

# The Development of a Linkage between Count Nouns and Object Categories: Evidence from Fifteen- to Twenty-One-Month-Old Infants

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WAXMAN, SANDRA R., and HALL, D. GEOFFREY. *The Development of a Linkage between Count Nouns and Object Categories: Evidence from Fifteen- to Twenty-One-Month-Old Infants*. CHILD DEVELOPMENT, 1993, **64**, 1224–1241. Recent research suggests that, although young children appreciate many different kinds of conceptual relations among objects, they focus specifically on taxonomic relations in the context of word learning. However, because the evidence for children's appreciation of this linkage between words and object categories has come primarily from children who have made substantial linguistic and conceptual advances, it offers limited information concerning the development of this linkage. In the experiments reported here, we employ a match-to-sample task to focus specifically on the development of an appreciation of the linkage between words (here, count nouns) and object categories in infants in the period just prior to and just subsequent to the naming explosion. The results demonstrate that, for 21-month-old infants, most of whom have recently entered the vocabulary explosion (Experiment 1), and for 16-month-old infants, most of whom have yet to commence the vocabulary explosion (Experiment 2), novel nouns focus attention on taxonomic relations among objects. This is important because it reveals a nascent appreciation of a linkage between words and object categories in infants who are at the very onset of language production. Results are interpreted within a developmental account of infants' emerging appreciation of a specific linkage between count nouns and object categories.

Linguistic and conceptual development have each, independently, served as a focus of decades of productive investigation. However, more recently, the nature of the relation between these two naturally emerging capacities has become a topic of lively debate (see, e.g., Gelman & Byrnes, 1991). Several researchers have pointed out that, although young children appreciate many different kinds of conceptual relations among objects, they do not attend to these relations equally when trying to determine the meaning of a new word. Instead, particular types of words (e.g., nouns, adjectives) focus young children's attention on particular types of meanings. For example, children as young as 2 and 3 years of age expect that solid objects and object categories will be

described by count nouns and that properties of objects will be marked by adjectives (Markman & Hutchinson, 1984; Markman & Wachtel, 1988; Soja, Carey, & Spelke, 1991; Taylor & Gelman, 1988; Waxman, 1990).

However, because the experimental evidence for an appreciation of these precise linkages has come primarily from children who have already made substantial progress in both the linguistic and conceptual arenas, we are left with a very limited understanding of when and how an appreciation of these linkages develops. Therefore, in the experiments reported here, we focus specifically on the development of an appreciation of the linkage between count nouns and object categories in infants ranging from 15

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to 21 months of age—infants in the periods just prior to and just subsequent to a phenomenon known as the naming explosion or the dawning of nominal insight (Dromi, 1987; Goldfield & Reznick, 1990; McShane, 1979).<sup>1</sup>

This developmental period is of special interest primarily because of infants' remarkable accomplishments in word learning. Before this period opens, at approximately 10–12 months of age, infants reach a major developmental milestone—they begin to produce their first words. At this point, word learning proceeds at a steady, gradual pace. Yet several months later, both the pace and character of lexical acquisition advance dramatically. At approximately 17–20 months of age, or once infants have acquired approximately 50 words in their productive vocabularies, there is a sudden burst in lexical acquisition (Benedict, 1979; Dromi, 1987; Goldfield & Reznick, 1990; Nelson, 1973). Infants begin to learn new words at a rate of approximately nine per day (Carey, 1978). It is because most of the words acquired during this period are count nouns (Gentner, 1982) that this period of rapid lexical acquisition has been referred to as the naming explosion. The naming explosion draws to a close when infants begin to produce multiword utterances, sometime around the second year.

Our goal in the experiments reported here was to examine how infants' appreciation of the noun-category linkage corresponds to the major developmental milestones occurring during this active period. One possibility is that an appreciation of the noun-category linkage is in place from the very onset of lexical acquisition (Macnamara, 1982; Pinker, 1984; Waxman, 1991). If this is the case, then the tendency to interpret nouns (or, perhaps, words from any grammatical category—see "General Discussion") as referring to object categories should be evident in infants even as they begin to produce words. That is, it should be evident in infants prior to the naming ex-

plosion. Such a finding would suggest that infants' first efforts to map words to their meanings may be guided by an expectation that words and object categories are linked.

Another possibility is that an appreciation of the noun-category linkage emerges later and is dependent on experience with the language system. If this is the case, then an appreciation of the linkage might be absent during the very earliest stages of lexical acquisition; it should emerge only after the process of word learning is well under way, after children have acquired a sufficient number of words to permit them to induce the appropriate correlation between count nouns and object categories (Bauer & Mandler, 1989; Landau, Smith, & Jones, 1988; Markman, 1992; Nelson, 1988; Waxman, 1991). A finding like this would suggest that, with experience, children come to notice the correlation between count nouns and categories of objects. They then may exploit this correlation to learn the meaning of subsequent words.

To evaluate empirically these two broad alternatives, researchers have begun to examine the impact of introducing novel labels to young infants on a range of behavioral tasks. For example, Baldwin and Markman (1989) have reported that 10–14-month-old infants devoted more attention to objects that had been labeled with a count noun than to objects that had not been labeled. This finding suggests that labels help to direct infants' attention toward objects even before the infants are themselves producing language.

Others have taken this issue a step further to ascertain whether labels focus infant's attention on *categories* of objects. For example, Waxman and her colleagues used an object manipulation task, analogous to more standard infant habituation procedures, to examine the influence of novel labels on infants' categorization (Markow & Waxman, 1992; Waxman & Heim, 1991). The data revealed that labels focus 12- and 13-

<sup>1</sup> In this article, we seek to establish the effect of novel count nouns on infants' object categorization. Because we test only count nouns, we cannot compare the influence of various other syntactic categories (e.g., proper nouns, adjectives) on infants' object categorization. We therefore cannot determine whether the effects demonstrated here are specific to count nouns, to all nouns, or to novel words (e.g., adjectives) in general. This important issue, which will be addressed in future work, is considered in the "General Discussion." The existing literature suggests that 15–21-month-old infants do not distinguish the syntax of count nouns from mass nouns or from adjectives (Bloom, 1990; Gordon, 1985; Markow & Waxman, 1992; McPherson, 1991; Prasada, in press; Soja, 1992; Valian, 1986). However, 17-month-old females may distinguish proper from common nouns under certain circumstances (Katz et al., 1974).

month-old infants' attention on object categories. (See the "General Discussion" for a fuller treatment of this finding.) Other recent studies have provided converging evidence that by 13–15 months of age, novel labels direct infants' attention to object categories (Echols, 1991; Roberts & Jacob, in press).

Thus, a clear consensus has begun to emerge regarding infants' appreciation of the relation between nouns and object categories in the period prior to the onset of the naming explosion. The accumulated evidence suggests that novel nouns focus infants' attention on objects and categories of objects. This is consistent with the hypothesis that sensitivity to a linkage between nouns and object categories is in place, in at least a rudimentary form, at the very beginning of the process of lexical acquisition.

There is, however, one published report that is at odds with this emerging consensus. Bauer and Mandler (1989) used a triad task to examine the categorization abilities of 16–31-month-old infants. One goal of their experiments (Experiments 1 and 3) was to "assess the influence of novel labels on categorical responding" (p. 161). They hypothesized that the sensitivity to the linkage between nouns and object categories develops during the second year of life, in the period subsequent to the naming explosion. To test this hypothesis, they compared performance in Novel Label and No Label conditions. They predicted that, prior to the onset of the naming explosion, novel nouns would exert no influence on categorization performance, but that, subsequent to the naming explosion, novel nouns would focus attention on taxonomic relations (p. 160, p. 166). However, the data were not consistent with this prediction. Instead, novel nouns had no apparent effect. Interestingly, infants at all ages and in both the Novel Label and No Label conditions demonstrated an overwhelming preference for the taxonomic alternatives.

Bauer and Mandler's is the only published report in which infants have failed to reveal a sensitivity to novel nouns in an object categorization task. When their result is considered against the backdrop of existing work in the field, it raises the possibility that there may be a *discontinuity* in the development of the linkage between nouns and category relations. Recall the evidence indicating that labels highlight object categories for

infants ranging in age from 12 to 15 months (Baldwin & Markman, 1989; Echols, 1991; Markow & Waxman, 1992; Roberts & Jacob, in press; Waxman & Heim, 1991) and for preschool children, ranging in age from approximately 30 months to 4 years (Markman & Hutchinson, 1984; Waxman, 1990; Waxman & Kosowski, 1991). Bauer and Mandler's data suggest that these labeling effects may be absent in the period from 16 to 31 months of age. This apparent discontinuity is especially surprising because it would coincide precisely with the period during which infants are in the most active phases of word learning. Because the possibility of a developmental discontinuity raises an important theoretical issue, it warrants careful attention.

A thorough examination of Bauer and Mandler's procedure suggests a likely explanation for their null effect. One key aspect of their procedure obscured the opportunity to observe the influence of novel labels in their task. In contrast to the procedures adopted in other empirical investigations of labeling effects in young subjects (e.g., Markman & Hutchinson, 1984; Waxman & Kosowski, 1991), in Bauer and Mandler's design, the experimenter systematically rewarded infants in both the No Label and Novel Label conditions for all and only categorical selections. This reinforcement began in an initial training period. In this period, the experimenter cheered and clapped when infants made categorical selections; she corrected infants when they selected the thematic alternative. After the training period, the reinforcement continued. During the test trials, infants were reinforced positively for making taxonomic selections but were offered only neutral comments (e.g., "Thank you") for making thematic selections. It is therefore not surprising that these infants selected the taxonomic alternatives with such great frequency, even in the absence of a label. Put simply, infants' uniformly high rate of taxonomic responses in both conditions illustrates the power of reinforcement. As Bauer and Mandler acknowledge, infants' highly taxonomic performance left little latitude for novel labels to influence performance.

It is important to note, however, that because Bauer and Mandler did not assess the influence of novel labels in the absence of reinforcement, these data do not bear directly on questions concerning children's interpretive biases in the context of word

learning.<sup>2</sup> This is because, under more naturalistic conditions, infants do *not* have the benefit of reinforcement that is perfectly contingent on their performance (Brown, 1957; Carey, 1978). Instead, in the more typical word-learning scenario, infants are faced with novel words, novel scenes (including objects and events), and a nearly infinite set of possible mappings between the two. We know that infants appreciate many different kinds of conceptual relations (e.g., taxonomic, thematic, causal relations). The key question is whether infants sample freely from among these various kinds of conceptual relations in nonlinguistic tasks but restrict their focus to primarily taxonomic relations in the context of word learning. The empirical evidence cited above suggests that this may indeed be the case, for subjects younger than 15 months and older than 30 months of age. At issue, then, is whether and how novel nouns influence children's performance in the intervening period.

The goal of the current experiments was to examine the influence of introducing novel count nouns to 15–21-month-old infants under experimental conditions that approximate the circumstances encountered by the young child in word learning. To this end, we employed a forced-choice match-to-sample procedure to compare performance in a Novel Noun condition (in which the experimenter labeled the target object with a novel count noun) with performance in a No Word condition (in which the targets received no label). Because we provided no reinforcement contingent upon the children's selections, our data serve as a direct test of the influence of novel labels in an experimental procedure that resembles the natural word-learning scenario. If labels direct infants' attention specifically on object categories, then subjects should be more likely to choose taxonomically in the presence of novel labels than in their absence.

## Experiment 1

The purpose of this experiment was to examine the influence of introducing novel count nouns during the periods just before and just after the naming explosion. The ex-

periment was designed to reveal the impact of novel nouns on 15- and 21-month-old infants' attention to object categories at the basic and superordinate levels.

## METHOD

### *Subjects*

Twenty 15-month-olds (with a mean age of 15 months, 17 days, ranging from 14 months, 17 days to 16 months, 29 days) and 20 21-month-olds (with a mean age of 21 months, 1 day, ranging from 19 months, 23 days to 22 months, 17 days) participated in the study. At each age level and within each condition (see below), there was an equal number of boys and girls. Subjects were recruited either via direct letters to parents or via an advertisement in a monthly parents' newspaper serving the greater Boston area. Subjects were drawn from a population of predominantly white middle- to upper-middle-class families in which English was the first language. All subjects completed the procedure.

### *Stimuli*

Stimuli were 36 toy replicas of animate and inanimate objects. A complete list of these stimuli may be found in Table 1. The objects were arranged into 12 sets of three objects each. Each triad included a target object (e.g., a carrot), a taxonomically related object (e.g., a tomato), and a thematically related object (e.g., a bunny rabbit). For all 12 triads, the target object and taxonomic alternative were toys representing inanimate objects (e.g., items of food, clothing, furniture); the thematic alternative was a toy representing an animate object (e.g., dolls, stuffed animals). This design feature was intended to highlight the distinction between the thematic and taxonomic relations among the objects in each triad. We note, however, that this feature also imposed a confounding between type of relation (thematic vs. taxonomic) and animacy (animate vs. inanimate). A wide range of thematic relations was depicted over the trials (e.g., drinking, washing, riding, eating). One additional design feature bears mention. For half of the triads, the taxonomically related object was a non-identical member of the same basic level

<sup>2</sup> Bauer and Mandier acknowledge this fact in their discussion. We note here that our question differs in emphasis and scope from the question posed by Bauer and Mandler. They were primarily concerned with increasing taxonomic responding in *their categorization task* (Bauer, personal communication, August 1992); we are primarily interested in examining the effect of introducing novel labels under conditions closely analogous to the conditions under which word learning naturally occurs.

TABLE 1  
OBJECT TRIADS USED IN EXPERIMENTS 1 AND 2

Target Object	Taxonomic Alternative	Thematic Alternative
Basic-level trials: <sup>a</sup>		
Cup .....	Cup	Baby doll
Shampoo bottle .....	Shampoo bottle	Baby doll
Airplane .....	Airplane	Clown
Bed .....	Bed	Smurf doll
Shirt .....	Shirt	Teddy bear
Cookie .....	Cookie	Cookie monster
Superordinate-level trials:		
Carrot .....	Tomato	Rabbit
Raincoat .....	Pants	Snoopy doll
Chair .....	Table	Minnie Mouse doll
Car .....	Boat	Adult figurine
Brush .....	Comb	Raggedy Ann doll
Bottle .....	"Sippy" cup	Baby doll

<sup>a</sup> Target object and taxonomic alternative on basic level trials were not identical. They differed from one another on a number of characteristics, including color, size, and patterning.

category as the target; for the remaining half, the taxonomically related object was a member of the same superordinate level category as the target.

Procedure

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 at a table across from the experimenter, either in an infant seat or in the parent's lap. The parent, who was present throughout the session, was instructed not to talk (to either the child or the experimenter) or to influence in any way the child's interest in or attention to the stimuli. The procedure consisted of 12 trials, each of which included a familiarization period followed immediately by an experimental period, described below. On each of the 12 trials, a different object triad was presented. The trials were presented in the same fixed order for each infant, beginning with a superordinate level trial and alternating between superordinate and basic level trials throughout.

*Familiarization period.*—Each trial began with a familiarization period, during which time the experimenter presented the child with the three objects for a given trial (the target object, the taxonomic object, and the thematic choice object). The child was encouraged to play freely with the objects for a total of 30 sec. After 30 sec had elapsed, the experimenter removed all three toys

from the child's view, placing them in her lap below the table.

*Experimental period.*—To begin each trial in the experimental period, the experimenter secured the child's attention by calling the child's name. She then introduced the target object, placing it alone on the table, directly in front of the child, but out of the child's reach. Next, she placed the two remaining objects (the taxonomic and thematic choices) on the table, to the left and to the right of the target, but within the child's easy reach. The choice objects were separated by approximately 10 inches. For each child, the left-right placements of the taxonomic and thematic alternatives were determined randomly for each trial. Toys were left within the child's reach for up to 30 sec.

Children were assigned randomly to either a No Word or Novel Noun condition. On each trial in the No Word condition, as the experimenter introduced the target object, she pointed to it, saying, "See this one?" As she placed the choice objects simultaneously on the table, she said, "Can you find another one (indicating the two choices) just like this one (indicating the target)?" Children were encouraged to indicate their choices by touching.

In the Novel Noun condition, the instructions were identical to those in the No Word condition, except for one crucial difference: On each trial, the experimenter labeled the target with a nonsense noun, using

a different noun for each trial. For example, she said, "See this X (where X was the novel noun)? Can you find another X just like this X?"

Children were given no feedback contingent upon their selections. For children in both conditions, the experimenter simply said, "Thank you" or "Good girl/boy" after any selection was made. Sessions lasted approximately 15–20 min and were videotaped for later transcription.

*Communicative Development Inventory (CDI).*—While the child was engaged in the experiment, the parent was asked to complete the Communicative Development Inventory (CDI), developed by Bates and her colleagues (Bates, Bretherton, & Snyder, 1988) for use with infants. Data from this standardized checklist provided information concerning each child's productive and receptive vocabulary.

#### Coding

Four different measures were derived from the videotaped sessions. For all four, the videotapes were transcribed with the sound removed to insure that the coders, who were blind to the hypotheses, were also blind to the condition in which each child had participated. The measures included (1) the duration of time spent playing with each object in the familiarization period; (2) the object chosen first during the experimental period (either the taxonomic or the thematic alternative), (3) the duration of time spent playing with each object during the experimental period, and (4) the incidence of thematic play demonstrated by the child at any time during a trial. For the duration measures (measures 1 and 3), the coder measured the total accumulated time the child spent playing with each object; duration scores could range from 0 to 30 sec. For the incidence measure (measure 4), the coder simply noted any demonstrations of thematic relations (e.g., putting a cup to the doll's mouth) made spontaneously by the subject at any point during each trial.

A second rater independently coded the videotaped sessions of 12 subjects, evenly divided among age groups and conditions. Agreement between coders was above 95% on each of the four measures. Interrater agreement was computed in the following manner: for the duration measures we used correlations to compare raters' judgments of the amount of time each child spent playing with each object; for the object chosen first and for the incidence measure, we com-

puted the proportion of trials on which coders agreed.

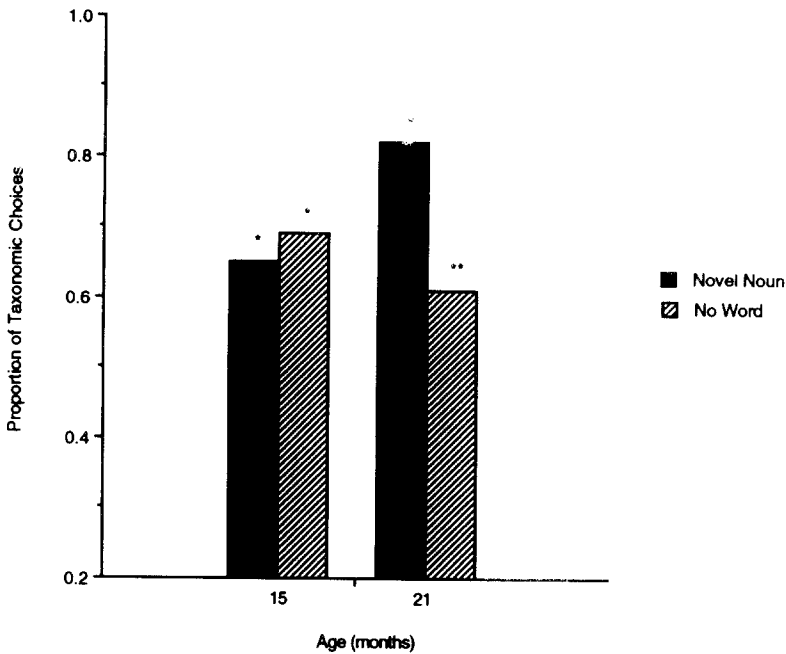
The language inventories were tabulated to reveal the number of words that parents reported in their child's productive and receptive vocabularies.

#### RESULTS AND DISCUSSION

The results of the Communicative Language Inventory confirmed that the subjects in our two age groups fell on opposite sides of the 50-word boundary that is typically taken as a rough index of the onset of the naming explosion (Benedict, 1979; Goldfield & Reznick, 1990; Nelson, 1973). The 15-month-olds had a mean productive vocabulary of 10.9 words (ranging from 0 to 39 words). In contrast, the mean productive vocabulary for the 21-month-olds was 86.6 words (ranging from 19 to 175 words).

On the forced-choice task itself, infants seemed to enjoy playing with the objects and interacting with the experimenter. They completed an average of 79% of the trials by selecting one of two choice objects during the experimental period. On the remaining trials, infants either selected both, or neither, of the objects. These trials are not included in subsequent analyses. The proportion of trials completed by each subject was submitted to a three-way analysis of variance, with condition (No Word vs. Novel Noun) and age (15 vs. 21 months) as between-subjects factors and hierarchical level (basic vs. superordinate) as a within-subjects factor. This analysis revealed that 15-month-olds completed more trials ( $M = .86$ ;  $SD = .17$ ) than did 21-month-olds ( $M = .72$ ;  $SD = .22$ ),  $F(1, 36) = 6.39$ ,  $p < .02$ . There were no other main effects or interactions.

The next set of analyses is based on the object chosen first on each trial during the experimental period. The scores were the proportions of trials in which infants first chose the taxonomically related item, computed separately for the sets of basic and superordinate level trials. A three-way analysis of variance, with condition (No Word vs. Novel Noun) and age (15 vs. 21 months) as between-subjects factors and hierarchical level (basic vs. superordinate) as a within-subjects factor revealed an interaction between age and condition,  $F(1, 36) = 5.1$ ,  $p < .05$ . This interaction is depicted in Figure 1. Follow-up tests revealed that, at 21 months, subjects in the Novel Noun condition chose the taxonomically related item on a greater proportion of trials ( $M = .82$ ;  $SD$



\*  $p < .05$  (two-tailed)

\*\*  $p = .05$  (two-tailed)

FIG. 1.—Experiment 1. The mean proportion of taxonomic choices made by subjects as a function of age ( $N = 20$  of each age) and condition. \* indicates comparisons to chance responding (50%).

= .19) than did their age-mates in the No Word condition ( $M = .61$ ;  $SD = .15$ ),  $t(36) = 1.93$ ,  $p < .05$ , one-tailed. In contrast, at 15 months, there was no apparent influence of introducing novel labels: the proportions of taxonomic choices in the Novel Noun ( $M = .65$ ;  $SD = .20$ ) and No Word ( $M = .69$ ;  $SD = .16$ ) conditions did not differ significantly.

We also carried out an analysis that treated items, rather than subjects, as a random factor. This analysis provided converging evidence for the labeling effect at 21, but not 15, months of age. For the 21-month-old subjects, when target objects were labeled with novel nouns, they elicited a significantly higher proportion of taxonomic responses ( $M = .81$ ;  $SD = .10$ ) than when the objects received no labels ( $M = .62$ ;  $SD = .25$ ), paired  $t(11) = 2.29$ ,  $p < .05$ , one-tailed. However, for 15-month-old subjects, there was no effect for labeling. Target objects elicited a comparable proportion of taxonomic responses when they were accompanied by novel nouns ( $M = .69$ ;  $SD = .15$ )

and by no labels ( $M = .70$ ,  $SD = .20$ ), paired  $t(11) = .31$ , N.S.

To provide a richer depiction of performance on this task, we examined each infant's individual pattern of response. For each infant, we determined the proportion of taxonomic objects selected over the set of 12 trials. These data are presented in Table 2, broken down to show the numbers of children selecting taxonomic alternatives on 0.00–.33; .34–.66; and .67–1.00 of their trials. For the purposes of statistical analysis, we collapsed the two left-most columns, enabling us to use a Fisher exact test to compare the number of children in the Novel Noun and No Word conditions making taxonomic selections on .66 or fewer trials versus .67 or more trials (Rosenthal & Rosnow, 1984). At 15 months, the distribution of these individual patterns was comparable in the Novel Noun and No Word conditions; at 21 months, the individual patterns observed in each condition were quite distinct,  $p < .05$ . Thus, the analyses based on individual pat-

TABLE 2

NUMBER OF INDIVIDUAL SUBJECTS MAKING  
TAXONOMIC SELECTIONS FALLING IN THE LOWEST,  
MIDDLE, AND HIGHEST THIRDS OF THE POSSIBLE  
RANGE

	Proportion of Taxonomic Selections		
	0-.33	.34-.66	.67-1.00
Experiment 1:			
15-month-olds:			
No Word .....	0	6	4
Novel Noun .....	1	4	5
21-month-olds:			
No Word .....	2	6	2
Novel Noun .....	0	3	7
Experiment 2:			
No Word .....	0	8	2
Novel Noun .....	0	3	7

terms of performance converge with those based on group means.

Each of these preceding analyses is consistent with the hypothesis that it is only after the onset of the naming explosion that nouns begin to focus infants' attention on object categories. However, there is an alternative interpretation. Perhaps this particular dependent measure—the object chosen first—is not a sensitive enough measure for children as young as 15 months. This alternative warrants consideration, especially in view of the fact that most of the published work regarding infants' sensitivity to the introduction of novel nouns has utilized measures based on the *duration* of time spent attending to objects (e.g., Baldwin & Markman, 1989; Markow & Waxman, 1992; Roberts & Jacob, in press; Waxman & Heim, 1991).

We therefore conducted a different analysis, based on the duration of time children spent playing with the taxonomic and the thematic alternatives during the experimental period. We derived a proportional measure by dividing (*a*) the amount of time spent playing with the taxonomic alternative by (*b*) the total amount of time spent playing with the choice objects (the thematic alternative, the taxonomic alternative, or both choice objects). We reasoned that, if nouns focus infants' attention on taxonomic relations, then infants in the Novel Noun condition should spend proportionally more time than those in the No Word condition playing with the taxonomic alternative.

The proportional data were entered into a three-way analysis of variance, with condition (No Word vs. Novel Noun) and age (15 vs. 21 months) as between-subjects factors and hierarchical level (basic vs. superordinate) as a within-subjects factor. The results of this analysis were consistent with those reported above. The interaction between age  $\times$  condition was again significant,  $F(1, 36) = 5.21, p < .05$ . As was the case in the previous analysis, 15-month-olds performed comparably in the Novel Noun ( $M = .65$ ;  $SD = .16$ ) and No Word conditions ( $M = .71$ ;  $SD = .16$ ),  $t(36) = .75$ , N.S.; only at 21 months did children in the Novel Noun condition ( $M = .71$ ;  $SD = .13$ ) spend proportionally more time than those in the No Word condition ( $M = .58$ ;  $SD = .16$ ) playing with the taxonomic choice object,  $t(36) = 1.7, p < .05$ , one-tailed. In addition, there was a level  $\times$  condition interaction,  $F(1, 36) = 5.44, p < .05$ . At the basic level, infants in the Novel Noun condition ( $M = .72$ ;  $SD = .17$ ) spent a larger proportion of time playing with the taxonomically related alternative than did infants in the No Word condition ( $M = .62$ ;  $SD = .16$ ); at the superordinate level, infants in the Novel Noun condition ( $M = .64$ ;  $SD = .14$ ) spent a smaller proportion of time playing with the taxonomically related alternative than did infants in the No Word condition ( $M = .67$ ;  $SD = .16$ ). Neither of these pair-wise comparisons reached significance.

The preceding analyses, based on the objects chosen first by infants and the duration of time infants spent playing with the objects, offer converging results. Both sets of analyses reveal in 21-month-olds, but not 15-month-olds, a tendency to link novel nouns and taxonomic relations. However, this pattern of results must be interpreted with some caution. As can be seen in Figure 1, children at both age levels and in both conditions had a strong tendency to select the taxonomic alternatives. This was surprising for three reasons. First, we provided no reinforcement for responding taxonomically; second, the published literature suggests that, early in development, children prefer thematic over taxonomic relations (Smiley & Brown, 1979); and third, we had taken care to select object triads with unambiguous thematic relations that would be familiar to 15–21-month-old infants.

There are two possible explanations for the high proportion of taxonomic selections. First, infants may have had a general preference for the taxonomic, as opposed to the



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thematic, choice objects. If this were the case, then they should demonstrate a preference for the taxonomic alternatives in the familiarization period as well. To examine this possibility, we submitted the duration data from the familiarization period to a three-way analysis of variance, with condition and age as between-subjects factors and hierarchical level as a within-subjects factor. There were no significant main effects or interactions. Averaging across ages and conditions, infants demonstrated no overall preferences for either the taxonomic (inanimate) ( $M = 9.54$  sec;  $SD = 2.95$ ) or thematic (animate) ( $M = 8.25$  sec;  $SD = 3.00$ ) test object; they devoted a comparable amount of time to each. Thus, infants' tendency to select the taxonomic alternatives in the test trials cannot be attributed to a general preference for the taxonomically related (or inanimate) objects themselves.

We next asked whether infants' highly taxonomic performance in the test trials could be attributed to their familiarity with the intended thematic relations. We wondered if the infants, particularly those in the youngest group, were indeed familiar with the thematic relations represented in our triads.

To address this question, we performed a different analysis. We examined each subject's behavior on each trial for spontaneous demonstrations of thematic relations (e.g., putting a cup to a doll's mouth). The scores were the proportions of basic-level and superordinate-level trials on which any demonstration(s) the thematic relations occurred. We submitted the data for the thematic demonstrations to a three-way ANOVA, with age and condition as between-subjects factors and hierarchical level as a within-subjects factor. A main effect for age,  $F(1, 36) = 4.07$ ,  $p = .05$ , revealed that 21-month-olds demonstrated thematic relations on a greater proportion of trials ( $M = .44$ ;  $SD = .25$ ) than did 15-month-olds ( $M = .32$ ;  $SD = .16$ ). A main effect for hierarchical level,  $F(1, 36) = 16.84$ ,  $p < .001$ , revealed that subjects at both ages demonstrated thematic relations proportionately more often on superordinate ( $M = .44$ ;  $SD = .21$ ) than on basic ( $M = .31$ ;  $SD = .19$ ) level trials. In addition, an interaction between age and hierarchical level,  $F(1, 36) = 4.56$ ,  $p < .05$ , revealed that, on basic level trials, 15- and 21-month-old infants were equally likely to demonstrate thematic relations ( $M = .29$ ;  $SD = .15$ ,  $M = .34$ ;  $SD = .23$ , respectively),  $t(36) = .85$ , N.S.; yet on superordinate-level trials, 15-

month-olds demonstrated thematic relations on a smaller proportion of trials ( $M = .35$ ;  $SD = .17$ ) than did 21-month-olds ( $M = .53$ ;  $SD = .26$ ),  $t(36) = 3.0$ ,  $p < .01$ , one-tailed. This suggests that 15-month-olds were less inclined than 21-month-olds to demonstrate thematic relations spontaneously, particularly those thematic relations presented on the superordinate trials. This finding raises the possibility that 15-month-olds' taxonomic preference on previous analyses may have been a consequence of their relative unfamiliarity with some of the specific thematic relations represented here.

Finally, there were other relevant, if less tangible, differences between the performances of the older and younger infants. A thorough examination of the videotaped sessions gave the impression that the forced-choice task may have been less than ideally suited for our youngest subjects. For example, although the subjects complied on most trials with the experimenter's request for an object, it was not uncommon for 15-month-olds to respond automatically, giving little apparent consideration to which of the two objects to offer. Other 15-month-olds displayed a different type of behavior; they failed to respond to the experimenter's request promptly. When they eventually did offer an object, they seemed to be responding more to her outstretched hand than to her specific verbal request. These types of behaviors may have introduced sufficient "noise" to obscure any existing sensitivity to the noun-category linkage. That is, the null effect for 15-month-old subjects may have been a function of the performance demands placed on them in this task. Therefore, in Experiment 2, we introduce several procedural modifications to clarify the task for these young subjects.

### Experiment 2

The purpose of this experiment was to examine further the influence of introducing novel labels to infants who had not yet commenced the naming explosion. We introduced several modifications to the procedure from Experiment 1 in an effort to make the forced-choice task more suitable for our youngest group of subjects.

#### METHOD

##### *Subjects*

Twenty-two 16-month-olds (with a mean age of 16 months, 22 days, ranging from 16 months, 14 days to 17 months, 14

days) were tested; two were excluded because they failed to complete the procedure. There was no significant difference between the mean ages of infants in this experiment and those in the younger group of Experiment 1. An equal number of boys and girls participated in each condition (see below). Recruitment procedures and demographic information were identical to those described in Experiment 1. None of the subjects in this experiment participated in Experiment 1.

### Stimuli

The stimuli were identical to those used in Experiment 1.

### Procedure

The procedure differed from that used in Experiment 1 in four ways. First, to encourage the infants to examine the objects more systematically and to take note of the relations among them, the experimenter demonstrated both the intended taxonomic and thematic relation during the familiarization period on the first four trials. Second, to help focus the infants' attention on the experimenter's specific verbal request, she repeated her request on any trial on which an infant failed to select a single choice object within 10 sec. Third, in an effort to reduce the generally high rate of taxonomic selections, the experimenter asked children to "find another one" (or "find another X") rather than to "find another one *just like this one*" (or "find another X *just like this X*"). Finally, we counterbalanced the order in which the trials were presented, such that (a) basic- and superordinate-level trials were presented in an alternating fashion, and (b) for exactly half of the subjects, the procedure began with a superordinate-level trial; for the remaining subjects, the procedure began with a basic-level trial. Counterbalancing was accomplished by randomly assigning each of the 10 children in each condition to one of the 12 possible rows in a complete Latin square design.

**Familiarization period.**—The familiarization period was modified in the following way: On Trials 1–4, while the experimenter presented the three objects to the child, she

demonstrated both the thematic and the taxonomic relations between the target and the choice objects in a standardized fashion. To convey a thematic relation, the experimenter demonstrated the thematic relation appropriate to the objects. For example, she sat the doll in the chair. To convey a taxonomic relation, she held the taxonomically related objects next to one another. For example, she touched the two chairs together.<sup>3</sup> The experimenter secured the child's attention by saying, "See?" as she demonstrated each relation. After she had demonstrated both relations, the child was allowed to play freely with all three objects for 30 sec, as had been the case in Experiment 1. On Trials 1 and 3, the experimenter demonstrated the thematic relation before the taxonomic relation. On Trials 2 and 4, she demonstrated the taxonomic before the thematic relation. Because the order of presentation for the triads was counterbalanced, the thematic and taxonomic relations were demonstrated by the experimenter on different triads across subjects in each condition.

For all remaining trials (Trials 5–12), the familiarization period was identical to that described in Experiment 1. The experiment made no demonstrations; she simply placed the three objects within the child's reach for 30 sec.

**Experimental period.**—As in Experiment 1, children were assigned randomly to either a Novel Noun or No Word condition. There were, however, two procedural modifications introduced during the experimental period. The first concerned the experimenter's instructions to the infants. In the Novel Noun condition, the experimenter pointed to the target, and labeled it, saying, "See this? This is an X." She then indicated the two remaining objects and asked the child to "find another X." (In Experiment 1, she had asked children to "find another X *just like this X*.") In the No Word condition, she pointed to the target saying, "See this one?" She then indicated the remaining objects and asked the child to "find another one." (In Experiment 1, she had asked children to "find another one *just like this one*.")

<sup>3</sup> We note here that, although it is a fairly straightforward matter to clearly and unambiguously demonstrate a thematic relation between two objects, this is not the case for taxonomic relations. It is difficult to indicate unambiguously a taxonomic relation between objects using nonverbal means. We chose to simply hold the two taxonomically related objects together in an effort to direct the infants' attention to the similarities between them. Fortunately, our goal in these demonstrations was to heighten infants' attention to the thematic, not the taxonomic, relations.

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The second modification concerned the timing of the experimenter's verbal requests. In this experiment, unlike Experiment 1, the experimenter systematically repeated her specific verbal request on all trials in which 10 sec elapsed before the child made a clear choice (e.g., if the child offered neither, or both, of the objects). For example, if a child in the No Word condition failed to make a clear choice within 10 sec, the experimenter would point to the choice objects, saying, "Can you find another one?" In the Novel Noun condition she would ask, "Can you find another X?"

For children in both conditions, the experimenter said, "Thank you" or "Good girl/boy" after all selections. Sessions were videotaped for later transcription. The procedure lasted approximately 15–20 min.

*Communicative Language Inventory (CDI).*—While the child was engaged in the experiment, the parent was asked to complete the CDI designed for infants.

### Coding

The videotaped sessions were coded for the same measures as in Experiment 1. A second rater independently coded the videotaped session of six subjects, three from each condition. Agreement between coders was above 90% on all measures.

## RESULTS AND DISCUSSION

The data from this experiment support the hypothesis that novel nouns focus attention on taxonomic relations even in infants who have not yet commenced the naming explosion.

The results of the Communicative Language Inventory yielded a mean productive vocabulary of 24.6 words, ranging from 0 to 74 words. Although 80% of the infants included in this experiment had not yet achieved the 50-word vocabulary boundary that is typically taken as a rough index of the onset of the naming explosion (Benedict, 1979; Goldfield & Reznick, 1990; Nelson, 1973), four infants (two in each condition) did exceed this index. Therefore, in the following analyses, we consider both the entire group of subjects and the subset of subjects producing fewer than 50 words.

In this experiment, the choices made by 16-month-old infants revealed a clear effect for novel nouns. In this first set of analyses, the proportion of trials on which infants first selected the taxonomically related alternative served as the dependent measure. A

two-way mixed ANOVA, with condition (Novel Noun vs. No Word) as a between-subjects factor and hierarchical level (basic vs. superordinate level) as a within-subjects factor revealed a significant main effect for condition,  $F(1, 18) = 7.27$ ,  $p < .05$ , illustrated in Figure 2. Infants in the Novel Noun condition ( $M = .74$ ;  $SD = .14$ ) selected the taxonomic alternative on a greater proportion of trials than did their age-mates in the No Word condition ( $M = .59$ ;  $SD = .11$ ).

When we considered items, rather than subjects, as a random factor, the same pattern emerged. When target objects were labeled with a novel noun, they elicited more taxonomic responses ( $M = .76$ ;  $SD = .21$ ) than when no novel word was presented ( $M = .58$ ;  $SD = .19$ ), paired  $t(11) = 2.82$ ,  $p = .008$ , one-tailed.

We also examined each infant's pattern of response by determining, for each individual infant, the mean proportion of taxonomic selections made over the set of 12 tri-

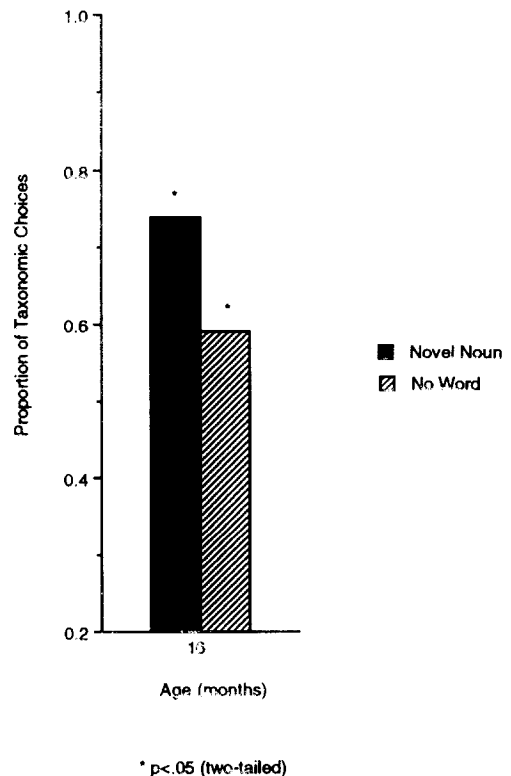


FIG. 2.—Experiment 2. The mean proportion of taxonomic choices made by subjects ( $N = 20$ ) as a function of condition. \* indicates comparisons to chance responding (50%).

als. These data are presented in Table 2. As in Experiment 1, we compared the numbers of infants in each condition making taxonomic selections on 0.00–.66 versus .67–1.00 of their trials. A Fisher exact test revealed that the distribution of individual patterns differed in the Novel Noun and No Word conditions,  $p = .03$ . This finding is consistent with the argument that Novel Nouns focus 15-month-olds' attention on object categories.

In the next analysis, we examine the possibility that 16-month-olds' sensitivity to the noun-category linkage derives from the fact that, in this experiment, unlike Experiment 1, two subjects in each condition had productive vocabularies exceeding the 50-word boundary. To determine whether infants prior to the onset of the naming explosion are indeed sensitive to the impact of novel nouns on categorization, we excluded those subjects (two in each condition) with productive vocabularies of greater than 50 words. A two-way mixed ANOVA, with condition as a between-subjects factor and hierarchical level as a within-subjects factor mirrored the analysis based on the entire group of subjects. There was a significant main effect for condition,  $F(1, 14) = 5.65$ ,  $p < .05$ . Infants in the Novel Noun condition made a significantly higher proportion of taxonomic choices ( $M = .75$ ;  $SD = .15$ ) than those in the No Word condition ( $M = .59$ ;  $SD = .11$ ). This constitutes clear support for the hypothesis that, even before the onset of the vocabulary explosion, infants are sensitive to a linkage between nouns and object categories. This analysis also revealed a main effect for hierarchical level,  $F(1, 14) = 8.81$ ,  $p < .05$ , with infants in both conditions proportionately more often selecting taxonomic alternatives at the basic ( $M = .77$ ;  $SD = .12$ ) than at the superordinate ( $M = .57$ ;  $SD = .23$ ) level.

We next sought to determine whether the infants' appreciation of the noun-category linkage was evident only on those trials on which the experimenter demonstrated both the intended thematic and taxonomic relations. We therefore compared infants' performance on the first four trials (during which the experimenter had explicitly demonstrated both the thematic and taxonomic relations among the objects) and the last eight trials (during which the experimenter provided no demonstrations). A two-way mixed ANOVA, with condition as a between-subjects factor and demonstration status (Demonstration vs. No Demonstration)

as a within-subjects factor, revealed only an effect for condition,  $F(1, 18) = 4.84$ ,  $p < .05$ , echoing the condition effect described in the preceding analyses. The fact that there was neither a main effect nor any interaction involving the demonstration factor indicates that children performed comparably on trials with and without demonstration.

As in Experiment 1, we also examined the proportion of time infants spent playing with the taxonomic choice object during the experimental period. Infants in the Novel Noun condition devoted a mean proportion of .56 ( $SD = .15$ ) of their time to the taxonomic choice object; those in the No Word condition devoted .48 ( $SD = .15$ ) of their time to the taxonomic choice object. Although the difference between these means is in the expected direction, it did not reach significance in a hierarchical level  $\times$  condition ANOVA.

In the next analysis, we examined infants' spontaneous demonstrations of thematic relations in their play. In the No Word and Novel Noun conditions, infants spontaneously demonstrated thematic relations on .49 ( $SD = .21$ ) and .42 ( $SD = .17$ ) of their trials, respectively. A two-way ANOVA, with condition as a between-subjects factor and hierarchical level as a within-subjects factor, revealed no significant main effects or interaction. Further analysis revealed that the tendency to demonstrate thematic relations was comparable on the first four trials (on which the experimenter demonstrated taxonomic and thematic relations) and on the remaining eight trials (on which the experimenter made no demonstrations).

Finally, we compared the percentage of trials on which infants demonstrated thematic play in Experiments 1 and 2. To derive this measure, we divided the number of trials on which the child demonstrated a thematic relation by the total number of trials completed by the subject. On average, infants in Experiment 2 demonstrated thematic play on .45 ( $SD = .17$ ) of their trials, while the 15-month-olds in Experiment 1 did so on only .32 ( $SD = .14$ ) of their trials,  $F(1, 36) = 8.04$ ,  $p < .01$ . This suggests that the procedural modifications for Experiment 2 were successful in increasing the general salience of thematic relations for our young subjects.

In sum, the results of this experiment are consistent with the hypothesis that infants are sensitive to a linkage between

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count nouns and object categories even before the onset of the naming explosion.

### General Discussion

The goal of these two experiments was to examine the development of an appreciation of the linkage between count nouns and object categories in infants on either side of the period known as the naming explosion. Although previous research has documented that novel nouns focus attention on objects and categories of objects in infants ranging in age from 9 to 15 months (Baldwin & Markman, 1989; Echols, 1991; Markow & Waxman, 1992; Roberts & Jacob, in press; Waxman & Heim, 1991) and from 30 months to 4 years (Markman & Hutchinson, 1984; Waxman, 1990; Waxman & Kosowski, 1991), the evidence from the intervening period has been scant (but see Bauer & Mandler, 1989, discussed in detail below). The results of the experiments reported here demonstrate that, for 16-month-old infants, most of whom have yet to commence the naming explosion (Experiment 2), and for 21-month-old infants, most of whom have recently entered the naming explosion (Experiment 1), novel nouns focus attention on taxonomic relations among objects.

This finding is important because it reveals a nascent appreciation of a linkage between words and object categories in infants who are at the very onset of language production. An early appreciation of such a linkage has clear advantages to the infant as a word learner: It insures that, in the context of learning novel words, infants will pay special attention to taxonomic, as opposed to thematic, relations among objects. Moreover, the fact that an appreciation of this linkage is evident prior to the onset of the vocabulary explosion suggests that it may be instrumental in guiding the infants' first efforts at mapping words to their meanings.

The results of these experiments go beyond the established finding that infants form categories (Bornstein, 1984; Sugarman, 1982; Younger & Cohen, 1983) to demonstrate how the introduction of novel words influences their categorization. However, these data do not reveal whether infants' early appreciation of a linkage between words and categories is part of their innate endowment or is learned on the basis of still earlier experience with the language system. Neither do these data reveal whether the facilitative effect of labels is specific to nouns or is generalizable to words from other syn-

tactic categories. Both of these issues are treated more fully below. Nonetheless, the data reported here do establish that an appreciation of the linkage between words and object categories is available prior to the onset of the naming explosion. These data therefore cast serious doubt on the possibility that there is a developmental discontinuity in infants' appreciation of this linkage.

*Infants' preferences: Taxonomic or thematic?*<sup>2</sup>—These data also reveal in infants as young as 15 months of age a surprising inclination to select primarily the taxonomic, as opposed to the thematic, alternative in a match-to-sample task. This taxonomic focus, which is consistent with the data reported by Bauer and Mandler, is particularly interesting in light of the well-documented finding that preschool children prefer thematic over taxonomic relations and that this initial thematic preference shifts toward a preference for taxonomic relations only later, during the school-aged years (Smiley & Brown, 1979). The data from infants raise the interesting possibility that this preference for thematic relations is not yet in place at 15–21 months of age. Indeed, these data call into question the assumption that a preference for thematic relations necessarily precedes a preference for taxonomic relations (Greenfield & Scott, 1986; Scott, Serchuk, & Mundy, 1982). In future work, it will be important to test this assumption directly, perhaps by extending the match-to-sample paradigm used by Smiley and Brown (1979) to include infants and toddlers.

It is quite possible that, early in development, an appreciation of thematic relations among objects lags behind an appreciation of similarities among objects. Notice that to appreciate any given thematic relation, one must have acquired enough real world experience regarding the objects in question to know about their typical functions and the actions in which they can be engaged. These functions and actions must be learned; they are not inherent in the objects themselves, but in the relations among them. In contrast, an early appreciation of the similarities among objects is likely based on observable characteristics that are inherent in the objects themselves (e.g., shape) (Baldwin, 1989; Daehler, Lonardo, & Bukatko, 1979; Fenson, Cameron, & Kennedy, 1988; Landau et al., 1988). An early appreciation of "brute," perceptual similarity may serve as an initial basis for early object categorization and may set the stage for subsequent, more sophisticated, systems of cate-

gorization (Gentner & Rattermann, 1991; Quine, 1960).

*The role of labels in 16–21-month-olds' object categorization.*—The principal focus on these experiments was not to describe infants' early preferences for thematic versus taxonomic relations, but to test whether and how novel nouns influence their object categorization. The fact that 16- and 21-month-old infants selected the taxonomic alternatives more frequently in the Novel Noun condition than in the No Word condition provides evidence that nouns focus attention on categories of objects even in infants who are just beginning to produce words.

How can we reconcile this result with Bauer and Mandler's (1989) data on categorization in infants ranging in age from 16 to 31 months? In our view, the contradictory results reported here and by Bauer and Mandler are most likely attributable to differences in the use of reinforcement. Recall that the latter authors reinforced their subjects for their selections by cheering and clapping; we offered no reinforcement. This is an important methodological distinction because, as Bauer and Mandler acknowledge, in their task, the "already high level of taxonomic responding left little latitude for novel labels to exert an influence on categorization" (p. 183). That is, the reinforcement was so successful in eliciting taxonomic responses that potential effects attributable to novel labels were eclipsed.

Moreover, the issue of reinforcement has important theoretical implications for our questions concerning infants' emerging appreciation of linkages between word meaning and object categorization. As we have argued, infants typically do not have the benefit of reinforcement trials in the context of word learning. Instead, in the typical word-learning scenario, infants encounter new words, new objects, and manifold possible mappings between the two. We therefore omitted reinforcement in an effort to approximate the interpretive problem faced by infants in word learning. And, under these circumstances, infants did focus on taxonomic relations more in the context of hearing a novel noun than in the neutral, no-word context.

We turn now to reconsider Bauer and Mandler's *conclusions* in light of the evidence reported here. Bauer and Mandler drew two conclusions based on their subjects' strong preference for taxonomic selections, even in the absence of a novel noun.

First, they argued persuasively that it is not exclusively in the context of word learning that taxonomic relations become salient. We agree entirely with this conclusion. There is no doubt that an appreciation of taxonomic relations does not depend on verbal labels. (See Waxman, Shipley, & Shepperson, 1991, for a discussion.) Indeed, the rich literature on categorization abilities in infrahumans (Herrnstein, 1984; Premack, 1976) and in prelinguistic infants (Sugarman, 1982; Younger & Cohen, 1983) is testimony to the fact that individuals lacking the linguistic ability to produce or reliably interpret nouns are nonetheless adept at forming object categories.

Notice, however, that our argument for infants' appreciation of a linkage between nouns and object categories is fully compatible with this fact. Our position does not rest on an assumption that infants will fail to notice object categories *except* when they have been introduced to novel nouns. Indeed, we make no specific predictions about the base rates of taxonomic responding in a neutral, no-word condition. Instead, our predictions center on comparisons of performance with and without novel nouns. If nouns direct infants' attention specifically and reliably on object categories, then subjects should be more likely to choose taxonomically in the presence of novel nouns than in their absence, whatever the baseline rate in a neutral No Word condition might be. Stated in this way, it is clear that infants' ability to form object categories in the absence of the novel nouns does not in itself challenge the claim that they appreciate a linkage between nouns and object categories. It is also clear that infants' greater tendency to choose the taxonomic alternative in the Novel Noun than in the No Word condition constitutes straightforward evidence for their appreciation of a linkage between words and object categories.

Second, Bauer and Mandler argued that labels (as used by Waxman & Kosowski, 1991, and by Markman & Hutchinson, 1984) and explicit reinforcement (as used by Bauer & Mandler) may accomplish the same end for the young child: both serve as reminders of the task requirements. Although we take no issue with this very general interpretation, we do add two notes of caution. First, labeling with a noun and explicit reinforcement may well achieve the same behavioral ends, but the means by which they achieve it are likely to be quite different, indeed. Second, although Bauer and Mandler's in-

terpretation provides an accurate description of their own data, it is far too general to provide a satisfactory explanation for other findings in this rapidly growing field of research. For example, the argument that both labels and explicit reinforcement serve to remind children of the task requirements cannot account for the fact that, by 2 years of age, novel nouns "remind" children effectively of the task at hand, but novel adjectives fail to do so (Waxman, 1990; Waxman & Kosowski, 1991). The differential effects of nouns and adjectives (vis-à-vis object categorization) cannot be attributed to general notions of "reminding" children or keeping them "on task." Therefore, in what follows, we articulate a more precise account of the development of an appreciation of the linkage between words and object categories.

*The development of an appreciation of the linkage between count nouns and object categories.*—A central question in this rapidly growing field of research is whether the facilitative effect of novel labels is tied specifically to language or whether it is a more general function of auditory stimulation (see Baldwin & Markman, 1989; Roberts & Jacob, in press; Waxman & Balaban, 1992). The answer to this question appears to depend crucially on the developmental status of the subjects under consideration. In an effort to specify more precisely the development of an appreciation of the linkage between count nouns and object categories, we tentatively suggest the following progression.

Early in development, infants' visual attention is augmented by what appear to be very general sensory and/or perceptual factors rather than by specifically linguistic ones. Throughout infancy, the distinctive intonational contours characteristic of infant-directed speech are especially effective in arousing and sustaining infants' attention (Fernald, 1992). Moreover, in the first 6 months, infants' visual attention is also heightened when objects are presented in conjunction with moderate auditory stimulation (Kaplan, Fox, Schueneman, & Jenkins, 1991; Mendelson & Haith, 1976; Paden, 1975; Self, 1975). Initially, then, general auditory factors (rather than specifically linguistic ones) appear to intensify infants' general visual interest (rather than their interest in objects or categories of objects in particular).

In the latter half of the first year, a more specific pairing becomes evident as infants

begin to single out words from other, more general sources of auditory input. By 9–12 months of age, infants focus more on objects and categories of objects in the presence of novel words than in their absence (Baldwin & Markman, 1989; Markow & Waxman, 1992; Waxman & Balaban, 1992; Waxman & Heim, 1991). Although this focus appears to be related to language, *per se*, rather than to more general auditory factors (but see Roberts & Jacob, in press), infants do not yet make systematic distinctions among words from various form classes. Indeed, infants at this point tend to interpret most words, independent of their syntactic status, as referring to objects or categories of objects. Waxman and her colleagues (Markow & Waxman, 1992; Waxman & Heim, 1991) have recently reported that at 12 and 13 months of age infants interpret words from diverse linguistic categories (e.g., nouns, adjectives) as referring to object categories. Therefore, prior to the onset of the naming explosion, infants appear to assume that there is a general linkage between words (not specifically count nouns) and object categories.

The evidence suggests that by 2 years of age children have clearly learned to map particular linguistic forms onto particular types of meaning. (See Pinker, 1984, or Macnamara, 1982, for an analysis of how such mappings might be learned.) For example, 2-year-old children expect that object categories will be marked linguistically by count nouns (Brown, 1957; Markman & Wachtel, 1988; Waxman, 1990; Waxman & Kosowski, 1991), that substances will be marked by mass nouns (Prasada, in press; Soja et al., 1991), that individuals will be marked by proper nouns (Gelman & Taylor, 1984; Hall, 1991; Katz, Baker, & Macnamara, 1974); and that various properties of objects will be marked by modifiers (Taylor & Gelman, 1988; Waxman, 1990). It is interesting to note that even at this point, when children are clearly capable of using syntactic information as a cue to meaning, they do not do so invariably. Instead, the tendency to use syntactic information is affected considerably by the child's existing lexical and conceptual knowledge (Waxman et al., 1991). If children have already acquired a count noun label for an object, then they are more likely to use syntactic information in interpreting subsequent words applied to that object. However, if they have not yet acquired a count noun for the object, they tend to rely on an earlier pattern of behavior; they tend to interpret any word applied to that object

(whether it is a count noun, a proper noun, or an adjective), as referring to an object category, typically at the basic level (Hall, 1991; Hall & Waxman, in press; Hall, Waxman, & Hurwitz, in press; Markman & Wachtel, 1988).

Clearly, more work will be required to test this proposed account of the development of an appreciation of a specific linkage between count nouns and object categories. The existing evidence suggests that a nascent appreciation of the linkage is in place prior to the onset of the naming explosion, that it may serve as a general guide to lexical acquisition, and that it will become increasingly specific over the course of development.

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