

Words as Invitations to Form Categories: Evidence from 12- to 13-Month-Old Infants

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Recent research has documented specific linkages between language and conceptual organization in the developing child. However, most of the evidence for these linkages derives from children who have made significant linguistic and conceptual advances. We therefore focus on the emergence of one particular linkage—the noun-category linkage—in infants at the early stages of lexical acquisition. We propose that when infants embark upon the process of lexical acquisition, they are initially biased to interpret a word applied to an object as referring to that object and to other members of its kind. We further propose that this initial expectation will become increasingly specific over development, as infants begin to distinguish among the grammatical categories as they are marked in their native language and assign them more specific types of meaning. To test this hypothesis, we conducted three experiments using a modified novelty-preference paradigm to reveal whether and how novel words influence object categorization in 12- to 13-month old infants. The data reveal that a linkage between words and object categories emerges early enough to serve as a guide in infants' efforts to map words to meanings. Both nouns and adjectives focused infants' attention on object categories, particularly at the superordinate level. Further, infants' progress in early word learning was associated with their appreciation of this linkage between words and object categories. These results are interpreted within a developmental and cross-linguistic account of the emergence of linkages between linguistic and conceptual organization. © 1995 Academic Press, Inc.

Questions concerning the relation between language and conceptual organization have long been a topic of vigorous debate. The notion that language may serve as a catalyst for the acquisition of particular concepts has been one focus of this debate. Some of the most exciting current work on this topic has been

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designed to explore the relation between early linguistic and conceptual development. Researchers have begun to ask whether children direct their attention differently in the context of word learning than in other, non-linguistic contexts. To answer this question, researchers have compared children's performance with, and without, novel labels. Several important findings have emerged and several linkages between linguistic and conceptual organization have been proposed (See Markman, 1991 or Waxman, 1991 for a review). In this article, we focus on the emergence of one such linkage—the noun-category linkage—in infants at the initial stages of lexical acquisition.

A brief summary of the evidence documenting this linkage between nouns and object categories will set the stage for our inquiries with infants. In a seminal paper, R. Brown (1957) demonstrated that school-aged children use the grammatical form of a novel word to determine some aspects of its meaning. Subjects in Brown's experiment interpreted novel count nouns (e.g., "Show me a *sib*.") as referring to solid objects; they interpreted novel mass nouns (e.g., "Show me some *sib*.") as referring to substances; they interpreted novel verbs (e.g., "Show me *sibbing*.") as referring to actions.

These finely tuned linkages, in which *particular* types of linguistic units (e.g., nouns) highlight *particular* types of conceptual relations (e.g., object categories), have now been revealed in younger children as well (Gleitman, Gleitman, Landau & Wanner, 1986; Hall, Waxman & Hurwitz, 1993; Katz, Baker, & Macnamara, 1974; Landau & Gleitman, 1985; Markman, 1994; Naigles, 1990). For example, by 2 to 3 years of age, children interpret novel count nouns as referring to categories of objects at the basic and superordinate level (D'Entremont & Dunham, 1992; Markman & Hutchinson, 1984; Soja, Carey, & Spelke, 1991; Waxman & Gelman, 1986; Waxman & Kosowski, 1990). However, when children are introduced to novel adjectives, they exhibit a different pattern: they interpret novel adjectives as referring to properties of objects (e.g., color; texture; size) and to subordinate level conceptual distinctions (Gelman & Markman, 1985; Hall, et al., 1993; Prasada, 1992; Taylor & Gelman, 1988; Waxman, 1990). The fact that novel nouns and adjectives each produce distinct and systematic effects reveals that preschool-aged children are not only sensitive to differences between grammatical categories (e.g., noun vs adjective), but expect grammatical form to be relevant to the establishment of meaning.

These precise linkages between particular types of words and particular types of conceptual relations reveal one important way in which language does indeed influence conceptual organization: When children as young as 2 years of age hear an object labeled, the grammatical form of the label directs their attention to particular aspects of that object. Several researchers have noted the utility of such linkages in children's efforts to map words to their meanings. For although there are a countless number of logically possible interpretations for any given word, young word learners do not sample randomly among them. These linkages between linguistic and conceptual organization help to narrow the range of mean-

ings that children will entertain when seeking to ascribe meaning to a new word (Gleitman, 1990; Hall, 1991; Hall & Waxman, 1993; Markman, 1989; Pinker, 1984; Waxman, 1991). In this way, despite the logical difficulty inherent in the task of word learning, children map novel words successfully to their appropriate meanings.

The claim that linkages like these streamline early word learning and conceptual organization has considerable intuitive appeal. Moreover, the evidence for some of these linkages is quite robust. Nonetheless, this claim has also generated considerable controversy. One locus of controversy concerns the extent to which such linkages are learned or innate (c.f., Behrend, 1990; Nelson, 1988, 1991; Waxman, 1994; Woodward, Markman, & Fitzsimmons, 1994).

Another locus of controversy concerns the *direction* of the mapping between grammar and meaning. Researchers working on this issue share with us an overarching assumption that there are indeed linkages between meaning and grammar (e.g., between nouns and objects or categories of objects; between adjectives and properties of objects), and that these are essential in guiding early development. Some have argued that the initial linkages are from meaning to grammar; others have argued that the initial linkages run in the opposite direction, from grammar to meaning.¹

On the first account, which has been dubbed the semantic bootstrapping hypothesis, preverbal infants depend upon abstract, universal links from meaning to grammatical categories to break into the linguistic system (Grimshaw, 1994; Pinker, 1984, 1994). Infants recruit the meaning-to-grammar linkages to identify particular cases of the grammatical categories in the input. This proposed inference is powerful, for it is meant to provide infants with a way to identify instances of abstract grammatical categories (e.g., nouns, verbs), and in this way to discover the relevant surface cues associated with that grammatical category in the particular language under acquisition. The young language learner is then in a position to take advantage of the syntactic surroundings of a novel word to help them pick out other instances of a given grammatical category, even if the reference is not transparent.

Other researchers have taken the position that the initial direction of the linkage is from grammar to meaning (Fisher, Hall, Rakowitz, & Gleitman, 1994; Gleitman, 1990). On this view, known as the syntactic bootstrapping hypothesis, infants derive the meaning of a word from the grammatical information that is available in the language input. Infants recruit the grammar-to-meaning linkage to discern the meaning of a novel word, especially in cases where meaning cannot be readily derived from observation at the time of the utterance (e.g., verbs). Thus, the young language learner on this account uses the syntactic

¹ It is now apparent that these two positions may be in less direct opposition than they originally appeared (Fisher, in press; Grimshaw, 1994).

frames and argument structure surrounding novel words to help them establish meaning, even in circumstances where this is not transparent.

These different accounts concerning the initial direction of the linkages between meaning and grammar have received considerable research attention, particularly in the current literature on language acquisition. However, in this paper we do not focus on the direction question. Instead, our goal is to discover when these linkages emerge and how they unfold as infants build conceptual categories and establish word meanings. This line of inquiry is especially important because the existing evidence derives primarily from children ranging from 2 to 5 years of age (but see Waxman & Hall, 1993, for evidence with 15-month-old infants), children who have already made significant advances in both the linguistic and conceptual arenas. As a consequence, questions concerning the emergence and role of these linkages in early development remain unanswered. The evidence gleaned from detailed studies with infants on the threshold of language acquisition should inform our theories of both language acquisition and conceptual development.

In this paper, we focus specifically on the emergence of the linkage between nouns and object categories in 12- and 13-month-old infants.² We selected this age group because it is an especially active phase of lexical and conceptual development. It is at this point that most infants begin to produce their first words. This early ability to establish word-referent mappings marks the beginning of an especially dynamic period in language acquisition. From approximately 12 to 17 months, infants add new words to their productive vocabularies at a steady and gradual rate. Then, at approximately 17 to 20 months, the pace increases dramatically. Most infants exhibit a burst in lexical production, adding between four and five new words to their vocabularies per day. Most of the words acquired during this period of rapid lexical acquisition dubbed the vocabulary explosion, refer to categories of objects. This vocabulary explosion typically tapers off at round 24 months, when infants begin to combine words to form phrases (Dromi, 1987; Goldfield & Reznick, 1990; Nelson, 1973). Thus, from (roughly) their first to second birthdays, infants go from making "first words" to "first syntax."

We directed our attention to the noun-category linkage because at least five lines of work suggest that this linkage in particular is likely to play a role in early development across human languages. First, infants focus attention on discrete physical objects and, in the first year of life, develop an elaborate system of

² In this paper, we use count nouns because in English, object kinds are typically marked in this manner. In other languages, object kinds may be marked with different aspects of the noun system. For example, in Japanese, where there is minimal syntactic distinction between mass and count nouns (Imai, Gentner, & Uchida, 1994) object kinds are referred to by nouns, coupled with numeral classifiers. As will become clear in our discussion, we predict that in the initial phases of word learning, count, mass, and proper nouns should have identical effects vis-a-vis object categorization.

knowledge concerning these entities (c.f., Baillargeon, 1993; Spelke, 1990). The fact that infants are so captivated by objects likely provides a firm conceptual foundation for the acquisition of their labels.

Second, infants are especially adept at learning nouns. Longitudinal, cross-sectional, and cross-linguistic studies have revealed that infants' early lexicons consist predominantly of nouns—that is, words that are considered nouns in the adult grammar (Gentner, 1982; Gleitman, 1990; Goldin-Meadow, Seligman, & Gelman, 1976; Huttenlocher & Smiley, 1987; Macnamara, 1982; Nelson, 1973). This preponderance of nouns seems to be evident across languages, despite differences in the frequency and salience of nouns in the input to the infant. For example, in Korean, where verbs are more frequent than nouns in the input, and where verbs (as opposed to nouns) typically occupy the salient phrase-final position, infants' earliest lexicons include more nouns than verbs (Au, Dapretto, & Song, 1994; but see Gopnick & Choi, 1990 for a different position). Of course, this is not to say that young infants fail to learn words from other grammatical categories; clearly they do. Early lexicons also include words like "uh-oh," "hot," "up," and "bye-bye." The point here is simply that infants are particularly successful at mapping nouns to their referents.

Third, cross-linguistic analyses have conferred a special status upon the grammatical category *noun* (c.f., 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 cross-linguistic stability of nouns, members of the *predicate* system (e.g., adjectives, prepositions, verbs) may have a more fluid status across languages. Researchers have noted that, 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; Choi & Bowerman, 1991; Gentner, 1981, 1982; Maratsos, 1991; Maratsos & Chalkley, 1980; Talmy, 1985; Wierzbicka, 1986). Fourth, although mappings between nouns and object categories may be established without recourse to other grammatical categories, this is not the case for predicate classes such as adjectives and verbs which may depend upon noun reference to fix their meanings (Fisher, in press; Gleitman, 1990; Hall, et al., 1993; Maratsos, 1991).

Fifth, recent experimental work suggests that even preverbal infants are especially attentive to words in spoken language (Fernald, 1992). By 8 months of age, infants' patterns of attention reveal that they distinguish between words they have previously been exposed to and those they have not (Jusczyk & Aslin, in press; Newsome & Jusczyk, 1994). Further, words direct infants' attention toward objects (Baldwin & Markman, 1989) and toward categories of objects (Echols, 1992; Markman, 1994; Roberts & Jacob, 1991; Waxman & Hall, 1993).

For example, Waxman and Hall (1993) have shown that 15- and 21-month-old infants are more likely to make category-based selections in a triad task if the target object has been labeled with a novel noun than when no novel words are presented.

Taken together, these cross-linguistic and developmental lines of work converge to suggest that the linkage between nouns and object categories emerges early and universally. We propose that infants embark upon the process of lexical acquisition equipped with a general expectation that a novel word applied to an object will refer to that object and to other members of its kind. We suggest that this initial expectation may be recruited by the infant, independent of grammatical form of the word. The more finely tuned linkages between specific grammatical forms and specific types of meaning could then emerge over the course of development as infants gain experience with the particular language to which they are being exposed.

Notice that in our proposal, infants' initial expectations concerning words and object categories are less specific than the linkages that have been revealed in older children. This raises an important question: How does an appreciation of more finely tuned linkages develop out of an initial, more general expectation? One possibility is that infants actually share with older children an abstract expectation that their language includes distinct grammatical categories that are linked to particular types of meaning (c.f., Gleitman, 1990; Grimshaw, 1994; Pinker, 1994). However, either because processing limitations prevent infants from perceiving the different relevant surface cues for each grammatical category (Fernald, 1992), or because they have not yet learned the relevant surface cues to identify instances of the distinct grammatical categories in the input (c.f., Grimshaw, 1981; Pinker, 1984), or because of issues related to familiarity with existing labels (c.f., Hall et al., 1993), infants may initially interpret novel adjectives as they do nouns. Another possibility is that infants begin with an expectation that words, independent of grammatical form, will refer to kinds of objects; only later do they learn that (in English) this linkage is typically true for count nouns, but not for words from other grammatical categories (e.g., adjectives, verbs). We return to these possibilities under General Discussion.

One appeal of the above proposal about initial learning is that while it offers the infant a guide in the early establishment of mappings between nouns and object kinds, it does not require infants on the threshold of learning language to be able to identify, on the basis of surface cues in the input, instances of the various grammatical categories (e.g., nouns, adjectives, verbs). This is important, because grammatical categories are not marked transparently or universally in the input children receive. For instance, there are no universally constant stress levels, affixes, or positions in a sentence that are associated with any of the grammatical categories (Pinker, 1984). Thus, in most current theories of language acquisition, the child's very ability to identify the grammatical categories, as instantiated in the language under acquisition, is itself a major achievement.

Also appealing is the fact that this account does not build into the infant any expectations that are not universal. That is, this account is flexible enough to account for the fact that infants readily acquire languages that differ among themselves in the ways in which they recruit particular grammatical categories to convey particular types of meaning. Finally, notice that this account 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).

If this account is correct, then infants in the initial phases of language acquisition will interpret all novel words applied to objects as referring to object categories. To determine whether this linkage is available to infants on the brink of language learning, and to elucidate the manner in which this linkage unfolds, we developed an object manipulation task, analogous to the standard novelty-preference paradigms used in infancy research (also see Oakes, Madole, & Cohen, 1991; Ross, 1980; and Ruff, 1986). The task, which was designed to accommodate the active exploratory nature of infants in this age group, consisted of two phases. 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 presented both (a) a new member of the give category (e.g., another animal) and (b) an object from a novel contrasting category (e.g., a tool). Infants manipulated the toys freely during each phase; their manipulation served as the dependent measure in our analyses.

The logic of novelty-preference procedures in examining infant categorization is straightforward (Eimas, Siqueland, Jusczyk, & Vigorito, 1971). If the infant notices the commonality or category relation among the stimuli presented during familiarization, then the infants' attention during this phase will wane. At test, when two objects are presented simultaneously, if the infant notices that one stimulus is from the now-familiar category, attention to that stimulus should remain relatively low. In contrast, if the infant notices that one stimulus is from a novel category, then attention to that novel test object should be relatively high. Hence, such an infant should show a preference for the novel, over the familiar, test object. Therefore, if an infant has formed an object category, that infant should evidence both (a) a decrease in attention during the familiarization phase and (b) a preference for the novel object at test.

We conducted three experiments to examine the influence of introducing novel words on object categorization. In the first and second, we assigned infants randomly to either a *No Word* or *Noun* condition; in the third, we included an *Adjective* condition as well. These conditions differed from one another only during the familiarization phase. In the *No Word* condition, the experimenter drew attention to each object and indicated it verbally, but offered no label (e.g., "Look at this."). In contrast, in the *Noun* (e.g., "Look at the X.") and *Adjective* (e.g., "Look at the X-ish one.") conditions, the experimenter introduced labels

as she presented the objects during familiarization. The only difference between the noun and adjective conditions was in the grammatical form of the label.

To test our hypotheses, we used two different dependent measures. The first measure reflected the extent to which infants' attention to the objects waned over the familiarization phase; the second measure reflected infants' object preferences during the test phase. We reasoned that if a linkage between nouns and object categories is unavailable to infants early in lexical acquisition, then novel words should exert no influence on categorization: performance in the *Noun*, *Adjective*, and *No Word* conditions should be comparable. If, on the other hand, infants do indeed distinguish nouns from adjectives on the basis of linguistic cues like the ones we present here, then infants in the *Noun* condition should evidence greater appreciation of the categories under consideration than should their age mates in either the *Adjective* or *No Word* conditions. Finally, we reasoned that if novel words (independent of their linguistic form) direct infants' attention toward object categories, then subjects in both the *Noun* and *Adjective* conditions should evidence a greater appreciation of the categories under consideration than should subjects in the *No Word* condition. More specifically, infants in the *Noun* and *Adjective* conditions should show (a) a greater decrease in attention during the familiarization phase and (b) a stronger preference for the novel object in the test phase than should infants in the *No Word* condition.

EXPERIMENT 1

The purpose of this initial experiment was to ascertain whether nouns highlight object categories for infants in the initial phases of lexical acquisition. A second goal was to determine the effectiveness of the object manipulation procedure in investigating this issue with this age group.

Method

Subjects

Thirty-two infants, 18 girls and 14 boys, participated. Infants ranged in age from 9.3 to 20.1 months, with a mean age of 13.5 months. The subjects, who were recruited from a population of middle-class families in the greater Boston area, were all in the process of acquiring English as their first language. Eight other infants were excluded due to fussiness (1), mechanical difficulty (1), or experimenter error (6).

Stimuli

The stimuli were 40 small objects that were easily handled by our infant subjects. These were commercially manufactured toys made from lightweight plastic. They ranged in size from 6 cm × 3 cm × 2 cm to 8 cm × 7 cm × 6 cm. They varied in color, shape, and detailed markings. See Table 1 for a complete list of stimuli.

As can be seen in Table 1, the objects were selected to form four different sets of 10 objects each. There were two basic (cars vs airplanes; cows vs dinosaurs) and two superordinate (animals vs vehicles; tools vs animals) level sets. The objects included within each set varied in color, shape and detailed markings.

Ensuring against "a priori" preferences among test stimuli. An initial control study was con-

TABLE 1
Familiarization and Test Phase Objects—Experiment 1

Set	Category	Familiarization phase				Test phase
Basic level Cars vs Airplanes	A	green car	orange car	blue car	red car	white car & white airplane
		OR				
Cows vs Dinosaurs	B	green airplane	orange airplane	blue airplane	red airplane	orange cow & orange dinosaur
	A	brown & white cow . . .	light brown cow	white & brown cow . . .	white cow	
		OR				
B	green dinosaur	light brown dinosaur . . .	dark brown dinosaur . . .	gray dinosaur		
Superordinate level Animals vs Vehicles	A	brown horse	orange tiger	brown bear	panda	yellow lion & yellow airplane
		OR				
Tools vs Animals	B	white roadster	black sports car	green truck	red airplane	yellow screwdriver & yellow cat
	A	red hammer	blue wrench	green pliers	orange saw	
		OR				
	B	blue dog	yellow lion	red duck	blue bear	

ducted with a separate group of infants to determine whether there were any a priori preferences among the test stimuli. Ten additional infants (6 girls and 4 boys) were drawn from the same population as that described above. These infants ranged in age from 11.7 to 15 months, with a mean age of 13.2 months. Each infant participated in a series of four 30-s test trials in which they were presented with each pair of test objects from the experiment proper (see Table 1, last column). The order of presentation of the four pairs was counterbalanced. An analysis based on the duration of attention that infants devoted to each member of the test pair (see Coding section, below) revealed no a priori preferences in any of the four sets. Therefore, any preferences that emerge in the experiment proper will be attributable to the experimental manipulations rather than to infants' existing preferences for any member of the test pairs.

Procedure

In the experiment proper, infants were tested individually in a laboratory playroom. After a brief period during which they became acquainted with the laboratory and the experimenter, the infants were seated in an infant seat attached to a table, with the parent seated at an adjoining side of the table.³ The experimenter sat at the opposite side of the table, facing the infant. The parent, who was present throughout the session, was asked not to talk (either to the infant or to the experimenter) or to influence in any way the infant's interest in or attention to the stimuli. Sessions lasted approximately 15 min and were videotaped for later transcription.

The novelty-preference task included a familiarization phase and a test phase. Each infant was encouraged to complete this novelty-preference task four times, with all four different sets of objects listed in Table 1. The order in which the sets were presented was completely counterbalanced. In both the familiarization and test phases, infants manipulated the objects freely. Trials were timed by the experimenter with a stopwatch that she kept in her lap.

Familiarization phase. In the familiarization phase, the experimenter offered the infant four toys from a given category (e.g., four different cars) one at a time, in random order, for 30 s each. Half of the infants in each condition were familiarized to one contrastive category from the set (e.g., cars); the other half were familiarized to the other contrastive category (e.g., airplanes). To secure the infant's attention, the experimenter began each familiarization trial by calling the infant's name as she held the object directly in front of the infant, but just beyond the infant's reach.

Infants were randomly assigned to either a *Noun* or *No Word* condition. Table 2 provides a complete list of the labels used in Experiments 1, 2, and 3. In the *Noun* condition, the experimenter labeled the objects during the familiarization phase, saying, for example, "[Infant's name]. Look, a(n) X." In the *No Word* condition, she drew attention to each object but offered no label, saying, for example, "[Infant's name]. Look what's here." After this introduction, the experimenter placed the object directly in front and within the reach of the infant. Infants in both conditions were allowed to examine the object for a total of 30 s. After approximately 10 s had elapsed, the experimenter indicated the object again. In the *Noun* condition she said, "Do you like the X?" In the *No Word* condition, she said, "Do you like that one?" After a total of 30 s had elapsed, the experimenter removed the toy from the infant's view.

As can be seen in Table 3, these introductory comments were offered on familiarization trials 1, 2, and 4. On familiarization trial 3, infants in both the *Noun* and *No Word* conditions were treated identically. They were told, "[Infant's name]. Look." This design feature insured that all infants were exposed to the introductory phrase employed in the subsequent test trials (described below).

Test phase. For each set of objects, a single test trial followed the four familiarization trials. The test phase was identical for infants in both conditions; no labels were introduced. The experimenter simultaneously held two objects in front of, but slightly beyond the reach of the infant. One object was a novel exemplar of the category presented during the familiarization phase (e.g., a car); the other

³ In a few instances, infants preferred to sit on their parents' lap.

TABLE 2
Object Labels Used during Familiarization Phase—Experiments 1, 2, and 3

Object	Experiment 1: Noun	Experiments 2 and 3: Novel noun	Experiment 3: Novel adjective
Car	Car	Auto	Autish
Airplane	Plane	Avi	Avish
Cow ^a	Cow		
Dinosaur ^a	Dinosaur		
Horse ^b		Equine	Equish
Cat ^b		Feline	Felish
Vehicle	Vehicle	Vehicle	Vekish
Tool	Tool	Implement	Implish
Animal	Animal	Fauna	Faunish
Fruit ^b		Produce	Prodish

^a Object used only in Experiment 1.

^b Object used only in Experiments 2 and 3.

was an exemplar from the contrastive category (e.g., an airplane). The experimenter presented the objects, saying “[Infant’s name]. Look.” Recall that this introductory phase was not novel to the infants; it was used on familiarization trial 3 in both conditions. After introducing the test pair, the experimenter placed the two objects within the infant’s reach. After 45 s had elapsed, the toys were removed from the infant’s view.

During both the familiarization and test phases, if an infant pushed a toy out of reach or dropped it off the table, the experimenter retrieved it and placed it back within the reach of the infant as quickly as possible. The experimenter did not extend the trial length to compensate for this infant behavior. (See Oakes, Madole, & Cohen (1991), Ross (1980), and Ruff (1986) for similar procedures.)

One additional procedural detail warrants attention. In both conditions, the experimenter used the “motherese” register. This was done because the distinct intonational contours characteristic of this infant-directed speech register have been shown to be especially effective in arousing and sustaining infants’ attention (Fernald, 1992). The experimenter made an explicit effort to keep the prosody and stress contours roughly comparable in the *Noun* and the *No Word* conditions. For example, in both conditions, she used rising intonation to emphasize the final word in the introductory phrases.

Language measure. While the infant was engaged in the experiment, the parent was asked to complete the Bates Language Checklist—Version 1.01B (Bates, Bretherton, & Snyder, 1988). This is a standardized and validated measure in which caretakers review a list of words and indicate those which their infant can produce and those which their infant can comprehend.

Coding. Two different measures were derived from the videotaped sessions. For each measure, the videotapes were transcribed with the sound removed to insure that the coders, who were blind to the hypotheses under investigation, were also blind to the condition in which each infant participated. The measures, derived for both familiarization and test phases, were (a) general attention and (b) looking time. General attention was defined as the amount of time that the infant looked at and/or actively manipulated the object (Ruff, 1986). This measure included time spent fingering, banging, and mouthing the object. Looking time was defined as the amount of time that the infant spent looking at the object. In our coding scheme, looking time constitutes a subset of the more inclusive, general attention measure. The primary coder for this experiment (and for each subsequent experiment reported in this paper) was trained by an experienced coder in the laboratory. The primary coder

TABLE 3
Examples of Introductory Phrases Used in Experiments 1, 2, and 3

Experiment	Condition	Familiarization phase				Test phase
		Trial 1	Trial 2	Trial 3	Trial 4	
1						
Car	Noun	Look, a car!	Look, a car!	Look!	Look, a car!	Look!
	No word	Look what's here!	Look what's here!	Look!	Look what's here!	Look!
2 and 3 ^a						
Car	Novel noun	See the auto?	See the auto?	See what I have?	See the auto?	See what I have?
	Novel adjective	See the autish one?	See the autish one?	See what I have?	See the autish one?	See what I have?
	No word	See here?	See here?	See what I have?	See here?	See what I have?

^a Experiment 2 consisted only of the *Novel Noun* and *No Word* conditions.

was required to achieve at least 85% agreement with the experienced coder. The primary coder then coded the performance of all the subjects in the experiment. In addition, a second coder (trained in exactly the same fashion as the primary coder) independently rated six subjects, three from each condition, on both the general attention and looking measures. For both measures, consistency between coders, computed for each trial and averaged across trials, was over 82% for the familiarization phase and over 99% for the test phase. There were no systematic inconsistencies between coders.

Because infants at this age actively explore objects, in many and various ways (e.g., mouthing, banging, looking), we relied primarily on the more encompassing general attention measure. In what follows, we present analyses based on the general attention measure. However, the two measures are positively correlated for both the familiarization and test phases (mean $r = .66$, all $ps < .02$). Further, analyses based on looking time and general attention yielded precisely the same pattern of results.

Results

The results of this first experiment reveal that words highlight categories of objects for infants as young as 13 months of age. Infants were readily engaged in this task, only occasionally becoming fussy or inattentive. In general, they seemed to enjoy interacting with the experimenter and the toys. They completed an average of 90% of all sets. There was no difference between the number of sets completed by infants in Noun (88%) and No Word (92%) conditions. (Note, however, that because some infants failed to complete the procedure on some sets, there are varying degrees of freedom on some subsequent analyses.) Thus, the modified novelty-preference paradigm served as an effective and appropriate means for answering questions concerning the influence of introducing words on object categorization in young infants.

Language Inventory

The parents of 21 of the 32 subjects were given the language inventory to complete. The parents of the remaining 11 infants did not complete the inventory due to a combination of oversight on the part of the experimenter or time constraints on the part of the parent (e.g., the infant subject or its sibling demanded the parent's attention after the experiment proper had been completed). The results of the inventory are summarized in Table 4. There was a significant positive correlation between infants' production and comprehension vocabularies ($r = .64$; $p < .01$). Two infants had particularly extensive productive lexicons of 165 words each. When these subjects were excluded from the calculations, the remaining sample had a mean production vocabulary of 9.4 words, ranging from 0 to 59 words, and a mean comprehension vocabulary of 71.5 words, ranging from 9 to 201 words.

Novelty-Preference Task

Table 5 contains a summary of the results from the familiarization and test phases of Experiments 1 and 2.

Familiarization phase. The results from the familiarization phase are depicted in Fig. 1. We first tested the prediction that infants in the *Noun* condition would

TABLE 4
Age and Vocabulary Information for Subjects in Experiments 1, 2, and 3

	Age (months)	Production vocabulary	Comprehension vocabulary
Experiment 1			
Mean	13.5	24.2	75.9
SD	2.1	49.1	58.9
Range	9.3-20.1	0-165	9-220
Experiment 2			
Mean	12.2	1.9	34.6
SD	0.3	2.6	22.3
Range	11.9-13.3	0-11	8-105
Experiment 3			
High vocabulary group			
Mean	12.5	9.0	52.2
SD	0.53	7.8	25.8
Range	11.5-13.7	3-37	15-104
Low vocabulary group			
Mean	12.3	0.5	41.5
SD	0.58	0.8	20.4
Range	11.0-13.4	0-2	5-87

exhibit a greater decrease in attention during the familiarization phase than would their counterparts in the *No Word* condition. This was evaluated by submitting the average attention devoted to the familiarization objects in Block 1 (familiarization trials 1 and 2) and in Block 2 (familiarization trials 3 and 4) to a three-way

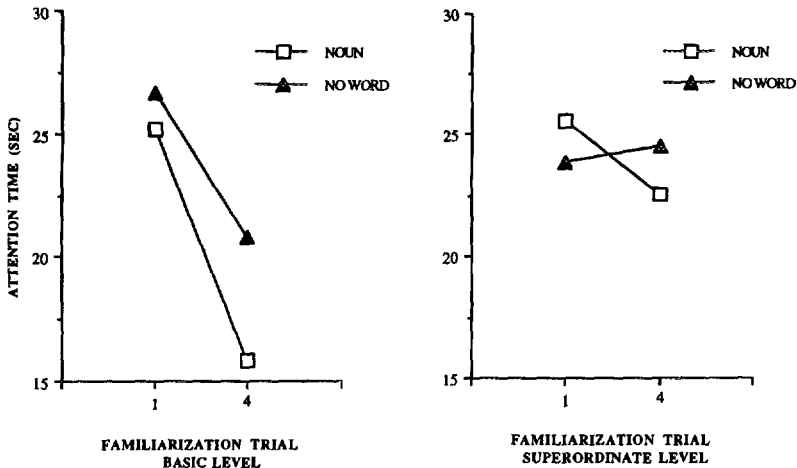


FIG. 1. Experiment 1—familiarization phase. The mean duration of attention during familiarization trials 1 and 4 as a function of hierarchical level and condition.

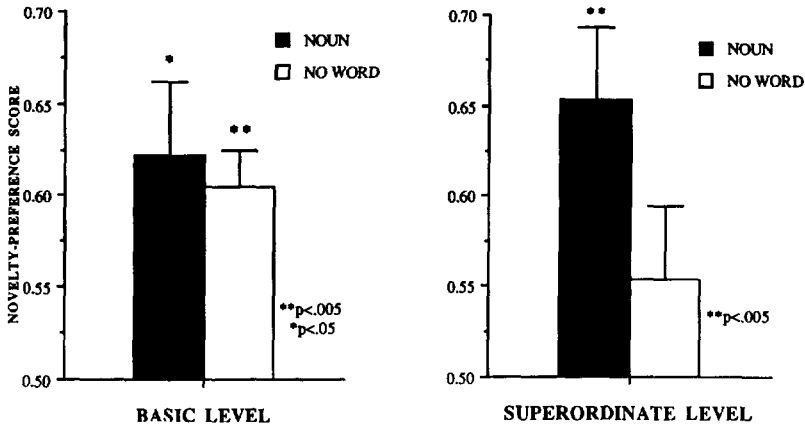


FIG. 2. Experiment 1—test phase. The mean novelty-preference score as a function of hierarchical level and condition. Asterisk indicates comparisons to chance responding (0.50).

analysis of variance, with Condition (*Noun* vs *No Word*) as a between-subjects variable and Level (Basic vs Superordinate) and Block (Block 1 vs Block 2) as within-subjects variables. This analysis revealed a significant effect for Block, $F(1,18) = 18.68$, $p < .001$. The Block \times Condition interaction approached significance, $F(1,18) = 3.59$, $p = .07$.

In the next analysis, we examined these data further. Following Rosenthal and Rosnow (1985), we operationalized our predictions concerning the familiarization phase by calculating individual contrast scores for each subject, for each familiarization phase. This score was derived by multiplying the duration of attention accumulated for each familiarization trial by the appropriate contrast weight for the predicted linear trend. These weights were 3, 1, -1, and -3 for familiarization trials 1 through 4, respectively. We then analyzed these contrast scores to ascertain whether infants exhibited a linear decrease in attention during the familiarization phase. If there was no linear decrease in attention, then the resulting mean contrast scores should sum to zero. Therefore, to conduct this analysis, we submitted the mean contrast score for each condition (*Noun*, *No Word*) and each hierarchical level (basic, superordinate) to a t test against the null hypothesis value of zero.

The results of this analysis strengthen those from the ANOVA. At the basic level, infants in both the *Noun* and the *No Word* conditions exhibited a significant linear decrease in attention (*Noun*: $t(10) = 5.68$, $p < .0005$; *No Word*: $t(11) = 2.58$, $p < .03$). However, at the superordinate level, infants in the *Noun* condition showed a trend in the predicted direction, $t(12) = 1.39$, $p = .09$, one-tail. This trend, which is merely suggestive, will be pursued in Experiment 2. Infants in the *No Word* condition exhibited no such decrease.

The advantage of utilizing individual contrast scores will become apparent

TABLE 5
Mean Contrast Scores and Novelty-Preference Scores in Experiments 1 and 2

	Familiarization phase: Contrast scores				Test phase: Novelty-preference scores			
	Basic level		Superordinate level		Basic level		Superordinate level	
	Noun	No word	Noun	No word	Noun	No word	Noun	No word
Experiment 1 ^a								
Mean	31.7	16.1	9.5	-1.4	.62	.60	.65	.55
SD	18.5	21.6	24.7	32.2	.15	.08	.14	.14
<i>t</i> value	5.68***	2.58*	1.39†	-0.16	2.76*	4.48***	3.98**	1.54
Experiment 2 ^b								
Mean	4.7	-6.0	-6.03	-3.0	.56	.50	.53	.56
SD	21.3	18.4	16.4	15.0	.11	.11	.12	.16
<i>t</i> value	0.76	-1.12	-1.27	-0.70	1.69	0.07	0.81	1.16

Note. Contrast scores: *t* tests against $H_0 = 0$. Novelty-preference scores: *t* tests against .50 chance level.

^a *N* = 16 per condition.

^b *N* = 12 per condition.

* *p* < .05 two-tail. ** *p* < .005 two-tail. *** *p* < .0005 two-tail. † *p* = .09 one-tail.

below in the analyses based on individual subjects' patterns of behavior. These analyses will require information concerning the number of individual subjects that exhibited a decrease in attention during the familiarization phase. This type of information for individual subjects is not available from the more standard factorial analyses of group data.

Test phase. The data from the test phase are presented in Fig. 2. To analyze performance in this phase, we computed a novelty preference score for each condition and each hierarchical level. To calculate this score, we divided the total number of seconds devoted to the novel object by the total attention devoted to both the novel and the familiar objects during each test trial. If infants devoted equal attention to the novel and familiar test objects, then the novelty-preference score would be 0.50. We therefore compared performance in each condition and at each hierarchical level to this level of chance responding.

The results at the basic level mirrored those from the familiarization phase. Infants in both the *Noun* ($M = .62$) and *No Word* ($M = .60$) conditions revealed a significant preference for the novel object at test (*Noun*: $t(10) = 2.76, p < .025$; *No Word*: $t(12) = 4.48, p < .001$). The results at the superordinate level amplified those from the familiarization phase. Here, infants in the *Noun* condition showed a clear preference for the novel object ($M = .65, t(13) = 3.98, p < .002$), while those infants in the *No Word* condition exhibited no such preference ($M = .55, t(14) = 1.54$).

Taken together, the results from the familiarization and test phases are consistent with the prediction that nouns focus infants' attention on categories of objects. It is striking that the facilitative effect of nouns is only evident at the more abstract superordinate level. Notice, however, that these group data are limited in that they cannot reveal how many infants followed the predicted pattern of behavior consistently over *both* the familiarization and test phases of the task.

Individual Patterns of Behavior

Therefore, to provide a richer depiction of performance on this task, we examined each individual infant's pattern of behavior. For each infant, we noted those trials on which there was both (a) a decrease in attention during familiarization (as indexed by a contrast score greater than 0) and (b) a preference for the novel object at test (as indexed by a novelty-preference score greater than 0.50). These data are presented in Table 6, to reveal the number of infants in each condition and at each level exhibiting this pattern of behavior on 0, 50, and 100% of their trials.

A χ^2 analysis revealed that the distribution of individual patterns in the *Noun* and *No Word* conditions was comparable at the basic level; at the superordinate level, however, the individual patterns observed in the two conditions were quite distinct, $\chi^2(2, N = 31) = 7.77, p < .05$. Of particular interest is the fact that in the *No Word* condition, 12 infants (86%) failed to meet our criterion on any super-

TABLE 6
 Number of Individual Subjects with Criterion Performance for the Familiarization (Contrast Score >0) and Test (Novelty-Preference Score >.50) Phase for 0, 50, or 100% of Trials

	Condition	Percentage of trials with criterion performance					
		Basic level			Superordinate level		
		0	50	100	0	50	100
Experiment 1 ^a	No word	4	8	4	12	2	2
	Noun	4	5	7	4	8	3
Experiment 2	No word	7	5	0	8	4	0
	Novel noun	8	3	1	8	4	0
Experiment 3							
High vocabulary group	No word	3	8	1	8	4	0
	Novel adjective	3	6	3	3	6	3
	Novel noun	0	7	5	1	6	5
Low vocabulary group	No word	1	9	2	5	4	3
	Novel adjective	4	6	2	5	6	1
	Novel noun	2	8	2	4	7	1

^a Includes only those infants who completed the familiarization and test phase for a set.

ordinate level trial; in the *Noun* condition, only four infants (27%) failed to meet this criterion.

Thus, the analysis of individual patterns of performance lends additional strength to the argument that nouns focus infants' attention on categories of objects.

Discussion

This initial experiment is important in several respects. First, the infants' interest and sustained cooperation, as well as their systematic performance, indicate the suitability of this method for exploring questions concerning the emergence of a relation between word learning and conceptual organization.

More importantly, the results from this initial experiment reveal that in the early phases of language acquisition, nouns do indeed highlight categories of objects, particularly those at the superordinate level. At the basic level, infants in both conditions were equally adept at forming object categories. Their appreciation of the basic level categories, both with and without the introduction of labels, is consistent with myriad arguments concerning the developmental primacy of the basic level (c.f., Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976; Waxman, 1990).

However, the effect of introducing labels became apparent at the more abstract superordinate level. Only infants in the *Noun* condition demonstrated an appreciation of the superordinate object categories; those in the *No Word* condition

exhibited neither (a) a decrease in attention during familiarization nor (b) a preference for the object from the novel category at test. This finding is consistent with existing evidence concerning the power of labels in focusing young subjects' attention on object categories, particularly those at superordinate levels. For example, in sorting tasks (Waxman, 1990; Waxman & Gelman, 1986) and in forced choice procedures (D'Entremont & Dunham, 1992; Waxman & Kosowski, 1990), children often exhibit an appreciation of superordinate level categories in the presence of labels, but not in their absence.

These findings constitute the first evidence that nouns influence object categorization in infants at the initial stages of lexical acquisition. As a next step, we sought to validate our task.

EXPERIMENT 2

Our goal in Experiment 2 was to ensure that the categorization behavior (that is, the decrease in attention during familiarization and the novelty-preference at test) is evident for sets of objects that are indeed members of an object category, but is not evident for *arbitrary* groups of objects. Evidence to this effect will fortify the claim that labels focus attention specifically on categories of objects.

Method

Subjects

Twenty-four infants (12 girls and 12 boys) participated. The subjects' ranged in age from 11.9 to 13.3 months, with a mean of 12.2 months. The infants were recruited in the same manner and from the same population as in Experiment 1. None of these subjects had participated in Experiment 1. Two additional infants were excluded due to experimenter error.

Stimuli

The stimuli were 24 small commercially manufactured toys made from lightweight plastic. They varied in color and shape, and ranged in size from 6 cm × 3 cm × 2 cm to 8 cm × 7 cm × 6 cm. See Table 7 for a complete list of stimuli.

As can be seen in Table 7, the objects presented during familiarization were unrelated; they were explicitly selected from various and disparate object categories. These unrelated objects did not represent any coherent object category. At the test phase, we presented precisely those pairs of objects that would serve as test objects in Experiment 3. In the current experiment, we designated sets 1 and 2 as basic level sets because they will serve as basic level test pairs in Experiment 3. Notice that in each, the test objects (car vs airplane; horse vs cat) are drawn from a single superordinate level category (vehicles or animals, respectively) and therefore they represent a contrast at the basic level (Miller & Johnson-Laird, 1976). We designated sets 3 and 4 as superordinate level sets because they will serve as superordinate level test pairs in Experiment 3. Notice that in each, the test objects are drawn from different superordinate level categories and therefore they represent contrast at the superordinate level.

Procedure

As was the case in Experiment 1, infants were tested individually in a laboratory playroom. After a brief period during which they became acquainted with the laboratory and the experimenter, the novelty-preference procedure was begun. The parent, who was present throughout the session, was

TABLE 7
Familiarization and Test Phase Objects—Experiment 2

Set	Familiarization phase	Test phase
Basic level ^a		
Set 1	blue bubble pipe green dinosaur . . . clown figure yellow cheese	blue car & blue airplane
Set 2	red grapes blue boat white hand red purse	pink horse & pink cat
Superordinate level		
Set 3	red accordion tube . . . pink comb yellow airplane blue funnel	yellow cat & yellow apple
Set 4	cowboy figure brown lion cub . . . yellow frying pan . . . hot dog	green pliers & green truck

^a Level (basic or superordinate) refers to the level of contrast between test objects.

asked not to talk (either to the infant or to the experimenter) or to influence in any way the infant's interest in or attention to the stimuli. The experimenter sat at the opposite side of the table, facing the infant. Sessions lasted approximately 15 min and were videotaped for later transcription.

The procedure was identical to that employed in the *Novel Noun* and *No Word* conditions of Experiments 1 and 3 (see below), and included two phases. In the *familiarization phase*, the experimenter offered the infant four toys from a given set of unrelated objects (e.g., pipe, dinosaur, clown, cheese) one at a time, in random order, for 30 s each. The *familiarization phase* was immediately followed by the *test phase* in which the experimenter presented the two test trial objects for 45 s. The left-right placement of the test objects was determined randomly for each trial. In both phases, infants manipulated the objects freely. Trials were timed by the experimenter with a stopwatch that she kept in her lap. Each infant completed this procedure four times, with all four different sets of unrelated objects listed in Table 7. The order in which the sets were presented was completely counterbalanced.

Each infant was randomly assigned to one of two conditions, which differed only in the experimenter's comments during the *familiarization phase*. (See Table 2 for a complete list of the novel labels used in Experiment 2 and Table 3 for an example of the introductory comments used.) In the *No Word* condition, she said, "[Infant's name], see here?" In the *Novel Noun* condition, she said "[Infant's name], see the X?"⁴ After approximately 10 s had elapsed, the experimenter indicated the object again, using one of the following phrases: "Do you like that? (*No Word* condition): "Do you like the X? (*Novel Noun* condition). In the *Novel Noun* condition, half of the infants were introduced to one label (e.g., "auto"); the other half were introduced to another label (e.g., "avi").

In this experiment, as in Experiment 1, infants in both conditions heard precisely the same labeling phrase on familiarization trial 3 and on the test trial ("[Infant's name], see what I have?").

Coding

The videotaped sessions were coded for both of the dependent measures described in Experiment 1—general attention and looking time. A second coder independently coded the videotaped session of four subjects, two from each condition, on the more inclusive general attention measure. For both measures, consistency between coders was 98% for the familiarization phase and 94% for the test phase. As in Experiment 1, we report on the results based on the general attention measure. However, analyses based on looking time converged perfectly with those based on general attention.

Results

Language Inventory

The parents of all 24 subjects completed the language inventory. The results of the inventory are summarized in Table 4. The infants had a mean production vocabulary of 1.9 words, ranging from 0 to 11 words, and a mean comprehension vocabulary of 34.6 words, ranging from 8 to 105 words. The mean vocabularies were comparable across the two conditions.

Novelty-Preference Task

Table 5 contains a summary of the results from the familiarization and test phases of this experiment. As described above, for the purposes of analysis, we

⁴ Notice that the introductory phrases used in the *Novel Noun* and *No Word* conditions differed slightly from those used in Experiment 1. These modifications were initiated to accommodate the inclusion of the additional, *Novel Adjective* condition that will be introduced in Experiment 3.

treated sets 1 and 2 as basic level sets and sets 3 and 4 as superordinate level sets. This decision rested upon the degree of contrast between the test objects.

Familiarization phase. The results of this phase are depicted in Fig. 3. We first tested the prediction that infants in the *Novel Noun* condition would exhibit a greater decrease in attention during the familiarization phase than would their counterparts in the *No Word* condition. We submitted the average attention devoted to the familiarization objects in Block 1 (familiarization trials 1 and 2) and in Block 2 (familiarization trials 3 and 4) to a three-way analysis of variance, with Condition (*Novel Noun* vs *No Word*) as a between-subjects variable, and Level (Basic vs Superordinate) and Block (Block 1 vs Block 2) as within-subjects variables. This analysis did not reveal any significant main effects or interactions.

We next calculated individual contrast scores for each subject and for each familiarization phase. We then compared the mean contrast score for subjects in each condition and at each hierarchical level to chance. If there was no linear decrease in attention during the familiarization phase, then the mean contrast scores should sum to zero.

At the basic and superordinate levels, infants in neither condition exhibited a significant linear decrease in attention.

Test phase. Figure 4 displays the proportion of attention the infants devoted to one test object. At the basic and superordinate levels, infants in neither condition showed an object preference.

Individual patterns of behavior. In the next analysis, we examined the patterns of behavior exhibited by individuals, rather than groups of subjects. As in Experiment 1, for each infant, we recorded the trials on which there was both a

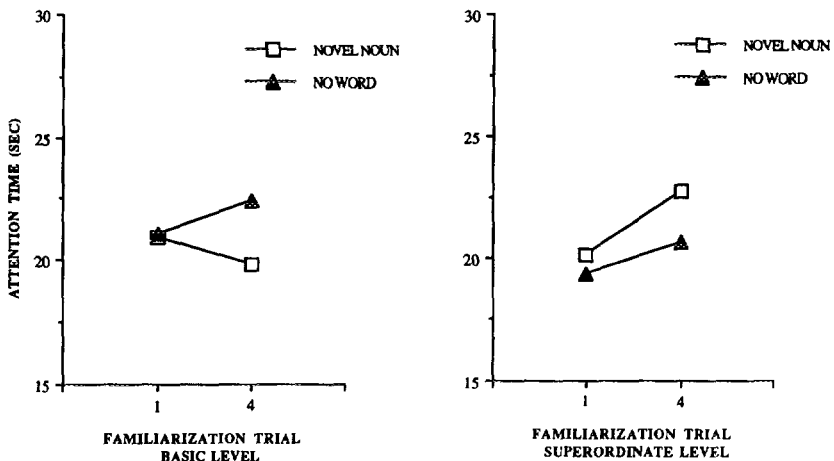


FIG. 3. Experiment 2—familiarization phase. The mean duration of attention during familiarization trials 1 and 4 as a function of hierarchical level and condition.

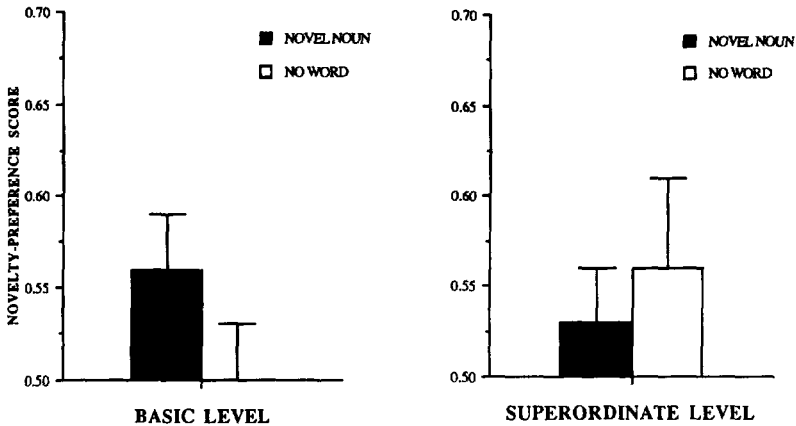


FIG. 4. Experiment 2—test phase. The mean novelty-preference score as a function of hierarchical level and condition.

decrease in attention during familiarization and a preference for the novel object at test. These data are presented in Table 6, broken down to show the number of infants in each condition exhibiting this pattern of behavior on 0, 50, and 100% of their trials. As in the previous analyses, these data fail to reveal any systematic effects.

Taken together, the results of Experiment 2 provide an important source of validation for our task. In Experiment 1, several aspects of infants' behavior suggested that, under certain conditions, they appreciated the object categories we had presented. In particular, their (a) decrease in attention during familiarization and (b) novelty preference at test are behaviors that are indicative of categorization. The results of Experiment 2 reveal that categorization behavior is not evident for arbitrary groups of objects. Moreover, nouns exert no influence on infants' behavior with these random sets.

Discussion of Experiments 1 and 2

The findings from Experiments 1 and 2 reveal that nouns focus infants' attention on categories of objects; nouns exert no influence on infants' attention to arbitrary sets of objects. These findings also raise several further questions, each of which is addressed directly in Experiment 3.

One question concerns the specificity of the phenomenon. Although the data from Experiment 1 reveal an impact of nouns on infants' formation of object categories, they do not reveal whether this facilitative effect is specific to nouns or is generalizable to words from other syntactic categories (e.g., adjectives). Because it is unlikely that 13-month-old infants have discovered the relevant surface cues to allow them to distinguish among grammatical categories such as *noun* and *adjective*, we expect that infants at this developmental moment will

interpret novel adjectives as they do novel nouns. We therefore predict that object categories will be highlighted by words from both grammatical categories, not by nouns in particular.

In Experiment 3, we test this prediction by comparing infants' performance under three different conditions: *Novel Noun*, *Novel Adjective*, and *No Word*. We predict that infants in both the *Novel Noun* and *Novel Adjective* conditions will categorize more readily than will infants in the *No Word* condition. More specifically, we predict that infants hearing novel words (be they nouns or adjectives) will show (1) a greater decrease in attention to the objects over the familiarization phase and (2) a stronger preference for the novel object in the test phase than will infants in the *No Word* condition.

A second question concerns the precise characterization of the phenomenon at the superordinate level. The sets used in Experiment 1 may be described as either superordinate level (e.g., animals vs vehicles) or as more abstract, global (e.g., animate vs inanimate objects; natural kinds vs artifacts) categories (Mandler & Bauer, 1988; Mandler, Bauer, & McDonough, 1991). In either case, the results from the first experiment illustrate that novel nouns focus infants' attention on these higher-order categories of objects. But in Experiment 3, we remove any ambiguity about the precise level of abstraction by comparing two contrastive superordinate level categories within the domain of natural kinds (animals vs fruits) and two contrastive categories within the domain of artifacts (tools vs vehicles).

A third question concerns the use of English category labels in the *Noun* condition. It is reasonable to assume that as a group, infants are more familiar with basic than with superordinate level labels (Anglin, 1977; Waxman, 1990; Waxman & Hatch, 1992). Therefore, in Experiment 3 we equate the familiarity of labels at each hierarchical level. To accomplish this, we introduced novel labels at both the basic and superordinate levels.

A fourth question concerns the intriguing possibility that infants' lexical advances are associated with a sensitivity to a linkage between words and object categories. It is a well-documented fact that normally developing infants vary considerably in their lexical achievements. For example, by their first birthdays, some produce very few words, if any; others are considerably more fluent. This natural variability presents us with an opportunity to examine whether and how the facilitative influence of novel nouns (and perhaps novel adjectives) is associated with the infant's level of lexical acquisition.

We address this question in Experiment 3 by examining two groups of infants, matched for age and differing in their lexical abilities. We used the Bates' language inventory to assign infants to either a High or Low Vocabulary group (see below). If lexical advances are associated with a sensitivity to linkages between words and object categories, then infants in the High Vocabulary group should be more likely than those in the Low Vocabulary group to be affected by the introduction of novel labels.

Finally, two more minor methodological changes were instituted. First, because Experiment 1 was largely exploratory in nature, the age range of the subjects was fairly wide. In Experiment 3, we restricted the range considerably. Second, in Experiment 3 we included only subjects who completed the procedure on all four sets of objects.

EXPERIMENT 3

The goal of this experiment was to pursue further the finding that novel nouns focus infants' attention on categories of objects, particularly at superordinate levels. To ascertain whether this effect is specific to novel nouns, we compare performance in a *Novel Noun*, *Novel Adjective* and *No Word* condition. To ascertain whether infants' lexical abilities are related to labeling effects, we examine two groups of 12-month-old infants—the High and Low Vocabulary Groups—that differed only in their lexical accomplishments.

Method

Subjects

Seventy-two 12-month-olds (with a mean age of 12.4 months, ranging from 11.0 to 13.7 months) were included. Recruitment procedures and demographic information were identical to those described in the previous experiments: none of the subjects in this experiment participated in either Experiment 1 or 2.

Subject assignment. Our first task was to obtain two groups of subjects, matched for age, and differing only in lexical abilities. To accomplish this, we tested an initial set of 36 infants in the novelty-preference task (described below) and collected language inventories from their parents. We used the language inventory data from this initial set of infants to delineate an appropriate boundary for distinguishing our two groups of infants.

An examination of this initial subset of 36 subjects revealed a median production vocabulary of two words and a median comprehension vocabulary of 40.5 words. We chose to establish our two groups on the basis of production because production and comprehension were highly correlated ($r(34) = .38, p < .05$), and because there was less variability in production than comprehension.

Based upon the language inventory data from our initial set of 36 infants, we designated the median in production (two words) as the boundary between what would become our Low and High Vocabulary groups. All infants producing two words or fewer were assigned to the Low Vocabulary group; all infants producing more than two words were assigned to the High Vocabulary group. We then collected data from additional subjects to bring the total number of subjects in each vocabulary group to 36.

Language inventories were completed by parents after the infants participated in the novelty-preference task; the inventories were coded after the infants and parents had left the laboratory. This design feature had two consequences. First, and most important, because the experimenter was unaware of infants' lexical abilities during testing, any expectations that she may have held could not influence her administration of the novelty-preference task. A second consequence concerned assignment of subjects to conditions. Because infants were assigned to a condition and tested in the novelty-preference task before we had assessed their vocabulary, several subjects that completed the novelty-preference procedure had to be eliminated from the final sample. For instance, in the final stages of data collection, an infant might have been tested in a particular order and condition in the novelty-preference procedure that was needed to complete the design for say, the Low Vocabulary group. If, after tabulating the language inventory, it turned out that the infant was producing more

than two words, then that infant could not, in fact, complete the design. As a consequence, data from that subject would be excluded from the final analysis and we would continue in our efforts to complete the design. Fifteen infants were trimmed from our final sample for this reason.

In addition, five infants who participated in the experiment were excluded from the analysis for the following reasons: failure to complete the entire procedure (3), experimenter error (1), and mechanical difficulty (1).

Stimuli

The stimuli were 40 small commercially manufactured toys made from lightweight plastic. They varied in color and shape, and ranged in size from 6 cm × 3 cm × 2 cm to 8 cm × 7 cm × 6 cm. See Table 8 for a complete list of stimuli.

As can be seen in Table 8, the objects were selected to form four different sets of 10 objects. There were two basic level sets (cars vs airplanes; horses vs cats) and two superordinate level sets (animals vs fruit; tools vs vehicles). The objects included within each set varied in color and shape.

Ensuring against a priori preferences among test stimuli. An initial control study was conducted with a separate group of infants to determine whether there were any a priori preferences among the test stimuli. Eight additional infants (four girls and four boys) were drawn from the same population as that described above. These infants ranged in age from 12.3 to 13.6 months, with a mean of 12.7 months. Each infant participated in a series of four 30-s test trials in which they were presented with each pair of test objects (see Table 8, last column). The order of presentation of the four pairs was counterbalanced. An analysis based on the duration of attention infants devoted to each member of the test pair (see Coding section, below) revealed no a priori preferences. Therefore, any preferences that emerge in the experiment proper will be attributable to the experimental manipulations rather than to any a priori object preferences.

Procedure

As was the case in Experiments 1 and 2, infants were tested individually in a laboratory playroom. After a brief period during which they became acquainted with the laboratory and the experimenter, the novelty-preference procedure was begun. The parent, who was present throughout the session, was asked not to talk (either to the infant or to the experimenter) or to influence in any way the infant's interest in or attention to the stimuli. The experimenter sat at the opposite side of the table, facing the infant. Sessions lasted approximately 15 min and were videotaped for later transcription.

The procedure itself included two phases. In the *familiarization phase*, the experimenter offered the infant four toys from a given category (e.g., four different cars) one at a time, in random order, for 30 s each. Half of the infants in each condition were familiarized to one contrastive category from the set (e.g., cars); the other half were familiarized to the other contrastive category (e.g., airplanes). The *familiarization phase* was immediately followed by the *test phase* in which the experimenter presented both (a) a new member of the familiar category (e.g., another car) and (b) an object from a novel contrasting category (e.g., an airplane) for 45 s. The left-right placement of the test objects was determined randomly for each trial. In both phases, infants manipulated the objects freely. Trials were timed by the experimenter with a stopwatch that she kept in her lap. Each infant completed this procedure four times, with all four different sets of objects listed in Table 8. The order in which the sets were presented was completely counterbalanced.

Infants were assigned to one of three conditions, which differed only in the experimenter's comments during the *familiarization phase*. (See Table 2 for a complete list of the novel labels used in Experiment 3 and Table 3 for an example of the introductory comments used.) In the *No Word* condition, she said "[Infant's name], see here?" In the *Novel Noun* condition, she said, "[Infant's name], see the X?"; in the *Novel Adjective* condition, she said, "[Infant's name], see the X-ish one?" After approximately 10 s had elapsed, the experimenter indicated the object again, using one of the

TABLE 8
Familiarization and Test Phase Objects—Experiment 3

Set	Category	Familiarization phase		Test phase
Basic level Cars vs Airplanes	A	red car	green car white car orange car	blue car & blue airplane
	B	red airplane	green airplane white airplane orange airplane	
Horses vs Cats	A	green & yellow horse	yellow & purple horse yellow & purple horse blue & pink horse	pink horse & pink cat
	B	white & purple cat	pink cat white cat purple cat	
Superordinate level Animals vs Fruit	A	blue bear	red duck yellow lion blue dog	yellow cat & yellow apple
	B	green pear	red apple yellow banana orange	
Tools vs Vehicles	A	yellow screwdriver	blue wrench red hammer orange saw	green pliers & green truck
	B	yellow helicopter	blue airplane red van pink car	

following phrases: "Do you like that? (*No Word* condition); "Do you like the X? (*Novel Noun* condition); "Do you like the X-ish one? (*Novel Adjective* condition).

In this experiment, as in Experiments 1 and 2, infants in all conditions heard precisely the same labeling phrase on familiarization trial 3 and on the test trial ("[Infant's name], see what I have?").

Coding

The videotaped sessions were coded for both of the dependent measures described in Experiment 1—general attention and looking time. A second rater independently coded the videotaped session of 18 subjects, 3 from each condition and production group. For both measures, consistency between coders was over 94% for the familiarization phase and over 92% for the test phase. As in Experiments 1 and 2, we report on analyses based on the more inclusive general attention measure. With few exceptions (and these are noted below), analyses based on the looking time measure yielded a pattern of results that was consistent with those based on general attention.

Results

The results of this experiment provide evidence regarding the emergence of linkages between word learning and conceptual organization in 12-month-old subjects. In what follows, we first characterize the language abilities of the High and Low Vocabulary groups. We then go on to analyze the results of the novelty-preference task, presenting results from the High Vocabulary group first, followed by those from the Low Vocabulary group.

Language Inventory

Our total sample included 72 infants, with 36 each in the High and Low Vocabulary groups. The High Vocabulary group included 20 girls and 16 boys. The Low Vocabulary group included 12 girls and 24 boys. The data for these groups are summarized in Table 4. An analysis of variance revealed that although there was no mean difference in age between the High (12.5 months) and Low (12.3 months) Vocabulary groups, the groups did differ in their lexical accomplishments in both production, $F(1,70) = 42.26, p < .0001$, and comprehension, $F(1,70) = 3.84, p = .05$. The comprehension-production ratios for both the High and Low Vocabulary groups were both characteristic of those of other pre-vocabulary spurt infants (Dapretto & Bjork, 1993).

Within each Vocabulary group, the mean vocabularies and ages were comparable across the three experimental conditions (*Novel Noun*, *Novel Adjective*, *No Word*).

Novelty-Preference Task

Please refer to Table 9 for a summary of results for the familiarization and test phases of this experiment. They suggest that infants' lexical advances may indeed be associated with their sensitivity to a linkage between words and object categories. We found that infants in the High and Low Vocabulary groups exhibited different patterns of behavior. In the High Vocabulary group, novel words (both nouns and adjectives) facilitated the formation of superordinate level

TABLE 9
Mean Contrast Scores and Novelty-Preference Scores in Experiment 3

	Familiarization phase: Contrast scores						Test phase: Novelty-preference scores					
	Basic level			Superordinate level			Basic level			Superordinate level		
	Noun	Adjective	No word	Noun	Adjective	No word	Noun	Adjective	No word	Noun	Adjective	No word
Experiment 3												
High vocabulary group												
Mean	24.2	17.8	19.5	16.1	14.7	-2.8	.61	.60	.56	.59	.60	.56
SD	14.7	17.6	22.2	11.3	15.7	20.0	.09	.14	.17	.09	.20	.15
<i>t</i> value	5.71***	3.50**	3.03*	4.94***	3.23*	-0.49	4.54**	2.52*	1.33	3.51**	1.68	1.51
Low vocabulary group												
Mean	11.26	14.9	16.6	3.7	8.1	6.5	.52	.56	.62	.54	.58	.59
SD	23.5	14.6	11.7	20.2	13.1	22.2	.17	.07	.14	.12	.18	.16
<i>t</i> value	1.66	3.55**	4.91**	0.63	2.15	1.01	0.37	3.39*	3.00*	1.16	1.47	2.03

Note. $N = 12$ per condition. Contrast scores: t tests against $H_0 = 0$. Novelty-preference scores: t tests against .50 chance level.

* $p < .05$ two-tail, ** $p < .005$ two-tail, *** $p < .0005$ two-tail.

categories of objects. However, in the Low Vocabulary group, neither novel nouns nor adjectives exerted a consistent, demonstrable influence.

High Vocabulary Group

Familiarization phase. The results of this phase are depicted in Fig. 5. We first tested the prediction that infants in the *Novel Noun* and *Novel Adjective* conditions would exhibit a greater decrease in attention during the familiarization phase than would their counterparts in the *No Word* condition. We submitted the average attention devoted to the familiarization objects in Block 1 (familiarization trials 1 and 2) and in Block 2 (familiarization trials 3 and 4) to a three-way analysis of variance, with Condition (*Novel Noun* vs *Novel Adjective* vs *No Word*) as a between-subjects variable, and Level (Basic vs Superordinate) and Block (Block 1 vs Block 2) as within-subjects variables. This analysis revealed significant main effects for Level, $F(1,33) = 8.48, p < .01$, and for Block, $F(1,33) = 52.75, p < .001$. This latter main effect was qualified by a Block \times Condition interaction, $F(2,33) = 4.39, p < .05$. As predicted, tests of simple effects revealed that infants in the *Novel Noun* and *Novel Adjective* conditions showed a significant decrease in attention from Block 1 to Block 2 while those in the *No Word* condition did not, Tukey's HSD = 2.20, $p < .01$.

We next calculated individual contrast scores for each subject and for each familiarization phase. We then compared the mean contrast score for subjects in each condition and at each hierarchical level to chance. If there was no linear decrease in attention during the familiarization phase, then the mean contrast scores should sum to zero.

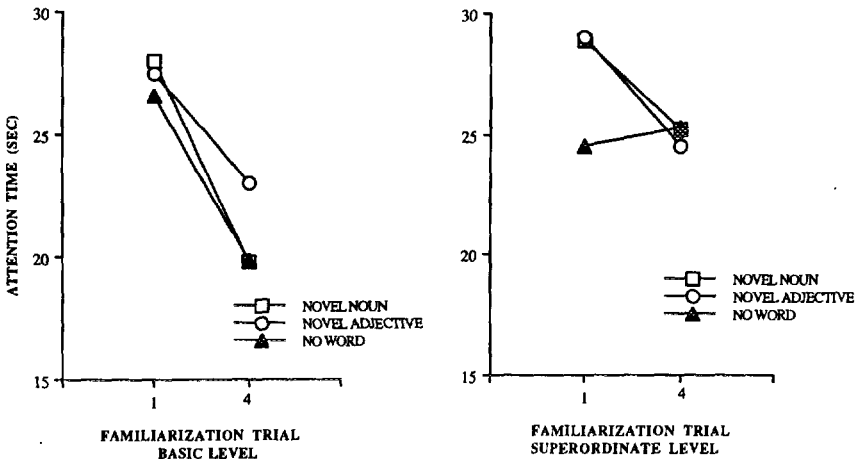


FIG. 5. Experiment 3—High Vocabulary group: familiarization phase. The mean duration of attention during familiarization trials 1 and 4 as a function of hierarchical level and condition.

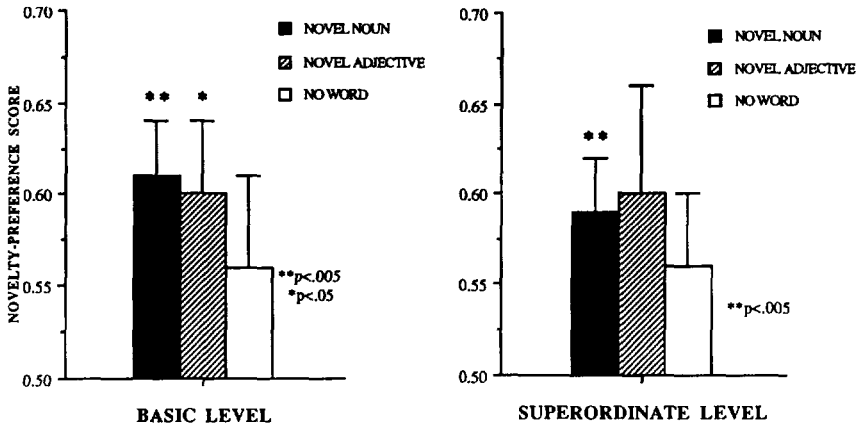


FIG. 6. Experiment 3—High Vocabulary group: test phase. The mean novelty-preference score as a function of hierarchical level and condition. Asterisk indicates comparisons to chance responding (0.50).

At the basic level, infants in all three conditions exhibited a significant linear decrease in attention. As was the case in Experiment 1, it was at the superordinate level that the effect of the novel words became evident. Infants in the *Novel Noun* condition showed a linear decrease in attention, $t(11) = 4.94$, $p < .0005$. Those in the *Novel Adjective* condition also exhibited a linear decrease in attention, $t(11) = 3.23$, $p < .01$. Only infants in the *No Word* condition failed to exhibit such a trend.

Test phase. During the test trials, the effects of novel nouns and adjectives were also quite comparable. Figure 6 displays the proportion of attention the infants devoted to the novel test object. At the basic level, infants in both the *Novel Noun* ($M = .61$; $t(11) = 4.54$, $p < .001$) and *Novel Adjective* ($M = .60$; $t(11) = 2.52$, $p < .05$) conditions showed reliable novelty preferences. Infants in the *No Word* condition showed no such preference ($M = .56$).⁵ At the superordinate level, only infants in the *Novel Noun* condition ($M = .59$; $t(11) = 3.51$, $p < .005$) showed this preference.

Individual patterns of behavior. In the next analysis, we examined the patterns of behavior exhibited by individuals, rather than groups of subjects. As in Experiments 1 and 2, for each infant, we recorded the trials on which there was both a decrease in attention during familiarization and a preference for the novel object at test. These data are presented in Table 6, broken down to show the number of infants in each condition exhibiting this pattern of behavior on 0, 50, and 100% of their trials.

⁵ Using looking time as the dependent measure, infants in the *No Word* condition did show a novelty preference, ($M = .60$; $t(11) = 2.27$, $p < .05$).

Our analysis revealed that at the basic level, the distribution of individual patterns was comparable in all three conditions. However, at the superordinate level, the effect of the novel words again became apparent. An overall χ^2 analysis revealed that the individual patterns of behavior differed among the three conditions, $\chi^2(4, N = 36) = 11.73, p < .02$. To provide a more focused test of our hypothesis, we conducted a "combined category" test, pitting the individual patterns observed in the *Novel Noun* and *Novel Adjective* conditions against that observed in the *No Word* condition. This analysis revealed that the combined distribution of performance in the *Novel Noun* and *Novel Adjective* conditions differed from that in the *No Word* condition, $\chi^2(2, N = 36) = 6.55, p < .05$. We note that eight (67%) subjects in the *No Word* condition failed to meet our criterion on any superordinate level trial. In the *Novel Noun* and *Novel Adjective* conditions, only one (8%) and three (25%) infants, respectively, failed to meet this criterion. Thus, these analyses based on individual patterns of performance converge perfectly with the group data to fortify the view that novel labels, both nouns and adjectives, focus infants' attention on object categories.

Low Vocabulary Group

Familiarization phase. The results from the Low Vocabulary group are depicted in Fig. 7. A three-way ANOVA revealed main effects for Level, $F(1,33) = 15.96, p < .001$, and for Block, $F(1,33) = 26.67, p < .001$; there were no reliable interactions. We next examined the individual contrast scores. At the basic level, infants in all three conditions exhibited a linear decrease in attention, although in

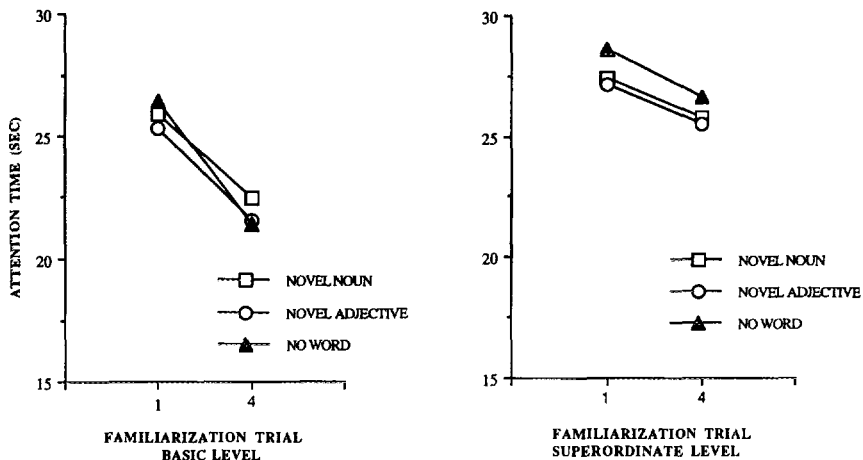


FIG. 7. Experiment 3—Low Vocabulary group: familiarization phase. The mean duration of attention during familiarization trials 1 and 4 as a function of hierarchical level and condition.

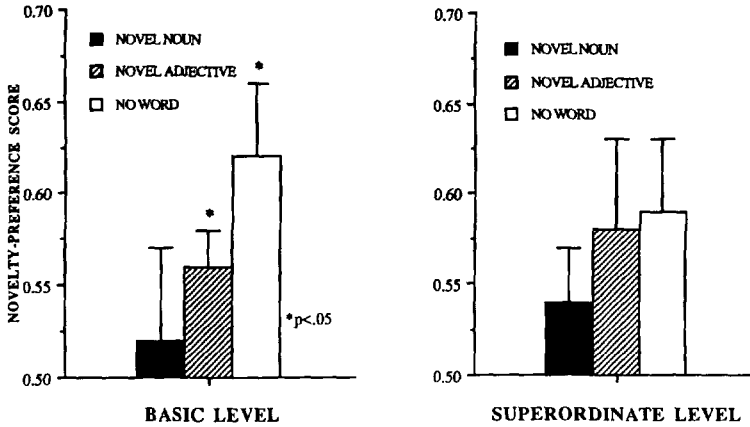


FIG. 8. Experiment 2—Low Vocabulary group: test phase. The mean novelty-preference score as a function of hierarchical level and condition. Asterisk indicates comparisons to chance responding (0.50).

the *Novel Noun* condition, this trend did not meet significance ($p = .12$).⁶ At the superordinate level, infants in all three conditions failed to demonstrate a reliable linear decrease over familiarization trials.

Test phase. An inspection of Fig. 8 reveals how this group's performance during the test phase was also markedly different from that of their counterparts in the High Vocabulary group. At the basic level, infants in the *Novel Adjective* ($M = .56$) and *No Word* ($M = .62$) conditions showed a preference for the novel object; those in the *Novel Noun* ($M = .52$) condition did not show such a preference. At the superordinate level, none of the groups showed a novelty preference.

Individual patterns of behavior. We next examined the patterns of individuals, rather than groups of subjects (see Table 6). A χ^2 analysis on these data also failed to reveal any systematic effect for novel words. The distribution of performance did not differ among the three conditions at either the basic or the superordinate levels.

Further Analyses Based on Lexical Abilities

The analyses described above suggest that infants' performance in the novelty preference task was related to their reported lexical abilities. Before discussing this finding, we sought to pursue this phenomenon further, primarily to ascertain whether it was a consequence of our having selected production as our criterion for distinguishing between the High and Low Vocabulary groups. We therefore

⁶ Using looking time as the dependent measure, infants in the *Novel Noun* condition did reveal a significant decrease in attention, $t(11) = 2.56$, $p < .05$.

reanalyzed the data from all 72 subjects in Experiment 3, but this time established High and Low Vocabulary groups on the basis of their reported levels of comprehension, rather than production. These analyses revealed the same pattern as that described above, with infants in the High Comprehension group demonstrating a facilitative effect of novel words (both nouns and adjectives) and infants in the Low Comprehension group demonstrating no effects of novel words. This outcome is not especially surprising, given the high correlation between parental reports of production and comprehension in this sample of infants.

In a subsequent analysis, we examined the two most extreme groups in our sample, selecting only those subjects falling above the median for both production and comprehension for the High Vocabulary group, and only those infants falling below the median on both comprehension and production for the Low Vocabulary group. The total number of subjects in the High and Low Vocabulary groups were 18 and 19, respectively. Once again, this analysis revealed the same patterns as those discussed above.

Discussion

The results of this third experiment amplify our understanding of the emergence of linkages between novel words and categories of objects. We focus here on three main points. First, the data from infants in the High Vocabulary group replicate the finding from Experiment 1 that novel nouns facilitate infants' appreciation of the commonalities among members of object categories at the superordinate level. Second, these data extend the results of Experiment 1 by revealing that this facilitative effect holds for the introduction of novel adjectives as well as for novel nouns. These points will be treated more fully under General Discussion.

Our third point concerns the finding that infants' performance in the novelty-preference task was related to their reported level of lexical acquisition. Recall that infants in the High and Low Vocabulary groups were matched for age and differed only in their reported levels of lexical accomplishments in production and comprehension. Performance in the High Vocabulary group was quite systematic and accorded well with our prediction that both noun and adjective labels should focus 12-to 13-month old infants' attention on object categories, particularly at the superordinate level. In contrast, performance in the Low Vocabulary group was considerably less systematic and revealed no consistent influence of novel labels.

These analyses suggest that infants' lexical advances may indeed be associated with their sensitivity to the linkage between words and object categories. This is an intriguing new finding that warrants careful consideration and further documentation. Notice, for example, that this association cannot reveal the *direction* of this effect. One possibility is that it is precisely those infants who become sensitive to the linkage early that fare best in word learning. Support for this

interpretation will require an independent explanation of why some infants gain sensitivity to this linkage earlier than others. Some candidate hypotheses might include maturational level, characteristics of the input, or the types of words that the infant first acquires.

However, it is also possible that the causal arrow points in the opposite direction. Perhaps infants only become sensitive to the linkage between words and object categories once they have acquired a sufficient number of entries in their lexicons. We note that although this interpretation of the data is similar to the theoretical position offered by Nelson (1988; 1991), there is one significant point of departure. Nelson speculated that a linkage might be learned at around the time of the vocabulary explosion, when infants had acquired roughly 30 words in their production vocabularies. Yet our data reveal that infants with a mean production vocabulary of only 9 words evidence an appreciation of this linkage. Moreover, the magnitude of the difference between the vocabularies of our two groups of subjects is a small (albeit, statistically reliable) one. A review of Table 4 reveals that on average, infants in the High Vocabulary group had command of only 8.5 more words in production and 10.7 more words in comprehension than did their counterparts in the Low Vocabulary group. We conducted a closer inspection of the particular additional words that were attributed to the High Vocabulary group. This inspection revealed that on average, two-thirds of these additional words were classified as nouns (in the adult grammar) and were used by the infants to refer to object kinds; the remaining one-third of the additional words were terms from other grammatical categories (in the adult grammar), including verbs, prepositions, modifiers, and social expressions. It is difficult to imagine that this distribution of newly acquired words would constitute a sufficiently large and consistent base upon which to induce an abstract linkage between words and object categories. Therefore, support for this interpretation will require an explanation of the mechanism by which such an induction might be made.

Third, it is possible that the association between the emergence of these linkages and infants' lexical advances is merely coincidental, bearing no direct causal relation, or that both are the result of a third variable (e.g., perhaps related to a general cognitive, social or dispositional style). Fourth, it is quite possible that the null effect obtained in the Low Production group is a consequence of the particular methods we selected. Perhaps with a more precise measure of lexical ability, a different picture would have emerged.

In sum, we argue for caution in interpreting the null effects in the Low Vocabulary group, and underscore the importance of pursuing this provocative result. In future work, it will be important to utilize more precise and objective measures of infants' lexical abilities than parental report and more varied measures of object categorization. In this next generation of studies, longitudinal work may be necessary to chart carefully the emergence of these linkages in the very initial stages of lexical acquisition.

GENERAL DISCUSSION

The goal of these experiments was to investigate the emergence of one particular linkage—the noun-category linkage—in infants at the very beginning of lexical acquisition. With this goal in mind, we devised a modified novelty-preference task to reveal whether and how novel words influence object categorization in infants just beginning to produce language on their own.

The results of this series of experiments provide the earliest documentation to date of infants' sensitivity to a linkage between words and categories of objects. Our findings reveal that a linkage between words and object categories emerges early in the process of lexical acquisition—early enough to serve as a guide in infants' efforts to map words to their meanings. These data also reveal another fundamental ability on the part of these very young word learners. Infants clearly notice when novel words are introduced; they distinguish between phrases in which novel words are present and those which contain no novel words (also see Jusczyk & Aslin, in press). Moreover, at this point in development, both nouns and adjectives appear to exert the same effect on categorization performance; novel words from both of these grammatical categories focus infants' attention on commonalities among objects, particularly those at abstract, superordinate levels. These experiments also suggest that infants' progress in word learning may be associated with their appreciation of linkages between words and object categories.

The results of these experiments are consistent with the hypothesis that when infants embark upon the process of lexical acquisition, they are initially biased to interpret words (from various grammatical categories, including both nouns and adjectives) applied to solid objects as referring to those objects and to other members of the same category. (See Echols, 1992, for evidence that verbs, too, may initially direct infants' attention to object categories.) We propose that this general linkage between words and object categories will become more specific as infants begin to distinguish among the grammatical categories in their language and assign them more specific types of meaning.

This initial linkage is important in two respects. First, the fact that it is available to infants at 12 and 13 months of age supports the claim that it serves as a guide in infants' early efforts to map words to their meanings, fueling the process of lexical acquisition well before infants enter the vocabulary explosion (also see Waxman & Hall, 1993). This strong empirical finding challenges directly the proposal that the noun-category linkage is unavailable during the initial stages of language acquisition (L. Bloom, Tinker & Margulis, 1993; Nelson, 1988).

Second, the fact that it is initially general (including both nouns and adjectives) converges well with existing developmental and cross-linguistic findings. It is consistent with *developmental* work suggesting that 12- and 13-month-old infants have probably not yet identified the relevant surface cues that will allow them to distinguish among the particular grammatical categories in the input. Our

proposal is also consistent with the *cross-linguistic* fact that languages converge in the mappings between nouns and categories of objects, but differ in the ways in which they recruit other grammatical categories to convey particular types of meaning (Bowerman, 1985; Gentner, 1981; 1982; Jackendoff, 1990; Maratsos & Chalkley, 1980; Talmy, 1985). These observations highlight the utility of our account: It is to the infants' advantage to begin with an initially general expectation that will guide them in establishing early word-meaning mappings and that can be tailored to suit the particular patterns encountered in their native language.

We have proposed that this initially general linkage will become increasingly specific over development and with experience with the particular language(s) under acquisition. For although infants in this series of experiments treated nouns and adjectives identically with respect to object categorization, this is not the case later in development. Preschool-aged children distinguish among particular types of words (e.g., nouns, adjectives) and assign them particular types of meanings (e.g., object categories, properties of objects) (Echols, 1992; Fisher et al., 1994; Golinkoff, Hirsh-Pasek, Cauley, & Gordon, 1987; Hall et al., 1993; Naigles, 1990; Taylor & Gelman, 1988; Waxman, 1990; Waxman & Kosowski, 1990). Clearly, then, between infancy and the preschool years, there is a burgeoning sensitivity to using syntax as a cue to meaning.

How does an appreciation of these more finely tuned linkages develop out of an initial, more general expectation linking words to objects and categories? A thorough discussion of this issue involves both linguistic and conceptual considerations.

The Specificity of the Phenomenon: Linguistic Considerations

Beginning with the linguistic considerations, we ask first whether infants' ability to categorize objects, particularly at the more abstract superordinate levels, is facilitated by labeling, per se, or by the more general arousing effects of infant directed speech. Recall that we used the "motherese" speech register to capture all infants' attention; we also attempted to keep the prosody and stress contours roughly consistent across conditions. Because we observed a facilitative effect in the *Word* conditions, as compared to the *No Word* conditions, we conclude that these effects are attributable to the introduction of the labels, per se, rather than to the more general arousing and attention-getting effects of infant-directed speech. This fits nicely with Fernald's (1992) observation that the function of infant-directed speech undergoes a developmental progression "... from the more general attentional and affective functions in the early months to linguistic functions toward the end of the first year" (p. 279).

However, data from Roberts and Jacob (1991) offer a different account. They report that both words and instrumental music facilitate 15-month-old infants' formation of superordinate level object categories, relative to their performance in a baseline, salient condition. Why would instrumental music have this facil-

itative effect on superordinate level categorization when the infant-directed speech of our *No Word* conditions did not? There are several differences in procedure that may account for this discrepancy. Infants in Roberts and Jacob's studies passively viewed a series of two-dimensional slides which were presented on a screen, with the auditory input emanating from an audio-speaker. In addition, because theirs was a more standard habituation task, Roberts and Jacob presented a greater number of familiarization trials to insure habituation. In contrast, we presented children with only four exemplars of each category, and we examined the influence of a narrower range of auditory stimuli. Moreover, our procedure may be more akin to the encounters in which infants typically learn novel words and explore objects. Infants in our experiments actively manipulated realistic toys which were introduced to them in face-to-face-interactions with an experimenter using infant-directed speech. Under such circumstances, infants more readily form object categories when they hear a novel word than when no word is present (also see Waxman & Hall, 1993). These results suggest that although labels are not the sole means by which infants form categories, providing a common label for a group of objects serves as a particularly swift and powerful cue.

We next ask how an initially general linkage, in which infants treat nouns and adjectives identically with respect to object categorization, gives way to the more specific linkages that have been revealed in older preschool aged children. There are several mechanisms by which this evolution may come about, although the data presented here do not allow us to specify this mechanism precisely.

One possibility is that infants begin the process of lexical acquisition with a general expectation that words applied to objects, regardless of their grammatical form, will refer to kinds of objects; only later do they learn that (in English) this linkage is typically true for count nouns, but not for words from other grammatical categories (e.g., adjectives).

Another possibility is that initially, infants (like older children and adults) hold an abstract expectation that there are distinct grammatical categories and that these are linked to particular types of meaning (c.f., Gleitman, 1990; Grimshaw, 1981; Pinker, 1984). However, either because their processing limitations prevent them from perceiving the differences between the syntactic frames surrounding novel words or because they have not yet learned the relevant surface cues to distinguish among these grammatical forms in sentences like the ones we presented here, infants initially interpret novel adjectives as they do nouns.

A third possibility is that even if infants do expect that each grammatical form maps to a distinct type of meaning, and even if they do perceive the differences between nouns and adjectives in the sentences we provided, they might still fail to exhibit this sensitivity because of the limited lexical knowledge. This possibility is consistent with data reported recently by Hall, Waxman, and Hurwitz (1993). These authors demonstrated that children's sensitivity to the grammatical form of a novel word (noun or adjective) applied to an object varied as a function

of their familiarity with an existing label for that object. Although Hall and his colleagues included only basic level kinds, their findings are highly relevant to those reported here. They found that subjects hearing novel nouns applied to objects (e.g., to a cup) interpreted these as referring to the object kind (e.g., other cups), as opposed to a salient property of the objects (e.g., the material (glass, metal) from which it was constructed). This effect held up whether the labeled object was familiar (e.g., a cup) or unfamiliar (e.g., a cornucopia). However, the results with the novel adjectives were more complex: Four-year-olds tended to interpret the novel adjectives as referring to properties *only* when the objects under consideration were familiar, when these were unfamiliar, 4-year-olds tended to interpret the adjectives, like nouns, as referring to the category of object. Two-year-olds tended to interpret novel adjectives as referring to object kinds on familiar as well as unfamiliar trials. This finding, which parallels the data we report here with infants, is intriguing because by two years of age, infants distinguish between these grammatical categories, and, moreover, expect that adjectives (but not count nouns) refer to properties (Taylor & Gelman, 1988; Waxman & Kosowski, 1990).

There are several possible interpretations of this finding. (See Hall et al., 1993 for a thorough discussion.) Perhaps most relevant is the fact that for infants in the studies reported here, the overwhelming majority of objects were ones for which infants had no demonstrable label. Of course, this is the modal case at the initial phases of lexical acquisition. Thus, infants' tendency to interpret novel adjectives as referring to object kinds may be, at least in part, a consequence of their limited lexical repertoires. This possibility is currently under investigation.

Although the three interpretations outlined above reflect different theoretical commitments, it is difficult to disentangle them empirically, for they are all consistent with the finding that infants' first linkage between words and object categories is general, as we have shown, and that more specific linkages will become evident as a function of infants' experience with the particular grammatical distinctions drawn in their language and their familiarity with labels for object kinds. In future research, it may be possible to ascertain which of these possibilities are responsible for the infants' tendency to treat nouns and adjectives identically with respect to object categorization.

The Specificity of the Phenomenon: Conceptual Considerations

Just as we expect there to be advances with development on the linguistic side of the noun-category linkage, so do we expect advances on the conceptual side. This is because although infants may, under certain circumstances, group together the same sets of objects as do older children and adults, this categorization performance 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, we assume that 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, 1985; Gelman & Coley, 1990; Gentner & Waxman, 1994; Keil, 1987; Murphy & Medin, 1985).

Although it is beyond the scope of this paper to describe how children acquire these deeper, more elaborate, more interconnected conceptual systems, it is important that we consider here what role labels might play in this process (also see Gentner & Waxman, 1994). We have argued that words focus infants' attention on commonalities among objects and in so doing, facilitate the establishment of object categories, particularly at abstract superordinate levels. Our data provide clear support for this view. On the superordinate level sets, infants who heard no labels exhibited no categorization performance in our task; *only* infants who were introduced to labels demonstrated consistent categorization. We interpret this as evidence that providing a common label launched a search for coherence among these otherwise disparate sets of objects. (See Waxman (1990) for evidence that labels exert a similarly dramatic effect at nonbasic levels with preschool aged children; see Waxman (1991; 1994) for fuller discussions of this point.)

Note that this search for commonalities among objects may also be unsuccessful: Recall that labels had no effect on infants' performance with arbitrary sets of objects (Experiment 2). In the initial phases of word learning, then, it is likely that labels require some perceptual support if they are to facilitate the formation of object categories.

These experiments raise several interesting issues and suggest several potentially productive avenues for future research. We suspect that in addition to highlighting perceptually based commonalities among objects, labels may offer an additional benefit in conceptual development: a common label may signal nonobvious and perhaps deeper commonalities among the objects as well (Gelman, 1988; Gelman & Coley, 1990; Gelman & Markman, 1987; Shipley, 1988). For example, at the basic level, where the perceptual similarity among the objects was most readily apparent, infants performed comparably in our categorization task both with and without the introduction of labels. However, it is possible that in such cases, labels may engender a search for non-obvious and perhaps deeper commonalities as well. In future work it may be possible to test whether those basic level categories that have been labeled have greater conceptual coherence or inductive depth than those that have not been labeled.

Another direction for future research is to specify the range of commonalities that are associated with novel words. For example, we suspect that in the earliest phases of lexical development, novel words may focus infants' attention on common properties (e.g., color or texture) as well as on categories of objects. If this is the case, then a novel word may facilitate the infant's ability to group objects together on the basis of properties (like color, material, size) that cut across object kinds (Markow & Waxman, 1994).

*On the Acquisition of Basic and Superordinate (or Global) Level
Object Categories*

The results of these experiments also bear on questions concerning the emergence of object categories at various hierarchical levels even in the absence of novel labels. Although the bulk of the evidence in developmental research is consistent with Rosch's (1978) assertion that basic level categories emerge earliest in development (Fenson, Cameron, & Kennedy, 1988; Mervis & Crisafi, 1982; Quinn, Eimas, & Rosenkrantz, 1993; Roberts, 1988; Roberts & Cuff, 1989; Roberts & Horowitz, 1986; Rosch et al., 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 that categorization at a more global, more abstract conceptual level *precedes* categorization at the basic level.

However, we see no support for this developmental progression. In our experiments, performance in the *No Word* conditions serve as a case in point. On Mandler's account, infants in this condition should perform at least as well, if not better, on the more abstract conceptual categories, as compared to those at the basic level. This is especially true for Experiment 1, in which we contrasted animate and inanimate kinds (e.g., animals vs vehicles) in our superordinate level sets. This distinction is one that Mandler offers as an example of early-emerging, abstract "global" categorization.

Yet Mandler's prediction that global categorization *precedes* basic level categorization is not borne out in our data. On the contrary, infants in the *No Word* conditions readily formed basic level categories, but evidenced no appreciation of the higher-order categories represented by our superordinate level sets. These results illustrate the facility with which infants form basic level, as opposed to higher-order categories.

Our results challenge those reported recently by Mandler and McDonough (1993). Using a novelty-preference task that is similar in many respects to the one we report here, Mandler and McDonough report that although infants successfully formed one global level distinction (animals vs vehicles), they failed to reveal a consistent pattern of performance at the basic level. Infants in their studies reliably formed some basic level categories (car vs plane), but not others (dog vs. fish). With 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 sufficient empirical support for the precedence of global over basic level categorization.

It is important to note that in principle, we take no issue with the theoretical position that global conceptual categories (e.g., animate objects, inanimate objects), as well as basic level categories, emerge early in development. Indeed, in our view, the possibility that infants acquire global as well as basic level cate-

gories is an attractive one that permits later category development to take advantage of both differentiation and generalization. However, on the basis of the existing empirical evidence, we dispute the claim that global categorization *precedes* basic level categorization, with the latter being derivative of the former.

*Words Are Not the Sole Vehicle by Which Infants Acquire
Higher-Order Categories*

Of course, this is not to say that in the course of development, infants will come to notice superordinate level categories *only* in the context of word learning. On the contrary, we fully expect that there are several other circumstances under which such categories become salient. For example, adults explicitly point out the commonalities among objects within superordinate level categories (Callanan, 1990), and we expect that such "tutorials" highlight taxonomic relations and facilitate the establishment of higher level categories (Horton & Markman, 1980; Mervis, 1984). In addition, there is evidence that the acquisition of higher-order relations is facilitated not only by use of common labels, but also by repeated exposure to exemplars (Gentner, Rattermann, Kotovsky, & Markman, in press). We therefore expect that if we had provided more than four familiarization trials in our task, infants may well have evidenced an appreciation of the superordinate level categories even without the introduction of labels (Mandler & McDonough, 1993; Roberts & Jacob, 1991). Our data are important because they reveal that novel words provide infants with a swift and especially effective cue to the establishment of object categories.

Words as Invitations to Form Categories

Our closing point is quite simple: Words serve as *invitations* to form categories. This invitation is at once modest and dramatic. We claim that words focus attention on commonalities among objects, highlighting them especially in cases where the perceptual similarity among objects may not be as apparent as at the basic level. Thus, novel words invite infants to assemble together objects that might otherwise be perceived as disparate and distinct entities. This modest invitation has dramatic consequences, for by engendering such groupings, words provide infants an opportunity to consider these objects together, to compare them, and in so doing, to discover deeper and perhaps more subtle commonalities among them. In this manner, words advance infants from forming primarily perceptually based groupings to gaining a richer appreciation of the important nonobvious commonalities that characterize our most powerful and inclusive categories of objects.

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