounter different objects, and will acquire different languages. Acquisition must be sufficiently *constrained* to permit the child to form fundamental categories of objects and to acquire their native language, yet sufficiently *flexible* to accommodate the systematic variations that occur across cultures and languages.

III. A Vignette

Infants living in remote villages in Tibet and infants living in Manhattan grow up in worlds filled with objects and events that the other has not experienced, and with words that the other cannot understand. Yet despite these vast differences, the conceptual and language development of infants in these diverse communities will be strikingly similar. Within the first year of life, infants in each of these communities will form categories that will capture both the similarities and differences among the objects they encounter. Most of these early object categories will be at the basic level (i.e., *dog*, rather than the more inclusive *animal* or the more specific *terrier*). Infants will use these early categories as an implicit inductive base to make inferences about the behaviors and properties of new objects. In addition to these conceptual advances, the infants in each community will acquire their native language naturally, at a remarkably swift pace. By their first birthdays, they will begin to produce words, most of which will refer to salient objects and categories of objects. By their second birthdays, they will have mastered hundreds of words and will begin to combine these words to produce short, well-formed phrases. Thus, although infants are exposed to widely varying types of experiences, they follow similar paths in their conceptual and language development.

IV. The Relation between Object Categorization and Naming: Background Issues

In the past decade, there has been a decisive renewal of scientific interest in questions regarding object categorization, object naming, and the relation between these. A central focus has been to discover whether and how the categorization of objects—a conceptual task—is influenced by the introduction of novel words. More recently, attention has been focused on how the categorization of objects is influenced by semantic aspects of the particular language under acquisition (Bowerman, 1996; Imai & Gentner, 1997; Naigles & Eisenberg, in press; Lucy, 1996; Waxman, Senghas et al., 1997).

Object categorization has figured centrally because it is a fundamental building block of human cognition, “. . . a contrivance for the best possible ordering of the ideas of objects in our minds . . . in such a way as shall give us the greatest command over our knowledge already acquired, and lead most directly to the acquisition of more” (Mill, 1843). Because object categorization provides an exceptionally efficient and powerful foundation for organizing existing knowledge and for discovery (Medin & Heit, in press; Shipley, 1993), it should be especially valuable early in development, as infants encounter new objects and witness new events. Indeed, an essential task of early human development is to form *categories* that capture the commonalities among objects and to learn *words* to express them. Infants accomplish each of these tasks naturally.

There is now ample evidence that infants appreciate many different kinds of relations among objects, including object categories based on taxonomic relations (e.g., flamingos and dogs are both animals). They also appreciate thematic groupings (e.g., flamingos run on sand), associative or *ad hoc* groupings (e.g., flamingos call to mind a tropical beach) and causal relations (e.g., flamingos sit on nests to hatch their eggs). These conceptual advances are remarkable in and of themselves. But they also set the stage for what has been described as the “induction problem” (Gleitman, 1990; Quine, 1960). To understand this problem, consider a typical word-learning scenario, in which an adult introduces a child to a novel object (say, a *flamingo*) and offers a novel label (“That is a *flamingo*”). How do infants discover which relation the new word is intended to convey? How do they so rapidly learn that a given word (e.g., *flamingo*) applies to a particular whole object, that it may be extended to other members of that object category (e.g., other flamingos), but not to salient parts or properties of the object (e.g., its long neck or unusual color), to salient actions in which it is engaged (e.g., feeding its young), or to salient thematic relations (e.g., a flamingo and palm trees)?

A. LINKING WORD LEARNING AND CONCEPTUAL DEVELOPMENT

To account for infants’ seemingly effortless solution to this logically difficult task, several scholars have proposed that there may be constraints on acquisition, and that these may lead infants to favor *some* types of conceptual relations over others when ascribing meaning to a new word (Chomsky, 1986; Landau & Gleitman, 1985; Pinker, 1984; Markman, 1989; Waxman, 1990, 1991). There is now substantial evidence for this position. One of the most robust findings is that infants and toddlers expect that a novel word, applied ostensibly to an object, refers to the whole named object and can be extended to other members of the same object category (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Markman & Wachtel, 1988; Taylor & Gelman, 1988; Hall, Waxman, & Hurwitz, 1993; Markman, 1989; Mervis, Johnson, & Scott, 1993; Soja, Carey, & Spelke, 1991, 1992; Waxman & Hall, 1993; Waxman & Markow, 1995). More specifically, their tendency is to extend the word to an object category at (roughly) the basic level (Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995; Gopnik & Meltzoff, 1992; Mervis & Mervis, 1988; Saah et al., 1996; Waxman & Senghas, 1992). This tendency reflects both the infants’ appreciation of the perceptual and conceptual similarity among objects at this level, and the naming practices of the adult community.

Perhaps even more remarkable is the fact that children as young as 2 years of age consistently use the *syntactic form* of a novel word as a clue to its meaning. For example, English-speaking children expect that a count noun, applied ostensibly to an object (“That is a *blicker*”), will refer to the whole object and other members of its kind (e.g., flamingo, animal), but their expectations for novel words presented as proper nouns or adjectives is quite different. They readily map a proper noun (“That is *Blicker*”) to the named individual, but they do not extend this to other members of its kind (Bloom, 1994; Hall, 1991, 1994; Katz, Baker, & Macnamara, 1974; Gelman and Taylor, 1984). They expect that adjectives (and other modifiers) (“That is a *blickish one*”) will mark object properties (e.g., color, textures, size) and will mark distinctions within a basic level kind (Brown, 1957; Prasada, 1996; Smith, Jones, & Landau, 1992; Taylor & Gelman, 1988; Waxman, 1990; Klibanoff & Waxman, 1997; Waxman & Markow, in press).

Interestingly, children’s ability to recruit these syntactic cues in word learning is influenced deeply by their existing knowledge. Children are most likely to use syntactic cues to word learning when they are introduced to a novel word for a familiar object—an object for which the child knows a basic level name, (e.g., a *horse*) (Au, 1990; Hall et al., 1993; Markman & Wachtel, 1988; Taylor & Gelman, 1988; Waxman, 1995). Under this circum-

stance, children rely systematically on syntactic form, as described above. But when a novel word is applied to an unfamiliar object (an object for which the child knows no basic level name, e.g., an *armadillo*), children tend to extend that word, independent of its syntactic form, to the basic level object kind (Hall et al., 1993).

Thus, children's interpretation of a novel word is mediated by their familiarity with a basic level name for that object. This suggests that there is a strong *conceptual priority* for establishing names for basic level categories (a.k.a., *kinds* or *sortals*). This priority is consistent with arguments pertaining to the logic of count nouns (Macnamara, 1994). Basic level count nouns provide principles of object individuation and object identity (Hall, 1993; Hall & Waxman, 1993; Macnamara, 1982); these terms also are the gateway for the acquisition of additional words, referring to other aspects of the named object.

To summarize, early object categorization and naming are not independent. On the contrary, children harbor strong, implicit, and precise expectations linking *particular* types of words (e.g., count nouns, adjectives) with *particular* types of conceptual relations (e.g., categories of objects, properties of objects, respectively). These expectations reveal children's *linguistic* capacity to distinguish among the relevant syntactic forms, their *conceptual* and *perceptual* ability to appreciate various relations among objects, and finally, their tacit expectation that these systems are linked. These linkages have been invoked to help explain how children so rapidly map novel words to meanings, and so successfully construct object categories and taxonomic systems of organization (Markman, 1989; Waxman, 1990, 1994).

B. SOME CONTROVERSIES REGARDING THE ORIGIN AND EMERGENCE OF THE LINKAGES BETWEEN WORD LEARNING AND CONCEPTUAL DEVELOPMENT

These discoveries have received considerable attention, in part because they offered empirical evidence for abstract linkages between syntax and semantics (e.g., Chomsky, 1965; Gleitman, 1990; Grimshaw, 1994). The evidence from children was also notable because it offered a developmental parallel to Berlin's (1992) discovery of a universal, systematic relation between object naming and categorization (Waxman, in press).

Yet this claim has also generated considerable controversy. One locus of controversy concerns the origin of these expectations. When do they become available to the learner? Another concerns their developmental course. Do these expectations exert a uniform influence across development, or are they modified as a consequence of interaction with the objects in the environment and the language under acquisition? A third concern

has focused on the characterization of infants' early object categories and the role of perceptual versus conceptual bases in categorization and naming. These concerns are addressed throughout the chapter.

V. Developmental and Crosslinguistic Considerations

To address these important issues, we have developed two distinct, but complementary, lines of evidence. First, because most of the research in this area was derived almost exclusively from preschool-aged children (who have already made significant linguistic and conceptual advances), we have begun to chart the emergence of these linkages in prelinguistic infants and in toddlers by examining the influence of language on their categorization abilities. This line of work permits us to ascertain which linkages (if any) guide acquisition from the outset and how these are shaped by experience. Second, because so much of the evidence was originally derived from children acquiring English, we have begun to examine the expectations of children acquiring languages other than English. This crosslinguistic line of work permits us to ascertain which (if any) of these linkages are universal features of human development and which (if any) are acquired via language-specific learning. This wedding of crosslinguistic and developmental evidence remedies several of the shortcomings of earlier work in this area. (Also see Bowerman, 1996 and Lucy, 1996 for fuller discussion.)

A. UNIFYING FEATURES OF THE EXPERIMENTS

The experiments that I will describe utilize a wide array of methods and subject populations, but share several important features. Each is essentially an object categorization task, tailored to suit the very different behavioral repertoires of infants versus young children, and of children raised in the United States versus those raised elsewhere. In each series, the goal is to observe the relation between object naming and categorization. To do so, we compare subjects' categorization of objects in "neutral" conditions (involving no novel words), with their performance when they are introduced to novel words, applied ostensibly to the objects under consideration. Because our goal is to examine an abstract linkage between particular syntactic forms and particular types of relations among objects, we introduce novel words (e.g., *fauna*), as opposed to familiar words (e.g., *animal*). This insures that the individual words themselves carry no *a priori* meaning for the child. To examine the influence of syntactic form, we vary the syntactic frame in which the novel word is embedded. We use short, simple syntactic constructions that (1) are typical in infant-directed speech, and that

(2) provide unambiguous contextual evidence that the novel word is either a count noun or an adjective. In the *Novel Noun* conditions, we introduce objects saying, for example, "This is a *blicker*" In the *Novel Adjective* conditions, I use a syntactic frame that is indicative of an adjective: "This is a *blick-ish* one" (See Gerken & McIntosh, 1993; Waxman & Markow, in press; Waxman, 1995 for evidence regarding infants' sensitivity to these distinct syntactic frames.) In the *No Word* control conditions, we introduce no novel words, but point out the objects, saying: "Do you like this?" Performance in this *No Word* control condition assesses how readily subjects form the various categories presented in our tasks (e.g., dog, animal, pink things). Performance in the *Novel Noun* condition assesses the role of naming in this important endeavor. Performance in the *Novel Adjective* condition permits a strong test of the specificity of the relation between object naming and categorization. Because both count nouns ("That is a *flamingo*") and adjectives ("That is *pink*") can be applied ostensibly to objects, this is an important control.

B. DISTINCTIONS BETWEEN COUNT NOUNS AND ADJECTIVES

Despite the fact that both count nouns and adjectives can be applied sensibly to objects, there are several crucial distinctions between these grammatical forms. These distinctions are evident in crosslinguistic, developmental, and semantic analyses. Crosslinguistic analyses have conferred a special status upon the grammatical category *noun* (Dixon, 1982; Gentner, 1981, 1982; Greenberg, 1963; Macnamara, 1982; Maratsos, 1991; Wierzbicka, 1986). Across languages, this grammatical category includes terms for referring to object categories. Indeed, the universality of this linkage between nouns and object categories has been noted by anthropologists (Berlin, 1973, 1992) and linguists alike (Gleitman, 1990; Grimshaw, 1981; Jackendoff, 1990). In contrast to this crosslinguistic stability of nouns, members of the *predicate* system (including, e.g., adjectives, prepositions, verbs) have a more fluid status across languages. In comparison to nouns, there is considerably more variation across languages as to what information is conveyed as part of one predicate class as compared to another (Bowerman, 1985, 1996; Choi & Bowerman, 1991; Gentner, 1981, 1982; Maratsos, 1991; Maratsos & Chalkley, 1980; Talmy, 1985; Wierzbicka, 1986).

In addition, developmental evidence suggests that infants reveal a special talent for mapping words to objects and categories. Longitudinal, cross-sectional and crosslinguistic studies have revealed that infants' early lexicons consist predominantly of nouns—that is, words that are consid-

ered nouns in the adult grammar (Au, Dapretto, & Song, 1994; Gentner, 1982; Gentner & Boroditsky, in press; Gleitman, 1990; Goldin-Meadow, Seligman, & Gelman, 1976; Huttenlocher & Smiley, 1987; Macnamara, 1982; Nelson, 1973; Saah et al., 1996). (See Bloom, Tinker & Margulis (1993) and Nelson, Hampson & Shaw (1993) for a different interpretation of the English data; see Choi & Gopnik (1995) and Tardif (1996) for a different interpretation of crosslinguistic data.)

In contrast to the developmental and crosslinguistic stability for the grammatical form *count noun*, there is substantially more variation associated with the form *adjective*. Although many languages (like English) have a richly developed adjective system, in others (like the Bantu languages) the adjective system is sparse, including as few as 8 to 10 property terms. In such languages, the types of meanings typically conveyed with adjectives in one language are expressed with a different grammatical form in another (Choi & Bowerman, 1991; Dixon, 1982; Talmy, 1985; Wierzbicka, 1986). Developmentally, adjectives tend to be acquired later than nouns (Bloom et al., 1993; Fenson et al., 1994; Gentner, 1981, 1982; Maratsos, 1991; Saah et al., 1996). Finally, adjectives are semantically, morphologically, and syntactically dependent upon the nouns they modify (Gleitman, 1990; Hall et al., 1993; Prasada, 1992; Waxman & Markow, in press).

These observations accord well with most current theories of language acquisition, which, despite marked differences in theoretical orientation, seem to agree that the grammatical category *noun* may be acquired earlier than other grammatical categories (including *adjective*), and that the mappings between *nouns* and their meanings may be established via different mechanisms than the mappings for other grammatical forms (Gentner, 1982; Gleitman, 1990; Grimshaw, 1994; Maratsos, 1991; Pinker, 1994; Tomasello & Olguin, 1993). Thus, in contrast to the developmental and crosslinguistic stability for the grammatical form *noun*, there is substantially more variation associated with the form *adjective*.

In addition to these developmental and crosslinguistic distinctions, a core semantic distinction between count nouns and adjectives has figured largely in psycholinguistic theories: Count nouns (but not adjectives) supply principles of identity and individuation; count nouns also support stronger and more enduring inferences about objects than do adjectives (Gelman & Markman, 1986; Macnamara, 1986; Hall & Waxman, 1993; Markman, 1989; Wierzbicka, 1986; Waxman, Senghas et al., 1997).

For example, within any given language, there are words that can be classified as both count nouns and adjectives (e.g., *liberal*, *intellectual*, *drunk*). Although the phrases "*She is a liberal*" (noun) and "*She is liberal*" (adjective) can refer to the same individuals, they are not synonymous (Clark, 1997; Putnam, 1975). According to several syntactic- and semantic-

based accounts, the nouns carry distinctly different and richer meaning than the corresponding adjectives. (See Jespersen, 1968; Lyons, 1977; Wierzbicka, 1986; for theoretical arguments pertaining to this claim.) A count noun (e.g., "She is a *liberal*," "This is a *flamingo*") (1) identifies an individual within a kind, and (2) provides principles of individuation and identity for that individual, tracing that individual across time and place. In contrast, an adjective (e.g., "She is *liberal*," "This is *pink*") does not name an individual within a kind; instead, its canonical semantic function is to identify a (possibly transient) *property* of the named individual (Hall, 1994; Hall & Waxman, 1993; Macnamara, 1986; Wierzbicka, 1986).

Adult speakers of English are sensitive to this semantic distinction, drawing deeper inferences about an object when it is labelled with a noun as opposed to an adjective, even when the nouns and adjectives are matched (*liberal*) (Markman, 1989). By four years of age, English-speaking children are sensitive to this core semantic distinction between count nouns and adjectives (Hall & Moore, 1997).

C. A DEVELOPMENTAL, CROSSLINGUISTIC PROPOSAL

Based on this comprehensive review, I proposed that early acquisition is guided by an initial, general linkage between *words* and object categories. This initial, rudimentary linkage serves three essential functions: (1) it guides infants in their earliest efforts to establish object reference; (2) it promotes the acquisition of a developmentally stable conceptual system for organizing object categories and gaining information about category members; and (3) it sets the stage for the acquisition of more specific expectations linking particular types of words (count nouns versus adjectives) to particular types of relations among objects (object categories versus object properties). I proposed that these more finely tuned linkages between specific syntactic forms (e.g., count nouns, adjectives) and specific types of meaning (e.g., object categories, object properties) would be shaped by language-specific experience (Waxman & Markow, 1995; Waxman, Senghas et al., 1997).

The crosslinguistic stability of count nouns insures that children across the world's languages will find support in their environment for the specific expectation that count nouns refer to object categories. The crosslinguistic variability of adjectives suggests that children's expectations for this grammatical category will vary, as children hone in on the particular functions associated with adjectives in their native language. By examining the influence of naming on (a) prelinguistic infants and (b) children acquiring various languages, this research strategy permits us to identify the contributions of language-specific experience.

VI. Empirical Evidence

A. DEVELOPMENTAL STUDIES (ENGLISH)

1. *Capturing Infants' Initial Expectations: Do Infants Harbor an Initial, General Expectation that Novel Words Refer to Object Categories?*

To address this question, we examined the influence of novel words on object categorization in 12- to 14-month old infants on the brink of language production (see Waxman & Markow, 1995, for a complete description). We developed a novelty-preference task, analogous to those used widely in infancy research. In the *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 (a) a new member of the now-familiar category (e.g., another animal) and (b) an object from a novel category (e.g., a fruit). Each infant completed this task with four different sets of objects. Two sets involved basic level categories (e.g., cars versus airplanes; horses versus cats); two involved superordinate level categories (e.g., animals versus fruit; tools versus vehicles). Infants manipulated the toys freely throughout this procedure; their manipulation served as the dependent measure. We argued that if infants detect the commonalities among the objects presented during *familiarization*, then (1) their attention to the objects presented during familiarization should wane, and (2) at *test*, infants should reveal a preference for the novel object.

To test the influence of novel words, we randomly assigned infants to one of three conditions. These differed only in the experimenter's comments during *familiarization*. In the *No Word* condition (control), she said, "See here?" as she introduced each object; in the *Novel Noun* condition, she said, "See the *blicket*?" In the *Novel Adjective* condition, she said, "See the *blick-ish* one?" In the test phase, infants in all conditions heard precisely the same phrase ("See what I have?").

We reasoned as follows: 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 *Novel Noun* and *Novel Adjective* condition permitted us to test the specificity of this initial expectation. If the expectation is general, then infants hearing either novel nouns or adjectives should be more likely than those hearing no novel words to form object categories.

The data were entirely consistent with this prediction. Infants hearing either novel nouns or adjectives were more likely to form object categories

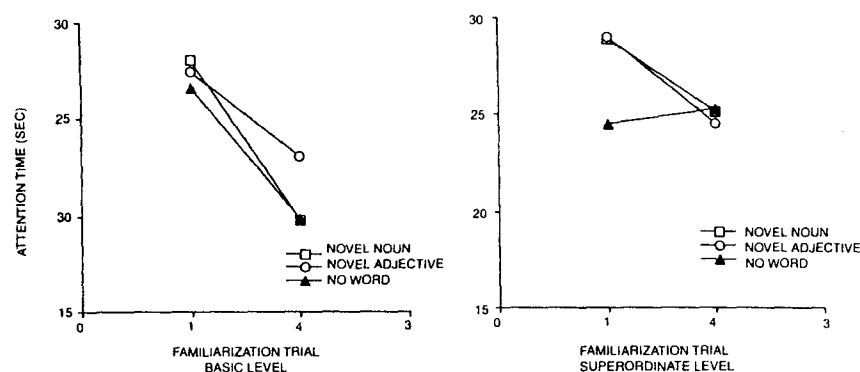


Fig. 1. Familiarization phase (Waxman and Markow, 1995).

than were infants in the *No Word* condition. Interestingly, this influence of novel words was most evident on superordinate level trials. See Figs. 1 and 2. On basic level trials, infants in all conditions successfully formed object categories. However, on superordinate level trials, the facilitative effect of introducing novel words became apparent. Infants in the *No Word* condition revealed no evidence of object categorization. In contrast, infants who heard either novel nouns or adjectives during familiarization successfully formed superordinate level object categories. This clear pattern indicates that novel words focused infants' attention on commonalities among objects.

I have interpreted this striking finding as evidence that *words serve as invitations to form categories*. Novel words (both adjectives and nouns) direct infants' attention to commonalities among objects, and in this way,

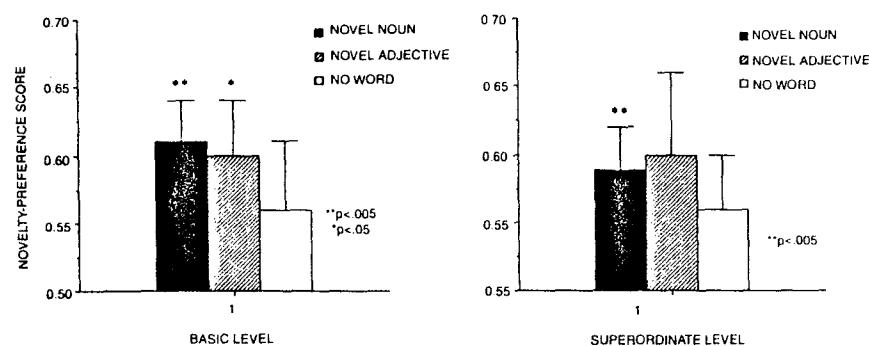


Fig. 2. Test phase (Waxman and Markow, 1995).

facilitate the acquisition of object categories. We have argued that the invitation to form object categories is especially powerful where the commonalities among the objects are not as readily apparent as those at the basic level (Gentner & Waxman, 1994; Waxman & Markow, 1995).

In subsequent work, we have considered the specificity of this phenomenon, exploring both (a) the range of signals that can serve as invitations to object categorization and (b) the range of commonalities that can be facilitated by naming.

a. Specifying the Range of Signals: Words, Tones, and Gestures It is important to bear in mind that in all of our experiments, we employ the "motherese" speech register to capture all infants' attention, including those in the *No Word* control condition. We therefore conclude that infants' expectations are related to the introduction of the novel words, rather than to the more general arousing, attention-getting effects of infant-directed speech. This well-controlled result fits nicely with the observation that the function of infant-directed speech undergoes a developmental progression "... from the more general affective attentional and affective functions in the early months to linguistic functions toward the end of the first year" (Fernald, 1992, p. 279).

But can signals other than words serve as invitations to form object categories? We have considered the influence of various types of signals to answer this question. In one series, we compared the influence of words, content-filtered words, and (pure sine-wave) tones on object categorization at 9 months (Balaban & Waxman, 1996; 1997). We selected 9-month-olds because it is at this developmental moment that infants first reveal evidence of rudimentary word comprehension (Fenson et al., 1994; Jusczyk & Aslin, 1995). We found that although infants' attention was captured equally by both tones and words, only words facilitated object categorization. Tones did not have this facilitative effect. This suggests that the invitation to form object categories cannot be explained as a consequence of a general alerting or attention-engaging function of auditory stimulation (cf., Roberts & Jacob, 1991). Instead, by 9 months of age, infants' expectations are specifically related to *words* and to other symbolic forms.

Namy (Namy & Waxman, in press, 1997) has also examined infants' expectations concerning manual gestures as symbols. In her experiments, objects are introduced either with novel gestures or with novel words. Her results reveal that early in acquisition, gestures (like words) facilitate object categorization (Namy & Waxman, in press, 1997). This intriguing result suggests that infants may initially accept a broad range of *symbolic* forms (including words and gestures, but excluding tones) as names for object categories, but that the range of signals that can serve this important func-

tion becomes more restricted over development (Waxman & Markow, 1995, in press; Waxman, Stote, & Philippe, 1997).

These data also reveal another fundamental ability on the part of very young word learners. Infants notice when novel symbols (words, gestures) are introduced, and they distinguish between phrases in which novel symbols are presented and those containing no novel symbols.

b. Specifying the Range of Commonalities among Objects Do words direct attention to commonalities other than those underlying object categories? At issue here is whether infants embark upon the process of acquisition with an expectation linking words (including both count nouns and adjectives) specifically to object categories (e.g., *flamingos*), or whether this linkage itself emerges out of a more sweeping expectation linking words to a wider range of commonalities, including perceptual commonalities like color (e.g., *pink things*) and texture (e.g., *bumpy things*).

If naming initially highlights a wide range of commonalities, then novel words (both count nouns and adjectives) should highlight not only object categories (flamingo, animal), both other commonalities as well, including those that cut across object categories. To address this issue, we adapted the novelty-preference paradigm (Waxman & Markow, 1995), this time examining the influence of novel words on infants' attention to shared perceptual properties (as opposed to shared category membership). In these studies, infants are familiarized to objects sharing a common salient perceptual property (either color or texture). For example, during familiarization, we present infants with four different purple objects (e.g., a car, a dog, a spoon, and a key) and then examine their novelty preferences at test (e.g., a new purple object versus a blue object).

By 12 to 14 months, the invitation to form object categories is not extended to include salient property-based commonalities among objects (Waxman, Philippe, & Branning, 1997). When the objects presented during familiarization shared a common property, rather than category membership, a very different pattern emerged. Infants in the *No Word* condition revealed a consistent preference for the novel objects at test. This suggests that infants are sensitive to the color- and texture-based commonalities among objects, and do not depend upon a novel word to focus attention on them. Infants in the *Novel Adjective* condition were also successful in noticing the property-based commonalities. However, performance in the *Novel Noun* condition was somewhat surprising: Unlike infants in the *Novel Adjective* and *No Word* conditions, those hearing novel nouns revealed no novelty preference at test.

This outcome is consistent with the possibility that by 14 months, infants in an English-speaking environment have begun to develop a specific expecta-

tation that count nouns can refer to object categories, but not to individual object properties (color, texture). (Note that ours is a receptive measure; using a productive measure, Tomasello & Akhtar (1995) report evidence of a grammatical category *noun* by 23 months.) There is no doubt that additional work will be necessary before any strong conclusions can be drawn. However, this intriguing outcome suggests that infants' expectations for novel adjectives may enjoy greater latitude at this point in development than their expectations for novel nouns; adjectives focus attention on object categories (Waxman & Markow, 1995) as well as individual object properties (Klibanoff & Waxman, in press); nouns may be reserved for the types of commonalities underlying object categories.

In sum, infants on the threshold of lexical acquisition harbor a broad, initial expectation that words (presented either as count nouns or as adjectives) applied to objects will refer to those individual objects and will be extended to refer to other members of the same object category. This rudimentary linkage is important because it is available early enough to guide infants in their earliest efforts to map words to categories of objects. It also sets the stage for the emergence of a more specific set of expectations regarding particular types of words (e.g., nouns, adjectives, verbs) and particular types of conceptual relations (e.g., object categories, object properties, events). For although infants expect that both nouns or adjectives can refer to object categories, a more specific set of expectations emerges with development. By 2.5 years of age, there is clear evidence that children are sensitive to linguistic form cues, can distinguish novel nouns from adjectives, and assign each distinct types of meaning (e.g., Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Hall et al., 1993; Taylor & Gelman, 1988; Smith et al., 1992; Waxman, 1990; Waxman & Kosowski, 1990). But how do infants accomplish this task?

2. *Modification of Initial Expectations: How Do Learners Develop the More Specific Expectations?*

This is an especially intriguing problem, particularly because count nouns ("This is a *flamingo*"), adjectives ("This is *pink*"), and even proper nouns ("This is *Alice*") can all be applied ostensibly to objects. How, then, do learners gain a toe-hold that permits them to tease apart these syntactic forms and to develop the more specific expectations that (1) count nouns, but not adjectives, refer to object categories, and (2) adjectives, but not count nouns, refer to object properties?

To address this question, we designed two independent series of cross-sectional experiments, targeting 4 strategic points in language acquisition: 16-month-olds (each had fewer than 50 words in their productive lexicons);

21-month-olds (each had over 50 words in their productive lexicons); 30-month-olds (each had begun to combine words); and 48-month-olds (each had full productive command of various syntactic constructions). We examined how the lexical and syntactic advances that occur at these developmental points were related to the ability to distinguish between novel words presented as nouns versus adjectives. We predicted that throughout this period, (1) count nouns would continue to promote object categorization (e.g., *flamingos*), but would not highlight object properties, and that (2) novel adjectives would no longer promote object categorization, but instead would begin to map specifically to object properties (e.g., *pink things*, *striped things*). We tested these predictions with forced choice word-extension tasks.

a. Count Nouns and Object Categories In this series, children were introduced to a target (e.g., a dog) and asked to choose between two alternatives: a matching test object (from the same category as the target, e.g., another dog) versus a contrasting test object (from a different category, e.g., a banana). The target and matching test object were members of the same basic level category (e.g., dog) on half of the trials; these were members of the same superordinate category (e.g., animal) on remaining trials. We reasoned as follows: If count nouns draw attention to object categories, then children in the *Novel Noun* condition should be more likely than those in a *No Word* control condition to select the matching (same-category) test object. When this effect becomes specific to novel nouns, then children hearing novel adjectives should reveal no such preference. As predicted, (1) count nouns exerted a uniform influence across this period. At all ages, children consistently extended nouns to the same-category alternative, (2) a clear distinction between count nouns and adjectives emerged during this period. By 21 months, the tendency to extend adjectives to object categories began to diminish markedly. This distinction between novel nouns versus adjectives in object categorization became more entrained with age (Waxman, 1995; Waxman, Stote et al., 1997).

b. Adjectives and Object Properties This series of experiments represented a subtle, but important, change in focus. Rather than using adjectives as a control (to test the specificity of the noun-category linkage), we sought a more positive characterization of the influence of adjectives. Comparatively little research has been devoted to the acquisition of words other than count nouns. Although research on verb acquisition has begun to pick up pace (Behrend, 1990; Naigles, 1996; Fisher, Hall, Rakowitz, & Gleitman, 1994; Hirsh-Pasek, Golinkoff, & Naigles, 1996; Gleitman, 1990; Tardif, Shatz, & Naigles, in press; Tomasello, 1992), research on adjectives has been sparse. However, because both nouns and adjectives (but not verbs)

can be applied ostensively to objects, it is important to discover how learners begin to distinguish these forms. Moreover, the crosslinguistic and developmental variability associated with adjectives (like verbs) provides a fascinating opportunity to observe the rich interplay between expectations within the child and the shaping role of language input.

We examined the emerging expectation that an adjective, applied ostensively to an object ("That one is *yellow*"), will refer to an object property (e.g., its color, texture) rather than to the object category itself (e.g., *apple*). Note that this question hinges on a distinction between object categories (e.g., *flamingos*, *animals*) and object properties (e.g., *pink things*, *striped things*). Most current accounts distinguish object categories (also known as *kinds* or *sortals*) from other groupings on at least three grounds: Object categories (1) are richly structured, (2) capture many commonalities, including deep, nonobvious relations among properties (as opposed to isolated features), and (3) serve as the basis for induction (Barsalou, 1983; Gelman, 1996; Gelman & Medin, 1993; Gelman, Coley, & Gottfried, 1994; Kalish & Gelman, 1992; Keil 1994; Landau, Smith, & Jones, 1988; Macnamara, 1994; Markman, 1989; Medin & Heit, in press; Murphy & Medin, 1985; Rips, 1989; Waxman, Lynch, Casey, & Baer, 1997). See Gelman (1996) and Keil (1994) for evidence that although children may lack detailed knowledge about particular object categories, they nonetheless expect object categories to serve these functions. See Bhatt and Rovee-Collier (1996) and Younger and Cohen (1986) for evidence of a psychological distinction between individual properties and relations among properties in infants.

In a forced-choice task, infants were introduced to a familiar target (e.g., a yellow object) and asked to choose between two test objects. However, in this series, the matching test object shared a salient property with the target (e.g., another yellow object); the contrasting test object contrasted with the target along that property dimension (e.g., a green object). We examined 21-month-olds, using a *Novel Adjective*, *Novel Noun*, or *No Word* condition. We reasoned: If adjectives draw attention to object properties, then infants hearing novel adjectives should be more likely than those in a *No Word* control to select the matching-property test object. If this effect is specific to adjectives, infants hearing novel nouns should reveal no preference.

We also examined another factor: *the range of application for novel adjectives*. For adults, adjectives can identify a salient property of an individual (e.g., a spotted chair); they can be extended across individuals within a given category (e.g., the spotted dogs); and they can be extended across different categories (e.g., the spotted things, including dogs and cups). But the precise meaning for most adjectives is influenced by the noun they modify: *Soft* slippers and *soft* ice cream do not have the same texture; an

expensive tie and an *expensive* house do not have the same cost. This is because most adjectives do not indicate absolute measures, but instead indicate a relative point along a continuum. The range of this continuum is delimited by the category itself. This semantic dependency of adjectives on nouns has been observed across languages. Syntactic and morphologic dependencies have been documented as well. For example, in languages that mark grammatical gender or number, adjectives must accord with the basic level nouns they modify. *These observations suggest that there may be a linguistic or conceptual priority for establishing an object's basic level kind before marking its properties.*

If children are sensitive to this dependency, then they should succeed in extending property terms (e.g., *spotted*, applied to a spotted dog) to other objects from the same basic level category (e.g., other spotted dogs), but should fail to extend property terms to objects from different basic level categories (e.g., other spotted objects, including fish and cups). To test this hypothesis, children at each age were randomly assigned to either a Within Basic level or to a Across Basic level condition (see Fig. 3).

The results were straightforward. First, by 21 months of age, only children in the *Novel Adjective* condition consistently selected the matching-property test objects; those in the *No Word* and *Novel Noun* conditions did not select the property match. By 21 months, then, infants expect that adjectives, but not nouns, refer to object properties; they expect that nouns, but not adjectives, refer to object categories (cf., Waxman & Hall, 1993; Waxman, 1995; Waxman & Markow, in press). Second, infants were sensitive to the range of application. They successfully mapped novel adjectives to object properties *only* when the target and test objects were all drawn from the same familiar basic level kind (e.g., all dogs). In sharp contrast, when the target (e.g., a fish) and test objects (e.g., dogs) were drawn from different basic levels, infants *failed* to extend adjectives systematically; they performed at chance.







	Target	Test Trials	
		Matching Object	Contrasting Object
Within Basic			
Across Basic			

Fig. 3. One representative stimulus set (from Waxman & Markow, in press; Klibanoff and Waxman, in press).

Somewhat surprisingly, we have found that this pattern persists into the preschool years (Klibanoff & Waxman, in press). See Fig. 4. Three-year-olds successfully extended novel adjectives to object properties *only* if the objects were all drawn from the *same* familiar basic level category; they failed to extend novel adjectives systematically when the objects were drawn from *different* basic level categories. This difficulty was evident even when the objects represented different basic level categories within the same ontological kind (e.g., animate objects: dogs and snakes). By 4 years, children map novel adjectives to object properties even when objects are drawn from different basic level categories.

These studies are important for two reasons. First, they offer the earliest evidence of an ability to (a) distinguish the grammatical form *noun* from *adjective* and (b) assign each distinct types of meaning. Previous reports revealed distinct patterns for these two grammatical forms at 2.5 years (Hall et al., 1993; Taylor & Gelman, 1988; Smith et al., 1992; Waxman, 1990, 1995).

Second, infants' early expectations for novel adjectives appears to unfold within the support of a familiar basic level kind. This is consistent with arguments for the priority of establishing and naming basic level object kinds (Hall et al., 1993; Macnamara, 1986). The results from this series suggest that basic level distinctions, rather than global or ontological distinctions (e.g., animate versus inanimate object) may serve as the entry point

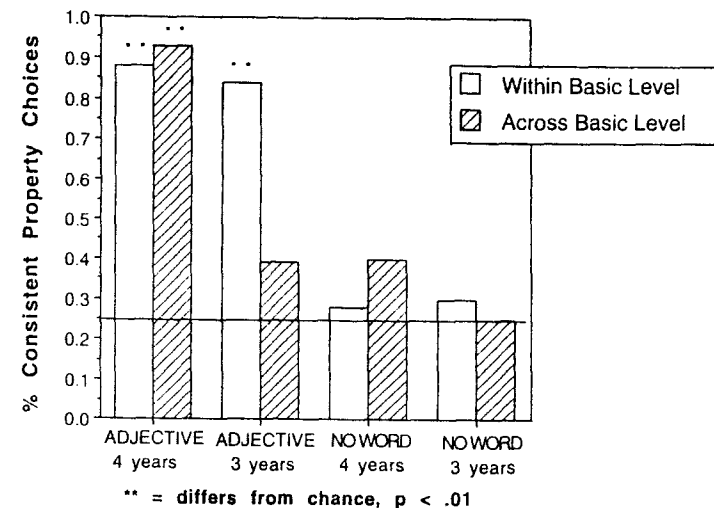


Fig. 4. Three- and four-year-olds' consistent property choices as a function of word and level (Klibanoff and Waxman, in press).

for working out the further semantic and syntactic distinctions between count nouns and adjectives. This is consistent with documentation of the dependency of adjectives on basic level count nouns—a dependency that has been observed across languages in morphological, semantic, syntactic, and lexical analyses.

Interestingly, it turns out that most of the developmental research on the acquisition of adjectives has capitalized on conditions in which the adjective picks out a property within, but not across, basic level kinds (cf., Au & Markman, 1987; Gelman & Markman, 1985; Hall et al., 1993; Prasada, 1992; Taylor & Gelman, 1988; Waxman, 1990). In our current work, we have begun to pursue this notion of dependency vigorously, examining the factors underlying the foundational role of the basic level, and the types of experience that permit children to advance beyond this initial entry point in interpreting novel adjectives.

In sum, these developmental studies have documented an initially general linkage between words and object categories that gives way to a more specific set of expectations regarding the particular types of referring associated with particular syntactic categories in English. The results suggest that count nouns exert a continuous influence from infancy through the preschool years, directing attention to the commonalities underlying object categories, particularly those at the so-called basic level. The expectations for adjectives vary considerably across this period. This variability in the adjective system provides us with an exciting opportunity to observe the developmental change that occurs as children hone in on the specific meanings associated with adjectives in their native language.

B. CROSSLINGUISTIC EVIDENCE

Crosslinguistic evidence is essential in piecing together the origin of these linkages, determining which links might be universal, and discovering how these are shaped by the language environment. We therefore buttress the developmental work with English-speaking children by examining the influence of novel words (nouns or adjectives) on object categorization monolingual children acquiring languages other than English, French, or Spanish as their native language (Waxman, Senghas et al., 1997).

1. Differences in Status of Adjectives across the Target Languages

We began our crosslinguistic work with a detailed examination of the expectations of children acquiring either French or Spanish. These Indo-European languages are closely related, but they provide an interesting crosslinguistic contrast, primarily because of differences in the grammatical

use and referential status associated with the grammatical form *adjective*. To get a sense of this difference, consider, for example, a cupboard filled with several cups. In English, we distinguish these linguistically by modifying a noun with an adjective (e.g., “the *blue* cup”). In Spanish, however, the head noun is omitted obligatorily from the surface of the sentence, leaving the determiner and adjective alone (e.g., “el *azul*” or “the *blue*”). Constructions like this are known as *determiner-adjective* (*det+A*) phrases.

Two features of *det-A* phrases are especially relevant to the issues at hand. Notice, first, that in *det+A* phrases, adjectives appear in syntactic contexts that are identical to those for count nouns. In Spanish, *det+A* constructions are ubiquitous; they are spontaneously productive in children as young as 2 years. In French and English, *det+As* are much less common; they are restricted to a much narrower set of properties (e.g., color, age). (See Waxman, Senghas, et al., 1997 for a more detailed discussion). As a consequence, in Spanish adjectives often appear in syntactic constructions that are identical to those for count nouns. Second, adjectives in *det+A* constructions are extended to include other members of the kinds denoted by a salient property. *In Spanish, then, there is considerable overlap in both the syntactic contexts and the extensions for count nouns and adjectives.* (See Gathercole, 1997 for other semantic/syntactic differences between Spanish and English, and their relation to acquisition.)

We suspected that experience with these structurally different native languages would lead to different outcomes in the expectations concerning the grammatical form *adjective*. Children acquiring French (like those acquiring English) should learn that adjectives do not, as a rule, refer to categories of objects. However, children acquiring Spanish may learn that novel adjectives, like nouns, can indeed be extended to refer to objects and categories of objects. If this is the case, then we would expect crosslinguistic consistency in children's expectations for novel nouns; in contrast, their extensions of novel adjectives should vary as a function of the structure of the language under acquisition.

2. Consequences on Children's Expectations

To test these predictions, we adapted a very robust forced-choice procedure to extend our examinations of the influence of novel nouns and adjectives on the formation of object categories to include monolingual children acquiring either French or Spanish (Waxman & Kosowski, 1990; Waxman, Senghas et al., 1997). Each child sat individually with an experimenter to “read” through a picture book that we had created. Each page of the book depicted five different objects, including a target (e.g., a cow), two objects from the same superordinate category as the target (e.g., a fox and a zebra), and

two objects that were thematically related to the target (e.g., a barn and milk). Children were assigned randomly to conditions that differed only in the way the experimenter introduced the target object. In the *No Word* (control) condition, the experimenter pointed to the target and said, "See this? Can you find another one?" In the *Novel Noun* condition, she said, for example, "See this 'blicket'? Can you find another 'blicket'?" In the *Novel Adjective* condition, she said, for example, "See this 'blick-ish' one? Can you show me another one that is 'blick-ish'?" (We examined Spanish-speaking children's performance with novel adjectives (a) when these were presented in conjunction with a head noun, as above, and (b) when they were presented within *det-A* phrases.) The child and experimenter went through the book two times. On the second reading, the experimenter reminded the children of their first choices and asked them to select another from the remaining (3) alternatives.

The results of these experiments were entirely consistent with our proposal. Performance in the *Novel Noun* condition was uniform across all three languages. Children extended novel nouns taxonomically, selecting objects from the same superordinate category as the target. Performance in the *No Word* control condition was also uniform across languages, suggesting that the materials were not biased in any way in any language. Children in this control condition revealed no preference for either the taxonomic or thematic alternatives.

However, as predicted, performance in the *Novel Adjective* condition varied systematically as a function of the language under acquisition. Children acquiring French (like those acquiring English) performed at chance in the *Novel Adjective* condition, revealing no preference for either the taxonomic or thematic alternatives. In contrast, Spanish-speaking children displayed a strong inclination to extend novel adjectives (like a novel nouns) to other members of the same superordinate level object category. This tendency was apparent whether the novel adjectives were presented in conjunction with an overt noun or within *det+A* phrases. This pattern, which has now been replicated in four different studies, suggests that Spanish-speaking children have learned that both count nouns and adjectives can be extended taxonomically, to include the named object and other members of an object category.

We currently are extending this crosslinguistic work in two directions. First, we are seeking replication in two additional languages (Swedish and Italian) that share important structural features with Spanish: both are *pro-drop* languages, in which *det+A* phrases appear fluidly across property types. These (predicted) replications will constitute strong converging evidence that (1) the noun-category linkage is robust across languages, and that (2) experience with the language system shapes the more specific

linkages for adjectives. This outcome would also serve as a firm foundation for considering a wider range of languages and language-types.

A second goal is to deepen the analysis of crosslinguistic differences in the adjective system, going beyond a word's extension alone to focus more specifically on the semantic distinctions between count nouns and adjectives. We predict that despite crosslinguistic differences in the *extension* of novel adjectives in Spanish, as compared to French and English, the core *semantic* distinction between the grammatical categories *noun* and *adjective* are as distinct in one language (e.g., Spanish) as another (e.g., French, English). Across languages, then, (1) count nouns (but not adjectives) should supply principles of object identity and individuation; (2) count nouns should also support stronger and more enduring inferences about objects than do adjectives (Gelman & Markman, 1986; Macnamara, 1986; Hall & Waxman, 1993; Markman, 1989; Wierzbicka, 1986; Waxman, Senghas et al., 1997).

We have now demonstrated, following Hall and Moore (1997), that 4-year-old French-speakers, like their English-speaking counterparts, expect that count nouns support more enduring inferences about objects than do adjectives (Waxman, Bredart, Nicolay, & Hall, 1998). Evidence from speakers of Spanish will provide a fascinating test case for this semantic distinction. Despite the extensional overlap between count nouns and adjectives (Waxman, Senghas et al., 1997), Spanish-speakers may nonetheless be sensitive to the (possibly universal) underlying semantic distinction between these forms, with count nouns providing richer and more enduring information about individuals than adjectives.

VII. Integrating the Developmental and Crosslinguistic Evidence

Together, the developmental and crosslinguistic findings offer important insights into the relation between object categorization and naming across languages and across development. From the earliest stages of word learning, infants interpret words (from various grammatical categories, including both count nouns and adjectives), applied to solid objects, as referring to those objects and to other members of the same kind. (See Echols, 1992, for evidence that verbs, too, may initially direct infants' attention to object categories.) This initial expectation is itself fine-tuned as a result of the child's experience with the native language under acquisition.

For infants on the brink of word learning, novel words (both count nouns and adjectives) highlight commonalities among objects and, in this way, foster the formation of object categories. This initial expectation is important in several respects. First, because it is evident as early as 9 to 12 months

of age, it is available to guide infants in their earliest efforts to link words to their meaning. In particular, it supports the early establishment of object reference and promotes the early establishment of a repertoire of object categories. These object categories will be stable over development and will support the acquisition of additional information about category members.

This strong empirical finding challenges directly the claim that a linkage between object categorization and naming is unavailable at the onset of lexical acquisition, that it is learned or constructed as a *consequence* of word learning (Bloom et al., 1993; Nelson, 1988; Smith, 1995; Xu & Carey, 1996). Instead, the evidence indicates that this general expectation fuels the acquisition of object naming and categorization from the start (also see Waxman & Hall, 1993).

This finding also suggests that although infants' concepts are certainly less elaborate, and less richly structured than those of older children and adults, there is nonetheless considerable conceptual continuity. In contrast, Xu and Carey (1996) have argued recently for radical conceptual change in infancy. They have suggested that before the onset of lexical acquisition, infants are unable to represent any concepts (sortals) that are more specific than the sortal *object* (but see Wilcox & Baillargeon, in press). Our results suggest a more continuous developmental trajectory: For prelinguistic infants (at 9 months of age), words focus attention on basic level object concepts, the very types of object concepts that figure prominently in the conceptual systems of older infants and adults. Interestingly, Xu (1997) has recently presented evidence that appears to concur with this conclusion.

One advantage of infants' initially general expectation is that although it offers a guide in the early establishment of reference, particularly for object kinds, it does not require infants on the brink of learning language to be able to identify the relevant surface cues that distinguish among the particular grammatical categories (e.g., nouns, adjectives) in their native language (Pinker, 1984; Gleitman, 1990; Gerken & McIntosh, 1993). This is important, because grammatical categories are not marked transparently or universally in the input children receive. There appear to be no universally constant stress levels, affixes, or positions in a sentence that are associated with any of the grammatical categories (Pinker, 1984). Indeed, in most current theories of language acquisition, the very ability to identify instances of the various grammatical categories is itself a major achievement. In fact, our proposal is consistent with the speculation that the ability to recognize the grammatical categories and establish their meaning may be dependent upon the prior establishment of object reference (Gentner, 1982; Gleitman, 1990; Hall et al., 1993), particularly reference to basic level kinds (Hall & Waxman, 1993; Waxman & Markow, 1995, in press).

Another advantage is that this perspective is flexible enough to account for the fact that infants readily acquire languages that differ in the ways in which they recruit particular grammatical categories to convey particular types of meaning (sometimes known as the conflation problem: Bowerman, 1996; Naigles & Eisenberg, in press). We suspect that it is to infants' advantage to begin with an initially general expectation—an expectation that will guide them in establishing their first word-meaning mappings and that can then be tailored to fit the particular variations (or conflations) encountered in their native language.

We have also demonstrated that infants' broad initial expectations are subsequently shaped by the structure of the native language under acquisition, and become more entrained with age and experience. Once infants have acquired a stable lexical repertoire, they begin to show consistent evidence of a more specific set of expectations linking particular types of words with particular types of relations among objects. Based upon a crosslinguistic analysis of the nouns and adjectives, we predicted that an expectation that count nouns refer to object categories would persist across development and be uniform across languages. As predicted, we discovered that the noun-category linkage was evident in French- and Spanish-speaking children, just as it has been evident in English-speaking children, and in infants immersed in an English-speaking environment (Markman & Hutchinson, 1984; Balaban & Waxman, 1996; Waxman & Hall, 1993; Waxman & Markow, 1995; Waxman, Senghas et al., 1997). We also predicted that the specific mappings for adjectives would vary according to the structure of the native language under acquisition. As predicted, children's extensions of novel adjectives did change across development (Waxman & Markow, 1995, in press) and across languages (Waxman, Senghas et al., 1997). We also discovered that the mappings between adjectives and object properties emerge within the support of a familiar basic level kind.

The results of this program of research raise several intriguing issues. In the following sections, I touch upon these and discuss their consequences for a comprehensive and integrative theory of development.

A. MECHANISMS UNDERLYING THE TRAJECTORY FROM A GENERAL TO A MORE SPECIFIC SET OF EXPECTATIONS

One central issue concerns the mechanisms underlying this proposed developmental trajectory. That is, how does an initially general expectation, in which infants treat nouns and adjectives identically with respect to object categorization, give way to the more specific expectations that characterize older children and adults? This issue touches upon both linguistic and conceptual factors. We consider several possible mechanisms by which this

evolution may come about. One possibility is that infants begin the process of lexical acquisition with a truly general expectation that words refer to commonalities among objects, including those underlying object categories, as we have proposed. Once they establish object reference and a stable set of object categories, they may be able (a) to identify more subtle regularities in the linguistic input that permit them to tease apart the different grammatical forms (e.g., count nouns versus adjectives) and (b) to discover that these tend to signal (or correlate with) particular kinds of relations among objects (e.g., object categories versus object properties). On this view, infants' early referential abilities serve as the essential bedrock for the subsequent acquisition of more specific expectations.

A second possibility grants infants a somewhat more "advanced" outlook, in which they share with older children and adults the expectations that (a) their language will include distinct grammatical categories and (b) these are linked to distinct types of conceptual relations (c.f., Gleitman, 1990; Grimshaw, 1981; Pinker, 1984). However, either because infants have not yet learned the relevant surface cues to distinguish among these grammatical forms, or because processing limitations prevent them from perceiving the differences between the syntactic frames surrounding novel words, infants initially fail to distinguish novel words presented as adjectives versus nouns (c.f., Grimshaw, 1981; Pinker, 1984).

A third possibility is that infants' initially general expectation is primarily a consequence of their very limited lexical knowledge. Perhaps infants (a) expect to find distinct grammatical categories, (b) are able to distinguish among these grammatical forms, and (c) expect that these are linked to distinct types of conceptual relations. On this view, infants' failure to reveal this specific expectation is related to their limited repertoire of basic level names. Recall that the use of grammatical form as a cue to meaning is dependent upon mastery of a basic level name for the objects under consideration (Hall, 1993; Hall et al., 1993; Macnamara, 1982). When a novel word is applied to an object for which children have no basic level name, they tend to extend any word (either a count noun or an adjective) to other members of the same object category. This pattern is evident in children as old as 4 years of age, children who clearly hold specific expectations linking particular types of words to particular types of conceptual relations. This is relevant because, by definition, infants on the brink of lexical acquisition are unfamiliar with most words, including the names for most basic level categories. Therefore, infants' initially general tendency to extend novel adjectives, like nouns, to object categories may be a consequence of their limited repertoire of basic level names.

Each of the possibilities outlined above reflects different theoretical commitment and a different account of the mechanism underlying the trajectory

from an initially general to a more specific set of expectations between words and object categories. However, these possibilities are difficult to disentangle empirically, because each is consistent with our demonstration that infants' first expectations for mapping words is general and that more specific linkages emerge later. Each possibility also predicts that object categories are prime candidates for word meaning early in acquisition.

B. WHAT IS THE RELATION BETWEEN OBJECT CATEGORIES FORMED EARLY IN DEVELOPMENT AND THOSE CHARACTERISTICS OF A MORE MATURE SYSTEM?

I have just discussed some of the mechanisms by which infants make advances on the linguistic side of the relation between words and object categories. Here, I discuss some of the advances that I expect come about on the conceptual side. Recent research has revealed that, under certain circumstances, infants and young children will group together the same sets of objects as do older children and adults. However, this does not constitute evidence that infants' conceptualization of various object categories is on a par with that of older children and adults. On the contrary, infants' conceptualizations of object categories (e.g., bear, animal) lacks the elaborate information, the richly interconnected theories, and the inductive depth that are available to older children and adults (Carey, 1975; Gelman & Coley, 1990; Gentner & Waxman, 1994; Keil, 1987; Murphy & Medin, 1985).

Although it is beyond the scope of this chapter to describe how children come to acquire these deeper, more elaborate, more richly structured conceptual systems (for discussions, see Gelman, 1996; Keil, 1994), it is important to consider here the role of naming in this process (also see Gentner & Waxman, 1994). I have proposed that words focus infants' attention on commonalities among objects and in so doing, facilitate the establishment of object categories. Words, particularly count nouns, exert a similarly dramatic effect in preschool-aged children (Markman, 1989; Ward, Becker, Hass, & Vela, 1991; Waxman, 1990, 1991, 1994). Providing a common label for a set of objects initiates a search for coherence among them. This search may be unsuccessful. For example, novel nouns do not influence infants' performance when sets of objects share no discernable perceptual or conceptual commonalities (Waxman & Markow, 1995).

However, when a commonality can be discerned, words serve as invitations to form categories. This invitation has several dramatic consequences. First, novel words invite infants to assemble together objects that might otherwise be perceived as disparate entities. In this way, words promote comparison among them. This process of comparison may lead infants to discover other commonalities that might otherwise have gone unnoticed (Gentner & Waxman, 1994; Gentner & Namy, 1998).

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 12-month-old infants successfully formed basic level object categories (whether or not they were introduced to novel words), their knowledge about these categories is not on a par with the knowledge of an older child or adult. Even preschool-aged children lack detailed knowledge about most categories (Gelman, 1996; Keil, 1994). Nonetheless, despite their relative lack of information, children seem to expect that members of object categories share deep, nonobvious commonalities. Indeed, children depend upon these to support induction. I suspect that novel words are instrumental in motivating infants and young children to discover the deeper commonalities that underlie our richly structured object categories (Barsalou, 1983; Gelman, 1996; Gelman & Medin, 1993; Gelman et al., 1994; Kalish & Gelman, 1992; Keil, 1994; Landau, Smith, & Jones, 1988; Lassaline & Murphy, 1996; Macnamara, 1994; Markman, 1989; Medin & Heit, in press; Murphy & Medin, 1985; Landau, 1994; Rips, 1989; Ross, 1996; Waxman & Markow, 1995).

Finally, I speculate that expectation that count nouns refer to object categories plays a central role in the acquisition of count nouns referring to a wide range of concepts, including abstract (e.g., *idea*, *dream*) and relational (e.g., kinship terms) concepts. Although infants may initially depend upon some perceptual support to form categories, I suspect that they can then extend their expectation more broadly. In this way, an expectation that count nouns refer to object categories can itself support the acquisition of abstract and relational concepts, particularly when these concepts are named with count nouns.

C. CONTINUITY IN DEVELOPMENT: PERCEPTUAL AND CONCEPTUAL CONTRIBUTIONS TO CATEGORIZATION AND NAMING

I have argued for developmental continuity in (a) the types of concepts entertained by infants, young children, and adults, and (b) the contribution of both perceptual and conceptual factors in categorization and naming. I have proposed that words are powerful engines, advancing us beyond our initial conceptual and perceptual groupings, and fueling the acquisition of the essential, rich commonalities and relations that characterize our most powerful concepts.

D. THE SCOPE OF INFANTS' EARLY OBJECT CATEGORIES AND THE ROLE OF NAMING IN THEIR ESTABLISHMENT

Two other developmental proposals have been offered recently. Each is predicated on a very different set of assumptions about the scope of infants' early object categories and the role of naming in their establishment.

1. On the Acquisition of Global versus Basic Level Object Categories

Although there is strong evidence that basic-level object categories emerge very early in development (Brown, 1958; Fenson, Cameron, & Kennedy, 1988; Mervis & Crisafi, 1982; Quinn, Eimas, & Rosenkrantz, 1993; Roberts, 1988; Roberts & Cuff, 1989; Roberts & Horowitz, 1986; Rosch, 1978; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Waxman, 1990), this view has recently been challenged. Mandler and her colleagues (Mandler, 1988; 1992; Mandler & Bauer, 1988; Mandler, Bauer, & McDonough, 1991; Mandler & McDonough, 1993) have argued (1) that conceptual development begins at a more abstract, global (e.g., animate versus inanimate objects) level, (2) that the acquisition of these global concepts *precedes* the organization of concepts at basic levels, and (3) that the basic-level groupings of infants and toddlers are entirely perceptually based, lacking in any conceptual grounding or inductive strength (Mandler & McDonough, 1996).

In contrast, we have argued that basic-level object categories serve as an important entry point in object categorization, naming, and inductive inference. Although we acknowledge that basic-level object categories certainly enjoy considerable perceptual support, this does not, in itself, mean that they lack conceptual force. On the contrary, like most cognitive scientists (coming from a wide range of disciplines and perspectives), we are committed to the idea that perceptual and conceptual information are not mutually exclusive. Indeed, to the best of our knowledge, there is no strong basis to the claim that in object categorization, perceptual and conceptual information or processes are frankly distinct, either in infancy or in adulthood.

We take no issue with the possibility that infants acquire both global (e.g., animate versus inanimate objects; land versus sea animals) and basic-level conceptual categories. The suggestion that infants can, under certain circumstances, form object categories at various levels of abstraction is attractive. It incorporates the view that infants' attend to several different kinds of perceptual and conceptual features in categorization, including an object's form, function, and type of movement (Baldwin, Markman, & Melartin, 1993; Kemler-Nelson, 1995; Smith & Heise, 1992). The early acquisition of global, as well as basic, categories also ensures considerable continuity in conceptual development.

However, on both logical and empirical grounds, we strongly doubt that the acquisition of global concepts *precedes* the acquisition of basic-level concepts, with the latter being strictly derivative of the former. We also doubt that there is a frank dissociation between perceptual and conceptual factors, in which infants' basic-level object categories are entirely perceptu-

ally based, whereas their global categories are conceptual. These doubts come from several different sources. First, there are perceptual, as well as conceptual distinctions underlying global categories. For example, infants are sensitive to the perceptual distinction between the types of motion displayed by animate versus inanimate objects early in development (Bertenthal, Proffitt, Kramer, & Spetner, 1987).

Second, the argument for the precedence of global- over basic-level categories in infancy is not supported strongly by the data. To take one example, Mandler and McDonough (1993) used a novelty-preference task that was similar in many respects to the one we have discussed here (Waxman & Markow, 1995). They report that 11-month-old infants successfully formed one global-level distinction (animals versus vehicles), but failed to reveal a consistent pattern of performance at the basic level. However, a careful analysis indicates that these infants reliably formed one set of basic-level categories (car versus plane), but failed to form another (dog versus fish). This reveals an effect of stimulus set at the basic level, an effect that may be attributed to several different factors. The contradictory pattern observed at the basic level also raises questions about the generalizability of the phenomenon. Unfortunately, this set effect was not pursued, leaving only a single test of categorization at the global level and contradictory results from the two tests of categorization at the basic level. This pattern provides insufficient empirical support for the precedence of global concepts.

Infants' performance in the novelty-preference tasks presented in our lab also raise doubts (Waxman & Markow, 1995). If Mandler is correct, then infants in the *No Word* conditions should have formed object categories at the more abstract superordinate level quite successfully, for the *conceptual* commonalities among these objects (e.g., animate versus inanimate objects) should have been readily available. However, this was not the case: although infants in the *No Word* conditions formed basic-level categories successfully, they evidenced no appreciation of these more abstract categories. The contrast between performance with and without novel words suggests that infants in this task depended upon the influence of a novel word to successfully form these more abstract object categories. This pattern underscores the facility with which infants form (or recognize) commonalities at the basic level, as opposed to those at a more abstract global level.

Leaving methodological issues aside (see Waxman & Hall, 1993; Waxman & Markow, 1995), consider the evidence from analyses of early lexical acquisition. Early in lexical development, words for basic-level categories are very common; indeed words falling into this category are the predominant form (Nelson, 1973; Nelson, Hampson, & Shaw, 1993; Gentner, 1982; Gentner & Boroditsky, 1997; Saah et al., 1996). In contrast, words for global categories are extremely rare (Fenson et al., 1994). As we have discussed,

infants' and young children's tendency to extend novel words, applied to novel objects, to other members of the same basic level object category is so strong that it overrides children's use of syntactic form as a cue to word meaning (Hall et al., 1993; Hall & Waxman, 1993; Au & Markman, 1987). This empirical result is also consistent with anecdotal evidence that infants and toddlers often interpret a *novel* word (e.g., *hot*) applied to a *novel* object (e.g., a stove or pot) as referring to a whole object, and not to an (intended) property. Recall also that infants' and young children's extension of novel adjectives appeared to depend upon the support of a familiar basic-level category. When objects were drawn from the same basic-level category, they mapped novel adjectives successfully to object properties such as color and texture. Strikingly, global superordinate level categories did not support such extensions (Klibanoff & Waxman, 1997; Waxman & Markow, in press). We therefore maintain that the acquisition of basic-level object categories and their names serve as a foundation for the acquisition of other types of words referring to other types of relations among objects.

How can Mandler's position be reconciled with these arguments supporting the central conceptual role of basic-level categories and the early acquisition of their names? One possible reconciliation is to argue that infants map their first words to perceptual, rather than to conceptual, groupings. However, this reconciliation is incomplete. First, it is unclear why abstract symbols (words) would be tethered so tightly to perceptual groupings (basic-level categories, in Mandler's view), but not extended to groupings with an abstract conceptual base (global categories, in Mandler's view). Second, even if one accepted the assumption that basic-level categories are purely perceptually based, it is unclear why infants would reveal such a strong talent for mapping words to some perceptual groupings (namely, those at the basic level), but not to other perceptual groupings, including words referring to color and texture. Names for perceptual properties like these enter the lexicon much later than names for basic-level object categories. Indeed, the acquisition of these terms seems to depend upon the prior acquisition of basic-level categories and their names (Waxman & Markow, in press; Klibanoff & Waxman, in press; Hall et al., 1993).

These observations, coupled with the arguments presented throughout this chapter, provide clear evidence for the importance of basic-level categories, their names, and their conceptual status, early in development. Our account also embraces a continuous view of development, in which perceptual and conceptual factors are recruited to support object categorization and naming throughout the course of development.

2. Object Categories vs. Object Shape

There has also been recent debate concerning the types of meaning that children (and adults) associate with novel count nouns. Simply stated, this

debate centers around whether count nouns direct word learners' attention to *categories* of objects (henceforth, the noun-category position: e.g., Gelman & Medin, 1993; Markman, 1994; Soja et al., 1991, 1992; Waxman, 1990, 1994) or to *shapes* of objects (henceforth, the noun-shape position: e.g., Landau, Jones, & Smith, 1992). Because it is not possible to do justice here to the complexity of this issue, I focus principally on three fundamental points: (1) the role ascribed to development, (2) the issue of generalizability, and (3) the underlying model of word extension.

I begin by noting several key points of convergence between the noun-category and noun-shape positions. Both illustrate the powerful role of count nouns in object categorization. Both assume that perceptual properties can strongly influence our judgments of category membership and noun extension. Both assume that an object's shape and category membership often covary, particularly when considering object categories at the basic level.

However, these positions differ in the role they ascribe to development. According to the noun-shape position, children (sometime after age 2, or perhaps even earlier) develop an expectation that count nouns refer to objects with the same shape (Landau, Smith, & Jones, 1988; Landau, Jones, & Smith, 1992; Smith, Jones, & Landau, 1992). This could be a powerful expectation, particularly early in development, when children may rely rather heavily on perceptual information (Imai, Gentner, & Uchida, 1994). Yet shape-based similarities do not represent the full extent of adults' or children's judgments regarding either category membership or noun extension. On the contrary, children and adults expect that two objects that look alike (say, by virtue of shape) will also share other, perhaps deeper, nonperceptual commonalities as well (Baldwin et al., 1993; Gelman, 1996; Gentner & Namy, 1998). In addition, if two objects share a common label, then children expect that these objects also share other nonperceptual commonalities, even when the objects are perceptually dissimilar (Gelman, 1988).

Thus, there is strong evidence that for both adults and children, neither the extension nor the intension of novel nouns rests upon shape-based similarities alone (Gelman & Medin, 1993; Gentner & Waxman, 1994; Soja et al., 1991, 1992; Waxman & Braig, 1996; Waxman & Markow, 1995). However, the noun-shape account cannot specify how the learner moves from primarily shape-based extensions to those that capture additional, perhaps deeper, properties. Because an object's shape is readily available from even a cursory inspection of an object, the noun-shape account includes no mechanism to look further for additional properties that bind a particular set together and serve as the basis for noun's extension. This mechanism appears to be beyond the scope of the noun-shape position.

In contrast, the noun-category position ascribes a more central role to development, with words serving as a catalyst for object categorization and for change. On this account, grouping objects together on the basis of shape can serve as one entry point (and perhaps an especially important entry point for simple artifacts in particular, as discussed below). Naming promotes the discovery of additional, perhaps deeper commonalities than those that might have formed the initial basis of the word's extension of the word. Therefore, the noun-category position incorporates a developmental mechanism that motivates learners to discover these powerful, additional commonalities among objects (Gelman & Medin, 1993; Gentner & Waxman, 1994; Waxman & Braig, 1996; Waxman & Markow, 1995). Another advantage is that this mechanism provides for continuity over development, with adults and children attending to both perceptual and conceptual relations among objects in the context of word learning (also see Gentner & Markman, 1994).

Second, the noun-shape is more restricted in its generalizability than is the noun-category position. The positive evidence for the noun-shape position rests primarily on observations of the influence of count nouns on the categorization of unfamiliar inanimate objects or artifacts. However, the reliance on object shape in word extension does not generalize beyond inanimates to include animate objects (Jones, Smith, & Landau, 1991). On the contrary, when a count noun is offered as a name for an animate-like object, the reliance on shape drops off dramatically (see Landau, 1994). This is consistent with the evidence that for adults and children, the signal value of shape (as well as other features) varies as function of object kind or ontology (Keil, 1994; Medin & Shoben, 1988). For animate objects shape is not a sufficient predictor of an object's category or its name. (See Ward et al., 1991, for additional evidence for this interpretation.) In contrast to the noun-shape position, the evidence for the noun-category position is robust for a broad range of ontological kinds, including both animate and inanimate objects.

Crosslinguistic comparisons reveal another limitation in the generalizability of the noun-shape position. In classifier languages, an object's shape is not incorporated within the head noun itself; instead, object shape is conveyed within a closed class system of noun classifier terms and the head noun refers to object substance. (See Craig, 1986; Lucy, 1996; Gentner & Boroditsky, in press for more extended discussions.) The noun-category position has sufficient breadth to account for this crosslinguistic variation. On this view, all infants begin with an early expectation that words refer to commonalities among objects. This general expectation is refined as infants come to notice (a) the distinct types of words in their language, and (b) the distinct types of relations among objects to which these words refer.

This prediction is consistent with Lucy's (1996) results on the acquisition of Maya (a classifier language). Lucy reports that early in acquisition, Maya children, like their English-speaking counterparts, prefer to extend nouns to object categories. As we have predicted, with development, this expectation is refined in accordance with their native language: infants acquiring classifier languages learn that nouns refer primarily to objects sharing a common substance, and that shape is marked within the classifier system. Imai and Gentner (1997) have offered similar evidence for children acquiring Japanese. What is missing from the noun-shape account is how children and adults come to discover commonalities among category members beyond those based on shape or substance.

Third, the noun-shape and noun-category positions instantiate different models of word extension. The noun-shape position is essentially a univariate model, with shape as its primary index. At its most complex, a univariate model permits researchers to pit one property (e.g., shape) against another (e.g., texture, size, function, animacy cues). And indeed, most work on the shape bias involves pitting object shape, texture and size against one another in a binary fashion. But it is clear that the interactions among these predictors are crucial. Because a univariate model can only isolate and compare each of these predictors, it cannot capture the complexity underlying word meaning and object categorization.

The noun-category position offers a more comprehensive account because it takes into account multiple indices, including (but not limited to) shape. It can therefore accommodate the fact that the relative weights associated with each predictor will vary as a function of ontological kind. For example, although shape may be weighted heavily in some categorization judgments (e.g., judgments regarding simple artifacts), it will carry less weight in others (e.g., judgments regarding animate objects). This position can also accommodate the fact that shape may receive greater emphasis early in development, but its relative importance may wane as infants and young children discover the additional commonalities underlying categorization and word extension (Imai, Gentner, & Uchida, 1994). This multivariate approach articulates well with current work documenting the contribution of many perceptual and conceptual factors in object categorization, naming and induction (Medin & Heit, in press).

The noun-category position also permits an explanation for the acquisition of words for object categories that are not bound together by shape similarities (*idea, museum, dream*). On the noun-category account, extending a novel word to objects of a similar shape is only part of the process: an initial grouping, perhaps on the basis of a perceptual feature (e.g., shape), is then subjected to further scrutiny. This leads learners (children and

adults) to discover additional commonalities that may extend beyond perceptual features like shape.

In sum, the noun-category position offers a more comprehensive account. It ensures that categorization in humans is a flexible and ongoing process. We continually incorporate new, perhaps deeper, information about commonalities within our existing categories; we also admit new instances into existing categories. These evolutions are, at least in part, an effect of naming. The complexities of objects (artifacts and natural kinds) and languages in the real world require that we attend to more than shape alone if we are to develop words and categories for the objects with which we daily do commerce.

Conclusion

Humans are uniquely endowed with a natural capacity for building complex, flexible, and creative conceptual and semantic systems. The research program described in this chapter articulates a precise link between these two systems early in development, and provides insights into the origins and unfolding of the relation between them—across development, across languages, and across ontological kinds. We have proposed a continuous view of development, in which infants' considerable perceptual and conceptual abilities are recruited early in the fundamental task of forming object categories and mapping words to their meanings. By integrating cross-linguistic and developmental investigations, we amplify the rich interplay between the expectations of the learner and the shaping role of the environment.

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