

## Seeing Pink Elephants: Fourteen-Month-Olds' Interpretations of Novel Nouns and Adjectives

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Words from different grammatical categories (e.g., nouns and adjectives) highlight different aspects of the same objects (e.g., object categories and object properties). Two experiments examine the acquisition of this phenomenon in 14-month-olds, asking whether infants can construe the very *same* set of objects (e.g., four purple animals) either as members of an *object category* (e.g., animals) or as embodying a salient *object property* (e.g., four purple things) and whether naming (with either count nouns or adjectives) influences infants' construals. Results suggest (1) that infants have begun to distinguish count nouns from adjectives, (2) that infants share with mature language-users an expectation that different grammatical forms highlight different aspects, and (3) that infants recruit these expectations when extending novel words. Further, these results suggest that an expectation linking count nouns to object categories emerges early in acquisition and supports the emergence of other word-to-world mappings. © 2001 Academic Press

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What resources do infants recruit in the process of mapping words to the objects and events they perceive in the world? We know that infants take advantage of the rich social and pragmatic contexts in which novel words are introduced to determine their meaning. For example, by their first birthdays, infants spontaneously follow a speaker's eye-gaze to discover the object or event of interest in a naming episode (Baldwin & Markman, 1989). In addition, during this period, infants' growing sensitivity to perceptual cues within the ongoing speech stream permits them to successfully parse novel words

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from familiar ones (Jusczyk & Kemler-Nelson, 1996; Morgan & Demuth, 1996; Werker, Lloyd, Pegg, & Polka, 1996) and to distinguish open class from closed class words (Shi, Werker, & Morgan, 1999).

However impressive these early social and perceptual achievements may be, they are not (singly or jointly) sufficient for successfully mapping a novel word to its meaning. This is because many different words—indeed many different *types* of words—may be offered in a naming episode. Importantly, each type of word highlights a different aspect of the observed scene. For example, for speakers of English, count nouns (“Look, it’s an elephant”) typically refer to the named object itself and are extended spontaneously to other members of the same object kind (other elephants); proper nouns (“Look, it’s Babar”) refer to the named individual, but are not extended further; and adjectives (“Look, it’s pink”), which refer not to the individual itself, but to a property of the named individual, are extended to other objects sharing that property.

By the time they are 2 years of age, infants appear to be sensitive to many of these word-to-world links (for a review, see Waxman, 1998 or Woodward and Markman, 1998). But which of these links, if any, are available at the onset of lexical acquisition? We have proposed that infants begin the task of word learning with a broad expectation that novel open class words (including both nouns and adjectives) highlight commonalities among objects and that this initial expectation is then fine-tuned on the basis of infants’ experience with the specific word-to-world links encountered in the native language under acquisition (Waxman, 1999; Waxman & Markow, 1995; Waxman, Senghas, & Benveniste, 1997). We have further proposed that as infants’ expectations become fine-tuned, they will first distinguish the nouns (from among the other grammatical forms) and map them to objects and categories of objects (rather than properties of objects or actions in which they are engaged) (Waxman, in press).

In support of this proposal, we begin with a brief review of the influence of novel words on infants’ behavior at the onset of lexical acquisition. By 9 months of age, infants devote more attention to objects that are named than those that are unnamed (Balaban & Waxman, 1997; Baldwin & Markman, 1989). This increased attention to named objects has consequences for infants’ conceptual development. Naming distinct objects (e.g., a dog, horse, monkey, and giraffe) with a *common* name (e.g., animal) serves to highlight commonalities among the objects and, in this way, promotes the formation of object categories (Balaban & Waxman, 1997; Waxman & Markow, 1995; Waxman, 1998). Naming also appears to support the discovery of stable, and perhaps nonobvious, commonalities among the named entities (Gelman, 1996; Gentner & Waxman, 1994). Conversely, naming distinct objects (e.g., ball and duck) with *distinct* names (e.g., ball and duck) promotes the process of object individuation at 10 months (Xu, 1999). Thus, even before infants begin to produce words on their own, naming promotes attention to individu-

als and to categories of objects. The early link between object naming and categorization was first revealed in a series of novelty-preference tasks (Waxman & Markow, 1995), in which 12- to 13-month-old infants were familiarized to members of a given object category (e.g., four different animals). At test, they saw (a) a new member of the now-familiar object category (e.g., another animal) and (b) an object from a contrasting object category (e.g., a fruit). Infants in these experiments revealed an important role for naming in categorization. When the familiarization objects were introduced in conjunction with a novel word (either a count noun or an adjective), infants successfully formed superordinate-level object categories (e.g., animal and vehicle). Those in a No Word control condition failed to do so.

The difference between performance with novel words and without them illustrates, first, that infants reliably detect novel words in fluent, infant-directed speech and, second, that novel words (either count nouns or adjectives) support the formation of object categories. Importantly, this link between naming and categorization is in place early enough to support infants in their earliest efforts to map words to meaning (Balaban & Waxman, 1997; Fulkerson & Haaf, 1998; Waxman & Markow, 1995).

In subsequent work, we asked whether infants link novel words specifically to object categories (e.g., *elephant* and *animal*) or whether they link words to a wider range of groupings, including, for example, property-based commonalities (e.g., *pink things* and *lumpy things*) (Waxman, 1999). To address this question, we maintained the logic and design of Waxman and Markow's original paradigm, but shifted the focus from object categories to object properties. Infants were familiarized to four objects, but this time, the commonality among the objects was property-based [either color (e.g., purple cat, purple plate, purple spatula, and purple bottle) or texture (e.g., rough cup, rough ball, rough hat, and rough boot)]. At test, all infants were presented with (1) an object with the now-familiar object property (e.g., a purple horse) and (2) an object with a novel object property (e.g., a blue horse). If infants attended to the property-based commonalities among the familiarization objects, then they should reveal a preference for the object with the novel property at test (e.g., the blue horse). If infants attended to the category-based commonalities among the familiarization objects, they should reveal no novelty preferences, since both test objects are members of the now-familiar object category (e.g., both are horses). By 13 months of age, infants hearing novel adjectives revealed reliable preferences for the test objects with novel contrastive properties (e.g., the blue horse). This suggests that they attended primarily to property-based commonalities during familiarization. In contrast, infants hearing novel nouns revealed no consistent preferences at test. This suggests that they attended specifically to the category-based commonalities during familiarization.

Taken together, these two series of experiments provide several insights into infants' expectations regarding word-to-world mappings at the onset of

lexical acquisition. By 13 months, infants are sensitive to (at least some of) the distinctions between novel words presented as count nouns versus adjectives, and this sensitivity has consequences on their attention toward objects in novelty-preference tasks. Infants hearing novel count nouns attended specifically to category-based commonalities; nouns did not promote attention to property-based commonalities. Infants hearing novel adjectives attended to both category- and property-based commonalities (Waxman & Markow, 1995; Waxman, 1999). Interestingly then, at this point in development, infants' expectation for count nouns appears to be more finely-tuned than their expectation for adjectives. In sum, although infants' grammatical form distinctions are certainly not as well honed as those of adults, and although their knowledge of categories and properties of objects is certainly not as rich, infants in these experiments do appear to share with adults an expectation that different types of words (count nouns versus adjectives) draw attention to different types of relations among objects.

This is a powerful claim. Unfortunately, however, the support for it is currently rather limited. First, the evidence is based entirely on infants' performance in novelty preference tasks. This leaves open the question of whether infants can actively recruit their expectations in the context of word learning. Second, the evidence that naming promotes attention to object categories has been documented with one set of materials, and the link between naming and attention to object properties has been documented with another. For example, in experiments documenting the contribution of naming to infants' attention to category-based commonalities (Balaban & Waxman, 1997; Fulkerson & Haaf, 1998; Waxman & Markow, 1995), the only consistent relation among the familiarization objects was category-based (e.g., animals). In contrast, in experiments demonstrating the effect of naming on infants' attention to object properties (Waxman, 1999), the only consistent relation shared by the familiarization and test objects was property-based (e.g., purple things).

We have suggested, based on this evidence, that infants' attention to category- and property-based commonalities is mediated primarily by their emerging grammatical form class distinctions. However, it is also possible that the differences observed across experiments reflect nothing more than differences in the materials presented. For no matter how carefully the objects in each independent experiment were chosen, the possibility remains that infants simply found certain relations among objects more salient in some sets of materials than others. On a related note, because the materials in each experiment shared only a single dimension of commonality (either category- or property-based), we cannot ascertain how novel words direct infants' attention when they are faced with objects that share more than a single dimension (e.g., *orange pumpkins* or *furry dogs*). We suspect that under such circumstances, infants would map nouns to object categories and not object properties. However, the influence of novel adjectives in such

cases is less clear. If infants' expectation for the grammatical form adjective is truly general, then infants should be drawn equally to category- and property-based commonalities. But it is also possible that when more than one potential interpretation is available, as is so often case in the natural course of word learning, infants will prefer to map adjectives to one type of commonality over the other.

In the current experiments, we addressed these issues by asking whether 14-month-old infants could construe the very *same* set of objects (e.g., purple animals) either as members of an *object category* (animal) or as embodying an *object property* (purple) and whether this construal would vary systematically as a function of naming. We familiarized infants in all conditions to precisely the same sets of objects. These objects shared both category membership (e.g., animals) and a salient object property (e.g., color: Experiment 1; texture: Experiment 2).<sup>1</sup>

A second goal of these studies was to bridge a methodological divide between research with infants and preschoolers. During this period, infants advance from producing sparse, single-word utterances (from approximately 9 to 12 months) to creating rich multiword expressions (from approximately 24 months). We have proposed that in the intervening period, infants fine-tune their general word-learning expectations to develop the more specific expectations characteristic of their native language (Waxman, Senghas, & Benveniste, 1997). Unfortunately, however, our view of this transition is clouded, at least in part, by the difficulties of accommodating the very different behavioral capacities of individuals at either end. *Novelty-preference tasks* have been powerful tools with infants, but are less than ideally suited for children beyond 18 months of age, who lose interest in such tasks. Forced-choice *word-extension tasks* form the backbone of research conducted with toddlers and preschoolers, but lack sensitivity with infants under 16 months of age, who often have difficulty choosing systematically among objects.

If researchers are to trace infants' evolving expectations regarding word learning and conceptual organization during this active developmental period, we must develop methods that are within the behavioral repertoires of

<sup>1</sup> Note that this approach is predicated on an assumption that a psychological distinction can be drawn between object categories and object properties. In our view, the distinction between categories and properties is not a sharp one (Goldstone & Barsalou, 1998; Quinn & Eimas, 2000), but that object categories (also known as *kinds*, *natural kinds*, or *sortals*) can be set apart from other types of groupings (e.g., *pink things*, and *things to pull from a burning house*) on three grounds: object categories (1) are richly structured; (2) capture many commonalities, including deep, nonobvious relations among properties (as opposed to isolated properties); and (3) serve as the basis for induction (Barsalou, 1983; Murphy & Medin, 1985). Developmental evidence indicates that despite the fact that infants and children lack detailed knowledge about many object categories, they clearly expect named object categories to serve these three functions (Gelman, 1996; Gelman & Medin, 1993; Keil, 1994).

individuals throughout this transition. We have therefore developed a new method, wedding features of the novelty-preference and word-extension paradigms. We noted that 13-month-old infants' ability to choose objects systematically in a word-extension task is improved greatly if they are first permitted to play with the objects briefly (Waxman & Hall, 1993; Waxman & Markow, 1998; Waxman & Namy, 1997). We capitalize on this finding by engaging infants first in a novelty-preference task, during which time they examine two test objects freely. This free exploration lays the groundwork for their participation in a subsequent word-extension task.

## EXPERIMENT 1

In this experiment, we familiarize 14-month-old infants with objects that are members of the same object category and are painted with the same color (e.g., purple horses). The goals were (1) to identify the conditions under which learners construe the very same set of objects (e.g., purple horses) either (a) as members of an object category (horses) or (b) as embodying an object property (e.g., purple), (2) to observe the influence of naming on these construals, and (3) to determine the feasibility of collecting novelty-preference and word-extension data from 14-month-olds.

### Method

#### *Participants*

Forty-eight infants (19 male and 29 female) with a mean age of 14.0 months (range = 13.4 to 14.7 months) were recruited from a population of middle-class families in the greater Chicago area. All were in the process of acquiring English as a native language. Infants who made clear choices on at least 75% of the word-extension trials (described below) were included in the final sample. Fourteen additional infants were excluded, 12 for failing to reach this criterion, and 2 due to experimenter error.

#### *Materials*

The materials included 52 small commercially manufactured toys, ranging in size from 5.5 to 19 cm. These were selected to form four different sets of 13 objects each (see Table 1 for an example and Appendix A for a complete list). For each set, during familiarization, half of the infants saw four discriminably different objects drawn from the same basic-level category (e.g., four purple horses) while the remaining infants saw four different objects drawn from the same superordinate-level category (e.g., four different purple animals). We included both basic and superordinate-level categories in an effort to ascertain whether infants' expectations for word meaning were influenced by the perceptual and/or conceptual similarity among category members. For each set, there were two types of test pairs, both of which pitted a familiar (e.g., a purple horse) against a novel object. For *Property* test pairs, the novel object was drawn from the same category as the familiarization objects, but had a novel property (e.g., a blue horse). For *Category* test pairs, the novel object had the same property as the familiarization objects, but was drawn from a novel category (e.g., a purple plate).

TABLE 1  
A Representative Set of Objects in Experiment 1 and Experiment 2

	Familiarization		Contrast		Test	
	Trial 1	Trial 2	Distractors	Target	Category	Property
Experiment 1: Color Basic	2 Purple horses	2 Purple horses	Orange carrot	Purple horse	Purple horse vs purple plate	Purple horse vs blue horse
Superordinate	2 Purple animals (bear and lion)	2 Purple animals (elephant and dog)	Brown rolling pin	Purple dog		
Experiment 2: Texture Basic	2 Rough horses	2 Rough horses	Smooth pepper	Rough horse		
Superordinate	2 Rough animals (bear and lion)	2 Rough animals (elephant and dog)	Smooth rolling pin	Rough dog	Rough horse vs rough plate	Rough horse vs smooth horse

*Insuring against a priori preferences among test objects.* In an independent control study, 17 additional infants examined each test pair, in counterbalanced order, for 20 s and were subsequently asked, "Can you give me one?" There were no preferences between test objects. Thus, any preferences that emerge in the experiment proper can be attributed to the experimental manipulations.

### Procedure

Infants were tested individually in a laboratory playroom. They sat in an infant-seat, directly across from the experimenter. Parents, who were seated behind their infants, completed the MacArthur Communicative Development Inventory during the experimental session. Parents were instructed not to talk (either to the infant or the experimenter) or to influence in any way the infant's attention. Sessions lasted approximately 15 min and were videotaped for later coding.

The procedure included three distinct phases: familiarization phase, contrast phase, and test phase (see Tables 1 and 2). Each infant completed this procedure with four different sets of objects that were presented in one of two orders. Two basic-level set versions and two superordinate-level set versions were presented to each infant, with an equal number of infants seeing basic-level and superordinate-level sets first. The level of each set presented was counterbalanced within conditions. Twenty-four infants were randomly assigned to either a Noun or an Adjective condition. Infants in both conditions heard infant-directed speech. The conditions differed only in the syntactic context in which the novel words were presented (see below). Within each condition, half of the infants were presented with Property test pairs throughout while the other half were presented with only Category test pairs.

*Familiarization phase.* The experimenter introduced infants to two familiarization objects at a time. In the Noun condition, the experimenter introduced each pair, saying, "These are *blickets*." After 10 s had elapsed, she pointed to each individual within the pair, saying, "This one is a *blicket* . . . and this one is a *blicket*." After another 10 s had elapsed, she removed the first pair and presented the second in precisely the same fashion. In the Adjective condition, she presented each pair saying, "These are *blickish*." After 10 s had elapsed, she pointed to each individual saying, "This one is *blickish* . . . and this one is *blickish*." Infants manipulated the objects freely throughout familiarization.

*Contrast phase.* Next, the experimenter presented a new object (e.g., an orange carrot), drawn from a contrastive object category and embodying a contrastive object property. She shook her head solemnly and said either "Uh oh! This one is not a *blicket*" (Noun condition)

TABLE 2  
A Representative Set of Introductory Phrases in Experiment 1 and Experiment 2

Condition	Familiarization: Trials 1 and 2	Contrast	Test	
			Novelty preference	Word extension
Noun	These are blickets. This one is a blicket and this one is a blicket	Uh-oh, this one is not a blicket!	Look at these!	This one is a blicket. Can you give me the blicket?
Adjective	These are blickish. This one is blickish and this one is blickish.	Uh-oh, this one is not blickish!	Look at these!	This one is blick- ish. Can you give me the blickish one?



or “Uh oh! This one is not *blickish*” (Adjective condition). She then re-presented a target object drawn from the original set of familiarization objects (e.g., a purple horse) and happily exclaimed, “Yay, this one is a *blicket*” (Noun condition) or “Yay, this one is *blickish*” (Adjective condition). She placed this target object in front of the infant. She then outstretched her palm and asked, “Can you give me the *blicket*?” (Noun condition) or “Can you give me the *blickish* one?” (Adjective condition).

*Test phase.* Infants in all conditions were presented with a familiar object (e.g., a purple horse) and a novel object. For half of the infants in each condition, this was a member of a novel object category, but embodied the now-familiar property (e.g., a purple plate). This constituted a Category test. For the remaining infants, the novel object was a member of the now-familiar object category, but embodied a novel object property (e.g., a blue horse). This constituted a Property test.

Using these test objects, each infant completed a novelty-preference task followed immediately by a word-extension task. Both tasks involved the same two test objects. To assess *novelty preference*, the experimenter placed the test pair easily within the infant’s reach, saying, “Look at these.” No labels were provided. Infants manipulated these objects freely. After 20 s had elapsed, the experimenter retrieved the test pair. Next, to assess *word extension*, she presented a target object, drawn from the set of familiarization objects (e.g., a purple horse) and drew attention to it by pointing and saying, “This one is a *blicket*” (Noun condition) or “This one is *blickish*” (Adjective condition). She then presented the two test objects, placing them easily within the infant’s reach, approximately 30 cm apart, saying, “Can you give me the *blicket*?” (Noun condition) or “Can you give me the *blickish* one?” (Adjective condition).

For each set of objects, infants completed the familiarization, contrast and test phases. Then, the contrast and test phases were repeated. On this second round, a new contrast object was presented, but the same two test objects were re-presented, with their left–right placement reversed (see Appendix A).

## Coding

The videotaped sessions were transcribed with the sound removed to insure that the coders, who were blind to the experimental hypotheses, were also blind to condition assignment. We developed the following measures.

*Novelty preference.* We coded infants’ attention to each test object. This measure, which includes time spent looking at and/or actively manipulating objects (e.g., banging and mouthing), correlates highly with looking time (Waxman, 1999; Ruff, 1986). We computed novelty preference for each infant on each set, dividing attention devoted to the novel test object by the attention devoted to the novel and familiar test objects. Scores greater than .50 signify a preference for the novel object.<sup>2</sup>

*Word extension.* We calculated the proportion of trials on which an infant selected the familiar test object. The probability of selecting the familiar test object by chance on each trial is .50. We also developed a more stringent measure, calculating the proportion of sets on which infants *consistently* selected the familiar object on *both* the first and second trials for a given target. The probability of making *consistently familiar* selections is .25 (.50 on Trial 1  $\times$  .50 on Trial 2).

A primary coder rated all of the infants. A second coder independently rated eight infants, four per condition. For novelty preference, consistency between coders, computed for each trial

<sup>2</sup> For the purposes of analysis, we considered infants’ attention on the first test trial per set only. Recall that in each set, the objects presented on the second test trial were identical to those presented on the first. Therefore, by second trial, neither test object could be considered novel.

and then averaged across trials, was 98.6%. For word extension, consistency was computed as the proportion of the trials on which the coders agreed. Agreement was 100%.

## Predictions

If infants distinguish between novel words presented as count nouns versus adjectives, and if this distinction is recruited in word learning, then infants should display different patterns of behavior in the Noun and Adjective conditions.

### *Noun Condition*

If novel count nouns focus infants' attention on the category-based, rather than the property-based, commonalities among objects, then we have the following:

1. On the *novelty-preference task*, infants should reveal novelty preferences on *Category* test trials, where the novel test object (e.g., purple plate) is a member of a new object category and the familiar test object (e.g., purple horse) is a member of the now-familiar object category. On *Property* test trials, where both the novel and familiar test objects (e.g., blue horse and purple horse) are drawn from the now-familiar category, infants should reveal no novelty preferences.
2. On the *word-extension task*, infants presented with *Category* test trials should switch their preferences, selecting the familiar test object (e.g., purple horse) over the novel test object (e.g., purple plate). On *Property* test trials, where both test objects are members of the now-familiar object category (e.g., purple horse and blue horse), infants should perform at chance levels.

### *Adjective Condition*

If novel adjectives focus infants' attention on both category- and property-based commonalities among objects, then we have the following:

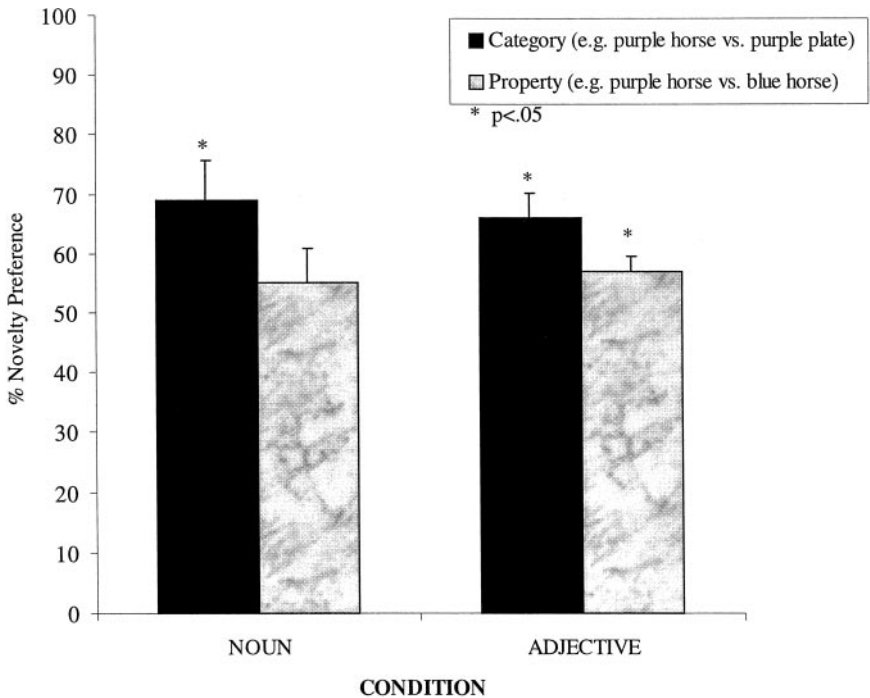
1. On the *novelty-preference task*, infants should reveal novelty-preferences on both *Category* and *Property* test trials.
2. On the *word-extension task*, infants should be equally likely to extend novel adjectives to the familiar or novel test object on both *Category* and *Property* test trials.

## Results and Discussion

### *Language Inventory*

Infants' mean production vocabulary was 15 words, ranging from 0 to 67; their mean comprehension vocabulary was 104 words, ranging from 20 to 241. Production and comprehension were significantly correlated [ $r(46) = .41$ ;  $p < .01$ ].<sup>3</sup>

<sup>3</sup> Although we scheduled only infants whose parents reported (via telephone interview) that their infant produced more than two words, the more thorough examination based on the MCDI revealed that some of the infants may actually have produced fewer. In both Experiment 1 and 2, these infants' performed comparably to others in their respective conditions.



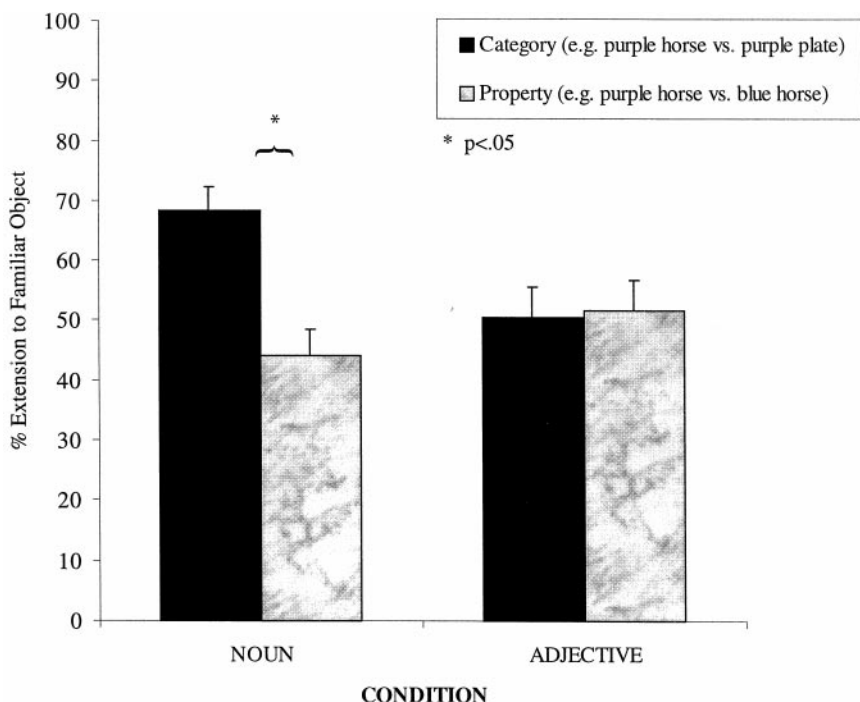
**FIG. 1.** Mean novelty-preference scores as a function of condition and test type for Experiment 1 (color). Asterisks indicate comparisons to chance responding (.50).

### *Novelty-Preference Task*

Infants in the Noun condition revealed reliable novelty preferences on Category trials [ $M = .69$ ;  $t(11) = 4.95$ ,  $p < .001$ ], but not on Property trials [ $M = .55$ ;  $t(11) = .86$ ,  $ns$ ] (Fig.1). This is consistent with the prediction that infants hearing novel count nouns would attend to category-based, rather than to property-based, commonalities among the objects presented during familiarization. In contrast, infants in the Adjective condition revealed reliable novelty preferences on both Category [ $M = .66$ ;  $t(11) = 3.89$ ,  $p < .005$ ] and Property [ $M = .57$ ;  $t(11) = 2.51$ ,  $p < .05$ ] trials. This is consistent with the prediction that infants hearing novel adjectives attended to both category- and property-based commonalities.

### *Word-Extension Task*

Infants made clear selections on 92% of their trials. The results are depicted in Fig. 2. We analyzed infants' tendency to select the familiar test object using an ANOVA with Condition (2: Noun versus Adjective) and Test-type (2: Category versus Property) as between-participants factors and Level (2: Basic versus Superordinate) as a within-participants factor. A main



**FIG. 2.** Mean percentage of word-extension test trials on which the familiar object was chosen as a function of condition and test type for Experiment 1 (color). Asterisks indicate comparisons to chance responding (.50).

effect of Test-type [ $F(1, 44) = 4.97, p < .02$ ] indicated that infants were more likely to select the familiar test object on Category trials ( $M = .59$ ) than on Property trials ( $M = .48$ ). This was qualified by a crossover interaction between Condition and Test-type [ $F(1, 44) = 6.32, p < .01$ ]. As predicted, infants were more likely to extend nouns to the familiar test object on Category trials ( $M = .68$ ) than on Property trials ( $M = .44$ , Fisher's LSD,  $p = .001$ ). Infants were equally likely to extend adjectives to the familiar test object on Category ( $M = .50$ ) and Property trials ( $M = .52$ ). There were no effects for Level, suggesting that infants' expectations for the extensions of novel words were equally strong whether they were presented with basic- or superordinate-level category members. A second ANOVA, based on infants' tendency to *consistently* select the familiar test object on both the first and second test trials for a given set, yielded precisely the same effects.<sup>4</sup>

<sup>4</sup> With this more stringent measure, the main effect of Test-type [ $F(1, 43) = 13.0, p < .01$ ] and the crossover interaction between Condition and Test-type [ $F(1, 43) = 6.22, p < .02$ ] held up. Infants were more likely to consistently extend nouns to the familiar object on Category trials ( $M = .46$ ) than on Property trials ( $M = .08$ , Fisher's LSD,  $p < .001$ ). Infants'

## Discussion

By 14 months of age, naming influences infants' construal of the very *same* set of objects (e.g., purple animals), as either members of an object category (e.g., animals) or as embodying an object property (e.g., purple). Infants hearing novel count nouns focused specifically on category-based commonalities among objects while those hearing novel adjectives focused on both types of commonalities. Performance on the novelty-preference portion of the task replicates previous work (Waxman & Markow, 1995; Waxman, 1999) and extends it to include circumstances in which both category- and property-based commonalities were present in the familiarization objects. Moreover, the current experiment documents for the first time that infants' expectations can be measured reliably in word-extension as well as novelty-preference tasks. The convergence between these two measures is striking.

We next ask whether these effects hold up for object properties other than color. We had selected color as our first test case because developmental work confirms that infants perceive color in much the same way as do adults (Bornstein, Kessen, & Weiskopf, 1976) and because across languages, color terms are almost universally marked as adjectives (Dixon, 1982). Nonetheless, there is reason to suspect that infants' performance with color may not be broadly representative of their performance with other object properties. For example, infants' ability to use color to reason about object individuation lags behind their ability to use other properties (e.g., pattern) in the same task (Wilcox, 1999). In addition, a review of early lexical acquisition reveals that in general, infants acquire color terms later than many other property terms (Bornstein, 1985; Fenson et al., 1994). These observations raise the possibility that mapping adjectives specifically to color may be more difficult than mapping adjectives to other properties.

## EXPERIMENT 2

The goal was to seek additional evidence for the influence of novel words on infants' construal of objects, using texture, rather than color, as a target property. We expected that performance in the Noun condition would replicate that of Experiment 1, with count nouns directing attention to category-based, rather than property-based, commonalities (here, texture). We considered two possible outcomes for performance in the Adjective condition. If a specific expectation linking adjectives to property-based commonalities emerges in parallel for color and texture, then performance in Experiments 1 and 2 should be comparable. However, if a specific link for adjectives is

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tendency to extend adjectives to the familiar test object did not differ on Category ( $M = .24$ ) versus Property trials ( $M = .16$ ).

more readily acquired for texture than for color, then infants in the current experiment may reveal a more precocious pattern than infants in Experiment 1: They may map adjectives specifically to property-based commonalities.

## Method

### *Participants*

Sixty-four infants (33 males and 31 females) with a mean age of 14.1 months (range = 13.5 to 14.7 months) were recruited from the same population as in Experiment 1. All were in the process of acquiring English as a native language. An additional 5 infants were excluded from the final sample, 4 for failing to make clear choices on at least 75% of their word-extension trials, and 1 due to a major interruption during testing.

### *Materials*

See Table 1 and Appendix A.

*Insuring against a priori preferences among test objects.* Twenty-four additional infants participated in an independent control task in which no novel words were introduced. There was no difference between infants' performance on Category versus Property test trials on either the novelty-preference or word-extension measure.<sup>5</sup> Thus any differences that emerge in the experiment proper can be attributed to the introduction of novel words.

### *Procedure*

Identical to Experiment 1.

## Results and Discussion

The results of this experiment replicate the finding that by 14 months of age, naming influences infants' construal of the same set of objects (e.g., rough animals), either as members of a common object category (e.g., animals) or as instances of a common object property (e.g., rough things).

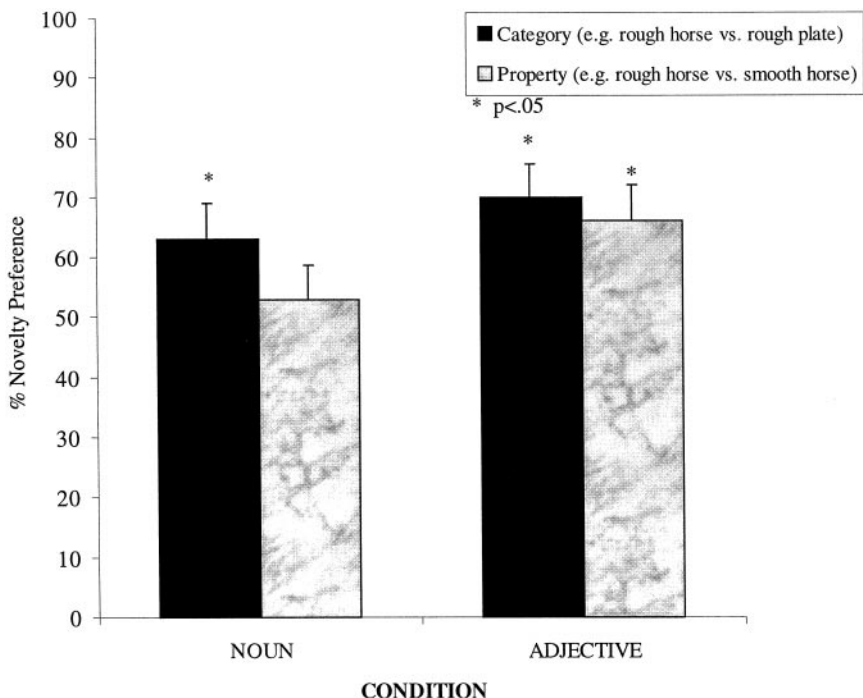
### *Language Inventory*

Infants revealed a mean production vocabulary of 14 words, ranging from 0 to 77, and a mean comprehension vocabulary of 122 words, ranging from 22 to 292. Production and comprehension vocabularies were significantly correlated [ $r(86) = .32$ ;  $p < .01$ ].

### *Novelty Preference*

As predicted, and as in Experiment 1, infants in the Noun condition revealed reliable novelty preferences on Category test trials only [ $M = .63$ ;

<sup>5</sup> Infants' revealed reliable novelty preferences on both Category [ $M = .62$ ;  $t(11) = 2.35$ ,  $p < .05$ ] and Property [ $M = .68$ ;  $t(11) = 4.01$ ,  $p < .005$ ] test trials, suggesting that both the category- and property-based commonalities were salient. Infants' tendency to select the familiar object did not differ from chance (50%) on either Category ( $M = .47$ ) or Property ( $M = .44$ ) test trials.

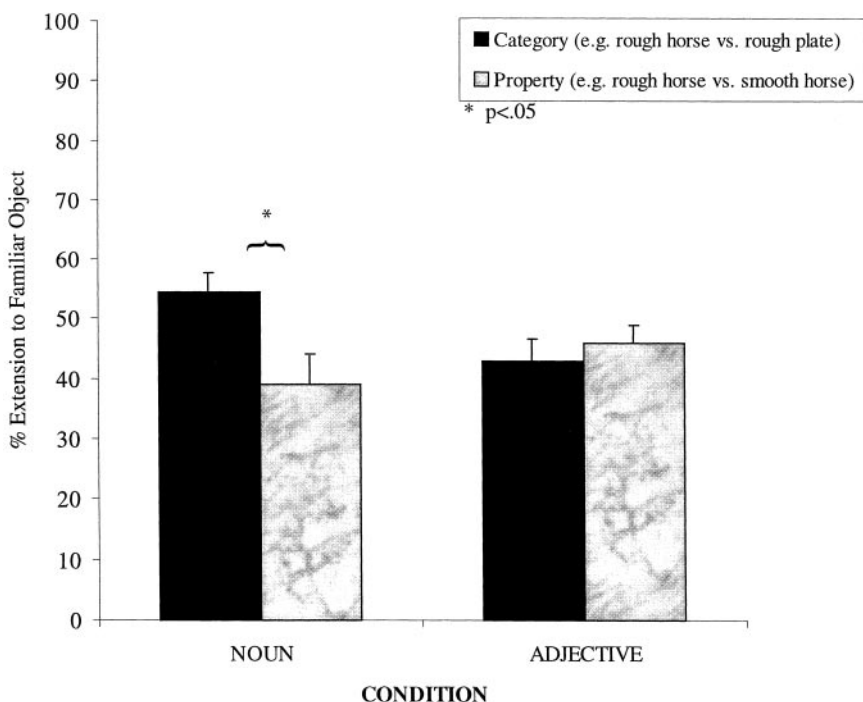


**FIG. 3.** Mean novelty-preference scores as a function of condition and test type for Experiment 2 (texture). Asterisks indicate comparisons to chance responding (.50).

$t(15) = 2.51, p < .025$ ) (Fig. 3). On Property test trials, where both test objects were members of the now-familiar object category (e.g., horses), they revealed no preference [ $M = .53; t(15) = .59, ns$ ]. This suggests that novel nouns direct infants' attention specifically toward category-based commonalities. Performance in the Adjective condition also mirrored that of Experiment 1. Infants hearing adjectives produced reliable novelty preferences on both Category [ $M = .70; t(15) = 4.04, p < .005$ ] and Property [ $M = .66, t(15) = 3.17, p < .01$ ] test trials. This is consistent with the prediction that novel adjectives highlight both category- and property-based commonalities among objects.

#### Word Extension Task

Infants made clear choices on 97% of the trials (see Fig. 4). An ANOVA, using infants' tendency to select the familiar test object as a dependent measure (chance = .50), revealed a Condition (Noun versus Adjective) by Test-type (Category versus Property) crossover interaction [ $F(1, 60) = 4.39, p < .05$ ]. As in Experiment 1, infants were more likely to extend nouns to the familiar test object on Category trials ( $M = .55$ ) than on Property trials



**FIG. 4.** Mean percentage of word-extension test trials on which the familiar object was chosen as a function of condition and test type for Experiment 2 (texture). Asterisks indicate comparisons to chance responding (.50).

( $M = .39$ , Fisher's LSD,  $p < .02$ ). Infants' tendency to extend adjectives to the familiar test object did not differ as a function of Test-type (Category trials:  $M = .43$ ; Property trials,  $M = .46$ ). This outcome replicates the results of Experiment 1.

A second ANOVA, using infants' tendency to *consistently* select the familiar object (e.g., purple horse) on both extension trials for a given set (chance = .25), revealed a crossover interaction between Condition and Test-type [ $F(1, 82) = 6.41$ ,  $p < .01$ ]. As predicted, and as in Experiment 1, infants in the Noun condition were more likely to consistently select the familiar objects on Category trials ( $M = .28$ ) than on Property trials ( $M = .11$ , Fisher's LSD,  $p < .02$ ). However, performance in the Adjective condition suggested a more precocious pattern than exhibited in Experiment 1. Infants in the current experiment were more likely to consistently extend a novel adjective to the familiar test object on Property trials ( $M = .24$ ) than on Category trials ( $M = .08$ , Fisher's LSD,  $p < .02$ ). Because this pattern did not emerge in any other analysis, it should certainly be interpreted with caution. Nonetheless, because it is consistent with the possibility that the specific



mappings linking adjectives to texture emerge earlier than those linking adjectives to color, this outcome warrants further investigation (Waxman, Booth, & Czernecki, submitted).

## GENERAL DISCUSSION

An important feature of human language is that words from different grammatical categories (e.g., count nouns and adjectives) highlight different aspects of a given scene (e.g., object categories and object properties). We have asked whether infants in the process of acquiring language are sensitive to this phenomenon. We focused on 14-month-old infants who had begun to produce at least a few words on their own and had established modest receptive lexicons. Previous work using the novelty-preference paradigm indicated that at this developmental moment, infants have begun to distinguish novel words presented as count nouns from those presented as adjectives and that they treat these as relevant to word learning, with novel nouns directing infants' attention specifically to category-based commonalities among objects, but novel adjectives directing attention more broadly to category- and property-based commonalities (Waxman & Markow, 1995; Waxman, 1999).

The experiments reported here provide a stronger test of infants' sensitivity to grammatical form distinctions and their links to meaning. We sought to discover whether 14-month-olds could actively recruit their emerging grammatical distinctions when extending novel words or whether these distinctions had a more limited effect, influencing behavior only in a passive, novelty-preference task. We also asked whether infants could construe the very *same* set of objects (e.g., four purple animals) either as members of an *object category* (e.g., animals) or as embodying a salient *object property* (e.g., purple things) and to ascertain whether naming these objects (with either count nouns or adjectives) influenced their construals. A third goal was largely promissory: If we are to trace the evolution of infants' expectations, we must first establish a method that falls within the behavioral repertoire of infants ranging from about 9 to 12 months of age (when they first begin to produce words) to about 24 to 30 months of age (when they create rich, syntactically complex multiword expressions). We developed a task that includes both a novelty-preference component (so successfully employed with infants) and a word-extension component (so successfully employed with toddlers and preschoolers). This task appears to be well suited for individuals throughout this important transition.

The results of the experiments using this task make several new contributions. First, the evidence from the novelty-preference and word-extension portions of this task converges well. This documents, for the first time, that infants' expectations for novel words not only influence their attention to objects in passive, novelty-preference tasks, but also are actively recruited

in the service of extending novel words to additional objects. Second, these results suggest that infants share with more mature language-users an expectation that different types of words will highlight different aspects (i.e., common category or common property) of the very same sets of objects (e.g., four purple animals). Infants hearing the objects described with novel count nouns attended specifically to category-based commonalities. In contrast, infants hearing the same objects described with novel adjectives apparently attended to a wider range of commonalities, focusing on both category- and property-based commonalities (color: Experiment 1; texture: Experiment 2).

The current results also open several avenues for future research. One set of questions concerns infants' early grammatical form distinctions. The difference between performance in the Noun and Adjective conditions confirms that 14-month-olds have indeed begun to distinguish among (at least some) grammatical forms in fluent, infant-directed speech (cf, Morgan & Demuth, 1996). But it does not pinpoint which cues in the speech signal permit infants to make this distinction. Neither do the current experiments specify the breadth of infants' emerging grammatical form distinctions. One possibility is that infants at 14 months distinguish count nouns specifically from adjectives. It is also possible that infants make a considerably more general "cut," distinguishing, for example, nominals (including count, mass, and proper nouns) from predicate forms (including adjective and verbs), but making no finer distinctions within these two broad form classes. The answer to these questions must await supplementary evidence, using additional grammatical forms (e.g., mass nouns and verbs) and additional kinds of relations among objects.

Another set of questions centers around infants' mappings from grammatical forms to meaning. The current results leave little doubt that 14-month-olds have discovered that count nouns map specifically to object categories (and not to object properties). The current results also indicate that infants' expectations for the grammatical form *adjective* do not yet match those of the adult language. However, capturing the precise characterization of infants' mappings for adjectives has proven somewhat elusive. We have interpreted the evidence as suggesting that infants map novel adjectives to a rather broad range of commonalities, including the category- and property-based commonalities present in the familiarization objects.

What remains unclear, however, is whether infants impose any boundary conditions or constraints on the types of commonalities to which adjectives may refer. There are two logical possibilities. First, it is possible that 14-month-old infants' expectation for novel adjectives is relatively unconstrained. If this is the case, they should extend novel adjectives willingly to additional types of commonalities among objects, including, for example, common motions in which objects are engaged or common contexts in which they tend to appear. However, it is also possible that by 14 months, infants impose principled boundary conditions or constraints on the extension of

novel adjectives. If this is the case, then infants may fail to extend novel adjectives to commonalities beyond those that are category- or property-based. An examination of the adult grammar lends an intriguing plausibility to the second alternative. The grammatical form *adjective* is predicated on the existence of a noun (but not on the existence of a verb, a preposition, etc.). As a result, any adjectival expression invokes (either implicitly or explicitly) a corresponding nominal (see Dixon, 1982; Prasada, 1992; or Waxman et al., 1997, for a fuller discussion). If 14-month-olds are sensitive to this convention, then although the instructions in the Adjective condition do not explicitly include a category name (e.g., a count noun), infants hearing novel adjectives might presuppose the existence of such a noun and, as a consequence, might extend novel adjectival phrases to *what a thing is* and *what property it embodies*. On this account, infants should be unlikely to license the extension of adjectives beyond category- and property-based commonalities. Teasing apart these alternatives will depend on broadening the current line of investigation to include commonalities other than those underlying object categories and object properties.

An independent question concerns the *interactions* among the commonalities that infants link to novel adjectives. Based on the current data, it is clear that 14-month-olds link adjectives to (at least) two types of commonalities among designated objects. What remains to be seen is whether adjectives highlight each of these commonalities independently (i.e., adjectives are mapped to objects that are either *animals* or *purple things*, respectively) or whether adjectives highlight the conjunction of these commonalities (i.e., adjectives are mapped to objects that incorporate both category- and property-based commonalities: *purple animals*). This latter alternative would be consistent with the possibility that infants interpret adjectival expressions as referring to something akin to subordinate level categories (Waxman, 1990; Klibanoff & Waxman, 2000). We are currently pursuing this question in our laboratory, using a design in which we directly pit category-based commonalities against property-based commonalities at test (Waxman & Booth, 2000).

Perhaps the most compelling goal for future work will be to trace the evolution of infants' expectations from the very onset of word learning through toddlerhood. Although the current experiments focus on infants at one developmental moment, our predictions regarding the evolution of their word-learning expectations is clear. We have proposed that infants begin the task of lexical acquisition with a general expectation that novel open class words (in general) direct attention to commonalities among objects (in general). If this is the case, then infants at the very onset of lexical acquisition should reveal more general expectations than those exhibited at 14 months: They should notice the introduction of novel words (Balaban & Waxman, 1997; Jusczyk, 1997), but fail to distinguish among them on the basis of grammatical form. Preliminary evidence from our laboratory is consistent

with this prediction: At 11.5 months, infants hearing either novel nouns or novel adjectives focus on both category- and property-based commonalities among objects (Waxman & Booth, in press). In contrast, we predict that more advanced language learners will have acquired a more specific set of expectations than the 14-month-olds. If this is the case, then older infants acquiring English should not only map count nouns specifically to category-based commonalities, they should also map adjectives specifically to property-based commonalities. Preliminary evidence from 24-month-old infants appears to be consistent with this prediction as well (Waxman & Booth, in preparation).

Bolstered by the current evidence, let us return to the question we posed at the outset. What expectations, if any, do infants recruit in the process of mapping their first words to the objects and events they perceive in the world? We have argued (1) that infants begin the task of word learning with a broad initial expectation that links novel open class words (independent of their grammatical form) to commonalities among named objects<sup>6</sup> and (2) that this initial expectation is subsequently fine-tuned as infants gain experience with the specific correlations between particular grammatical forms and their associated meanings in the native language (Waxman, 1999; Waxman & Booth, 2000; Waxman & Markow, 1995). We propose that this initially general expectation guides infants' first word-to-world mappings and supports the early establishment of reference. The infant's growing lexicon can then serve as the foundation upon which infants begin to notice correlations between particular types of words and particular types of relations among objects. In this way, infants' initially general expectation sets the stage for more specific expectations, calibrated in accordance with the correlations between form and meaning in the language under acquisition.

Our proposal offers several important advantages. First, we argue that infants' expectations are inherently dynamic, evolving over the course of acquisition in accordance with the observable regularities between form and meaning in the language under acquisition. Second, this view does not require infants at the very onset of lexical acquisition to be able to identify instances of particular grammatical categories (e.g., nouns, adjectives, and verbs). This is important because the grammatical categories are not marked universally or transparently in the input. There are no stress patterns, affixes, or sentential positions associated universally with any of the grammatical forms (Pinker, 1984). Thus, in our proposal, as in most theories of language acquisition, the very ability to identify specific grammatical categories, as instantiated in the native language, is itself a developmental achievement.

<sup>6</sup> This general expectation may stem from several sources. Perhaps infants have not yet successfully distinguished count nouns from adjectives in the input (see Mintz, Newport, & Bever, under review) or perhaps they have not yet noticed the correlation between count nouns and category-based commonalities.

A related advantage is that this proposal is flexible enough to account for the fact that infants naturally acquire a wide range of human languages and that these differ in the ways in which they recruit the particular grammatical forms to convey particular types of meaning. In our proposal, specific links between particular forms and their associated meanings are calibrated on the basis of correlations or regularities that are present in the language under acquisition. It therefore stands to reason that these more specific links would not be available from the start, but instead would emerge from the general expectation, once the process of lexical acquisition is underway.

Finally, to return to the evidence reported here, we have demonstrated that as infants induce these more specific links, they first distinguish the nouns (from among the other grammatical forms) and map them to object categories (from among the other kinds of commonalities). This interpretation accords well with current theories of language acquisition. Despite considerable debate on a wide range of issues, most agree on one fundamental point: that the grammatical category *noun* may be established earlier than other grammatical categories (Gentner, 1982; Huttenlocher & Smiley, 1987; Tomasello & Olguin, 1993; Valian, 1986) and, more provocatively, that the acquisition of the other grammatical categories may depend crucially on the prior acquisition of nouns (Dixon, 1982; Gleitman, 1990; Gillette, Gleitman, Gleitman, & Lederer, 1999; Grimshaw, 1994; Maratsos, 1998; Pinker, 1984; Talmy, 1985; Wierzbicka, 1986; Waxman, 1999).

APPENDIX A  
Complete Sets of Stimuli for Experiment 1

Group	Familiarization		Contrast		Test	
	Trial 1	Trial 2	Distractors	Target	Category	Property
Purple Basic	2 Purple horses	2 Purple horses	Orange carrot	Purple horse		
Superordinate	2 Purple animals (bear and lion)	2 Purple animals (elephant and dog)	Brown rolling pin	Purple dog	Purple horse vs purple plate	Purple horse vs blue horse
Yellow Basic	2 Yellow ducks	2 Yellow ducks	Blue cup	Yellow duck		
Superordinate	2 Yellow animals (cat and lion)	2 Yellow animals (fish and ele- phant)	Brown hat	Yellow lion	Yellow duck vs yellow spoon	Yellow duck vs pink duck
Green Basic	2 Green cars	2 Green cars	Pink cat	Green car		
Superordinate	2 Green vehicles (boat and plane)	2 Green vehicles (helicopter and truck)	Yellow banana	Green truck	Green car vs green frog	Green car vs black car
Red Basic	2 Red apples	2 Red apples	Purple boot	Red apple		
Superordinate	2 Red fruits (grapes and tomato)	2 Red fruits (pear and strawberry)	Silver pot	Red tomato	Red apple vs red hammer	Red apple vs green apple

APPENDIX B  
Complete Sets of Stimuli for Experiment 2

Group	Familiarization		Contrast		Test	
	Trial 1	Trial 2	Distractors	Target	Category	Property
Rough Basic	2 Rough horses	2 Rough horses	Smooth pepper	Rough horse		
Superordinate	2 Rough animals (bear and lion)	2 Rough animals (elephant and dog)	Smooth rolling pin	Rough dog	Rough horse vs rough plate	Rough horse vs smooth horse
Plush Basic	2 Plush ducks	2 Plush ducks	Hard cup	Plush duck		
Superordinate	2 Plush animals (rabbit and bear)	2 Plush animals (dog and butterfly)	Hard hat	Plush dog	Plush duck vs plush spoon	Plush duck vs hard duck
Bumpy Basic	2 Bumpy cars	2 Bumpy cars	Cloth carrot	Bumpy car		
Superordinate	2 Bumpy vehicles (plane and convertible)	2 Bumpy vehicles (helicopter and truck)	Smooth wrench	Bumpy truck	Bumpy car vs bumpy frog	Bumpy car vs smooth car
Ribbed Basic	2 Ribbed apples	2 Ribbed apples	Burlap block	Ribbed apple		
Superordinate	2 Ribbed fruits (pepper and tomato)	2 Ribbed fruits (pear and strawberry)	Metal pot	Ribbed tomato	Ribbed apple vs ribbed hammer	Ribbed apple vs smooth apple

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