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# Count Nouns, Adjectives, and Perceptual Properties in Children's Novel Word Interpretations

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Three-year-old children were shown a novel exemplar toy and asked to judge test items that differed from the exemplar in shape, coloration, or material substance. In the count noun condition, children judged whether test items had the same novel name as the exemplar. In the adjective condition, children judged whether a test item could be described by the same novel adjective as the exemplar. The results of 3 experiments indicated that children systematically attend to shape in interpreting novel count nouns, but their interpretation of adjectives is contextually determined.

By the age of 6, children have acquired roughly 14,000 words (Templin, 1957). How do they acquire so many words so fast? If one views the child's acquisition of word-referent relations as an instance of unbiased hypothesis testing, then the rate of early word acquisition is difficult to explain. As Quine (1960) pointed out, the use of a word in the context of some scene provides evidence consistent with many hypotheses, only one of which will usually be correct. Chomsky (1986) similarly argued that if language learners were free to form any possible hypotheses about intended meaning from spoken language, then it would be unlikely that they would learn language as rapidly as they do because it would be unlikely that they would test the correct hypotheses early in language learning by happenstance alone. Chomsky argued that the rapid and error-free language learning that we observe in children requires that children be biased to entertain some hypotheses more than others.

This idea has motivated much research on children's early word learning. Developmentalists have shown that children's novel word extensions are constrained or biased in certain directions. For example, young children appear biased to interpret count nouns as referring to object categories and not individual objects (Katz, Baker, & MacNamara, 1974) or thematic relations between objects (Markman & Hutchinson, 1984; Waxman & Kosowski, 1990). Children are biased to allow only one label for a single referent (mutual exclusivity, e.g., Markman, 1989; Markman & Wachtel, 1988), and they are biased to attend to shape when extending a novel count noun across novel objects (Landau, Smith, & Jones, 1988). The existence of these biases is sometimes cited as an explanation of rapid word growth; the idea is that word learning proceeds as fast as it does precisely because word learning biases exist.

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Although the identification of word-learning biases is an important first step, a complete understanding of the rapid word learning characteristic of early development requires an understanding of the mechanisms by which such biases operate and their origins in development. For example, do these biases grow out of nonlinguistic preferences and strategies, or do they arise specifically during the process of language learning? Does their influence depend on contextual factors or are biases all-or-none guides to word learning?

Explorations of such questions are sure to lead to a deepened understanding of biases and their role in word acquisitions. Recent findings about the mutual exclusivity bias provide a case in point. Markman (1989) has proposed that children's lexical acquisitions are guided by a principle of mutual exclusivity. Her claim is that children "are biased to assume, especially at first, that terms are mutually exclusive, relinquishing that assumption only when confronted with clear evidence to the contrary" (p. 188). However, Merriman and Bowman (1989) found that the mutual exclusivity bias develops with language learning and is much stronger for 4- and 5-year-olds than for younger children who presumably need it more in the course of actual language learning (see also Merriman, 1990; Taylor & Gelman, 1988, for 24-month-olds' tendency to apply new names to unfamiliar objects rather than familiar, already-labelled objects). Moreover, in the Merriman and Bowman study, the strength of the bias depended on varied contextual factors, and abandoning it did not seem to depend on contrary evidence. What seems to be true of the mutual exclusivity bias might also be true of other kinds of biases in children's language learning, that is, such biases might be products as well as causes of language acquisition, and these might result from psychological processes that operate in a context, rather than the all-or-none invocation of a principle.

Our purpose in this article is to closely examine the issues of linguistic and nonlinguistic context effects on the shape bias in children's word learning. Landau, Smith and Jones (1988) showed that the presence of a novel count noun causes young children to shift their attention among perceptual properties of an object and specifically to attend to shape. In one task, they showed 2- and 3-year-olds a novel wooden object and told the children that this exemplar object was a dax. The children were then asked whether each of a number of test items was also a dax. The test items varied from the exemplar in shape, size, or texture. Children showed a strong shape bias. They extended the novel name to objects that were the same shape as the exemplar despite dramatic differences in size or texture, and they did not extend the novel name to test items that differed slightly in shape from the exemplar. Moreover, the shape bias was stronger in 3-year-olds than in 2-year-olds.

This shape bias was not obtained in a similarity classification task in which there was no novel word to be interpreted. In the similarity task, the children were shown the exemplar and each test item and were asked if the test item was like the exemplar. In this task, children attended to all of the dimensions.

Landau et al. (1988) hypothesized that the shape bias in children's novel word interpretations derived from children's acquired knowledge about the kinds of entities encoded early by count nouns. Terms for objects in basic level categories (categories such as *dog, chair,* and *table*) are prominent among children's early word acquisitions (MacNamara, 1982; Rosch & Mervis, 1975) and basic level categories appear to be perceptually organized by shape (Biederman, 1985; Rosch, 1973). The idea, then, is that the shape bias is specific to learning count nouns and is an example of how children might derive general word-learning strategies from their acquisition of specific words.

In this article, we ask two questions about the shape bias that are relevant to Landau et al.'s (1988) interpretation of it. First, is the shape bias truly a lexical effect? Second, is the shape bias restricted to children's interpretations of count nouns or do children show a shape bias when interpreting novel adjectives as well as novel count nouns? We present our rationale for asking each of these questions in turn.

## Is the Shape Bias Specific to Words?

The effect of words—and especially of count nouns—on children's categorizations has been repeatedly documented. Providing names for familiar objects increases the tendency of children as young as 2 years of age to group objects by category more often than by thematic relations (Markman & Hutchinson, 1984; Waxman & Kosowski, 1990). Children's tendency to group unfamiliar objects by overall appearance rather than by color is also heightened in the presence of a word (Baldwin, 1989). However, in none of these studies does the addition of a word shift children from one systematic form of classification to another. In these studies, words did not reverse grouping preferences. Instead, the effect of words was either to move children away from chance level performance or to enhance a preference that was already detectable in the absence of words.

Thus far, studies showing shape bias in the presence of a novel word have also only shown an enhancement effect. In the Landau et al. (1988) study, children showed a strong shape bias in the naming tasks but not in the similarity classification tasks. However, weak shape biases were also evident in the similarity task in some experiments. Jones, Smith and Landau (1991) recently replicated a strong shape bias in naming, but they also found a weak shape bias in no-word conditions. Thus, in shape bias studies as in previous research, the effect of a word has been to reveal or to sharpen a preference for comparing things by shape but not to reverse or replace some other consistent grouping strategy with a shape strategy. Indeed, the extant data on the shape bias are consistent with two alternative interpretations to the specifically word-shape hypothesis posed by Landau et al.

The first alternative interpretation states that providing children with a word has some general rather than specifically lexical effect on their grouping behavior. For example, children might just understand their task better when it is presented as a word extension task than when it is presented as a similarity judgment task (cf. Baldwin, 1989; Mandler & Bauer, 1988; Mandler, Bauer, & McDonough, 1991; Nelson, 1988). In the case of the shape bias, children might find the shapes of objects their most perceptually salient characteristics and might routinely (perhaps preverbally) categorize objects by their shapes. However, to reveal this tendency in an experimental setting, they might need to be told that categorization is the task at hand. For young children, a word might define the task as a categorization task. This proposal receives some support from the fact that in all experiments in Landau et al. (1988), adults showed a strong shape bias in similarity tasks as well as in naming.

The second alternative interpretation states that there is no preexisting shape bias but that children simply link words to the single most salient dimension. The role of a novel word might be more generally to induce a more analytic strategy on the part of children and to cause them to focus attention more tightly on whatever object properties are most perceptually salient. Shape might simply have been the most salient dimension of the specific stimuli employed in the Landau et al. (1988) and Jones et al. (1991) studies—and in other studies (e.g., Au & Markman, 1987; Heibeck & Markman, 1987) in which children have shown a preference for shape as the referent of a new word. A tendency to name the most salient property might also explain the few cases in which children have interpreted new words as referring to dimensions other than shape (e.g., material; Au & Laframboise, 1990).

This second alternative interpretation is consistent with the nonword classification literature. In nonword classification tasks, 2- to 5-year-old children generally attend wholistically to all dimensions, whereas older children and adults compare and classify objects one dimension at a time. Smith (1979, 1983) has shown that 4- and 5-year-old children who do not spontaneously classify by a single dimension can do so if told to find a rule. Perhaps, then, the presence of a novel word works for 2- and 3-year-olds as "find a rule" does for 4- and 5-year olds, causing them to approach the task more analytically and maturely—that is, to systematically classify by a single dimension. By this argument, shape may have no special status when classifying by means of words. Instead, the most perceptually salient dimension of the particular stimuli used may be the dimension of choice for children, and the effect of a novel word may simply be to tell them to look for the most salient dimension.

We tested these hypotheses in three experiments by attempting to induce children to classify on the basis of a highly salient object property other than shape—namely, coloration. We specifically manipulated the relative salience of shape and coloration (i.e., the patterned colored surface of objects). Our specific questions are (a) Will young children interpret novel words as referring to categories defined by shape even when coloration is made highly salient? (b) Will young children interpret novel words as referring to categories defined by shape even with stimuli they systematically classify by another salient characteristic (coloration) in a nonword task? A finding that young children classify by shape in a novel word task but classify these same stimuli by coloration in a nonword task would provide unprecedented evidence of the power of words to change children's criteria for categorization, rather than just to amplify a perhaps already existing tendency. Thus, such a finding would be strong evidence that novel words do more than excite a preexisting shape bias or a generalized tendency to selectively attend to the most salient perceptual property of the objects at hand.

## Is the Shape Bias Specific to Count Nouns?

Landau et al. (1988) speculated that the shape bias is learned from the learning of early count nouns that typically refer to basic level categories of concrete things. This proposal fits with the arguments of developmental psycholinguists such as Gentner (1982) and Maratsos (1991) that the syntactic category of nouns is inextricably linked to the child's understanding of nouns as referring to concrete things—that is, to objects having specifiable edges and bounded shapes. If the shape bias has its origins in what young children know about how count nouns describe basic level objects, then the shape bias should be stronger for count nouns than for other syntactic form classes. In the present experiments, we ask whether the shape bias is specific to children's interpretations of novel count nouns and therefore does not extend to their interpretation of novel adjectives.

The evidence in the extant literature is mixed on the degree to which the shape bias might be specific to count nouns. Taylor and Gelman (1988) asked 2- and 3-year-old children to extend either a novel noun (e.g., "a zav") or a novel adjective (e.g., "a zav one") to objects that matched the labeled exemplar in its surface properties of color, pattern, and texture, or in all other ways including size and shape, which Taylor and Gelman called the *same-category choice.* In this task, children could extend the novel word to (a) the exemplar itself, (b) the object matching in surface properties, (c) the same-category (i.e., same shape) object, or (d) an object not matching at all. About half of the children showed some sensitivity to the syntactic information by choosing same-category objects more often in the presence of a noun and also choosing the same surface-property object in the presence of an adjective. However, because the children chose the exemplar 68% of the time and the entirely dissimilar object 4% of the time, same-category choices (17%) and same-material choices (12%) were relatively rare, and the differences between noun choices and adjective choices were necessarily small.

Several other studies pitting object shape against other perceptual properties in word extension have found that a noun versus adjective frame makes no difference to 2-, 3-, and even 4-year-olds' novel word extensions (Au & Markman, 1987; Heibeck & Markman, 1987; Markman & Wachtel, 1988.) Instead, children have extended both nouns and adjectives as though they referred to overall form (Markman & Wachtel, 1988) or specifically to shape (Au & Markman, 1987; Heibeck & Markman, 1987). Indeed, in the Heibeck and Markman (1987) studies, the strength of the shape bias in the context of an adjective was such that it persisted even though the children were also provided with linguistic contrasts indicating that the relevant perceptual dimension was not shape.

Gelman and Markman (1985) have reported data consistent with the idea that, by 4 years of age, children show a stronger shape bias for novel count nouns than for novel adjectives. However, the magnitude of the effect was quite small and the study was not well designed to investigate the status of shape as opposed to overall similarity or salience. For example, in one study (Gelman & Markman, 1985, Study 2), children were shown pictures of three highly similar objects (e.g., machines), one of which contrasted with the other two on a single dimension (color, size, or state), and a fourth picture of an item that differed from the others "on every important dimension" (p. 136). For example, children would see three identical machines, two blue and one red, and a fourth, furniture-like object that was (presumably) neither red nor blue. Their task was to find "the fep" or "the fep one." Children chose the completely dissimilar object most often on both noun and adjective trials. Only slightly more than half of the children (58.5%) showed some sensitivity to the syntactic information, choosing the set member with only one contrasting property more often in the context of an adjective (28% of responses) than in the context of a noun (20% of responses). Most of these children were 4 or 5 years old.

Landau, Smith, and Jones (1990) did find clear evidence for a noun–adjective distinction in 5-year-olds. In their study, 5-year-olds showed a clear shape bias in the context of a count noun (a dax) but a texture bias in the context of a novel adjective (a daxy one). This specificity, however, was not found in 3-year-olds who tended to interpret novel adjectives in the same way that they interpreted novel nouns.

Thus, although there are hints in the literature that older preschoolers may extend novel nouns differently from novel adjectives, the findings to date suggest that in the early years of language development most children most of the time initially interpret novel words applied to novel objects either as proper nouns (e.g., Taylor & Gelman, 1988) or as labels for categories of objects with the same shape (e.g., Au & Markman, 1987; Heibeck & Markman, 1987; Landau et al., 1990).

How do these facts fit with the hypothesis that the shape bias derives from children's learning about how count nouns refer to object categories? We suggest that the count-noun–shape link renders shape an especially salient property of objects and thus the shape bias sometimes leaks over to (and hinders) the interpretation of novel adjectives—especially in young children who are in the process of learning the semantic implications of syntax. However, children clearly do learn the meanings of adjectives, and at some point they learn to distinguish between nouns and adjectives on the basis of syntactic cues. Perhaps, as Nelson (1988) suggests, children often map new words onto the objects or object properties that they are attending to when the new word is heard. Thus, the property *red* might be learned in the context of several red objects of such disparate shapes that a shape interpretation of the word is precluded. And in this way children could learn the meaning of an individual adjective, such as red, without appreciating its syntactic form (Au & Laframboise, 1990; Gelman & Markman, 1985; Heibeck & Markman, 1987).

## Rationale for the Experiments

We suggest that the shape bias derives from knowledge about already-learned count nouns—specifically, their special relation to concrete objects; that young children initially attempt to find a common shape referent for both novel nouns and novel adjectives; and that experience with perceptually driven exceptions to this strategy—that is, exceptions to the same-shape solution for word reference—helps children begin to attend to the noun–adjective distinction in syntax. Once children know something about the differential semantic force of count nouns and adjectives, and once this knowledge enters into their interpretation of novel words, then the shape bias should be stronger for novel nouns than for novel adjectives.

We begin to test these hypotheses in the present studies. We specifically examined the influence of perceptual salience on young children's interpretations of novel count nouns and novel adjectives. We focused on 3-year-old children because previous studies suggested that children this age do not yet reliably distinguish between count nouns and adjectives on the basis of syntactic cues and because prior studies (Landau et al., 1988) also suggest that the shape bias is particularly robust at this age. Thus, we hope that by examining closely the interaction of syntactic context and perceptual salience we may determine whether in fact the shape bias is stronger for count nouns than adjectives and whether the novel word effect—be it specific to count nouns or general across count nouns and adjectives—successfully directs attention to shape even in the face of strong competition from a highly salient alternative dimension.

In the three experiments, we systematically varied the shapes of our stimuli and a nonshape property (coloration). We chose coloration—multicolored speckles and glittery surfaces—to allow for ample variation in salience and also to avoid attributes (such as colors) for which the children might already have acquired names. In this way, we hoped to reduce or eliminate the influence of lexical contrast or mutual exclusivity (Au, 1990; Clark, 1987; Markman, 1989) on children's judgments. In Experiment 1, the two dimensions were designed to be equally salient. We made coloration progressively more salient than shape in Experiments 2 and 3. We measured the relative salience of shape and coloration by means of a similarity classification task. We examined the interplay of salience and syntactic form class between subjects in a count noun extension task and an adjective extension task.

## Experiment 1

### Method

*Subjects.* The subjects were 48 children who ranged in age from 35 to 40 months ($M = 37$ months). The children in this and the subsequent experiments were recruited from child-subject files maintained by the Developmental Laboratory of the psychology department at Indiana University. These files contain names and ages of children secured through birth announcements and advertisements in the local newspapers. Children in this and the subsequent experiments were tested in the laboratory and were paid an honorarium of $3 for their participation. Sixteen children were randomly assigned to each of the three instruction conditions with the constraint of equal males and females in each condition.

*Stimuli.* The exemplar and test items are depicted at the top of Figure 1. The exemplar was an inverted **U** made of wood. Its width and height were approximately 5 cm, and its thickness was approximately 1.5 cm. It was coated with random spatters of bright red, green, blue, and white paint.

Shown in the figure are the four test items that differed in some way from the exemplar. One test item is not shown in the figure. This item, the ID item, was identical to the exemplar in all respects. Two test items were the same shape as the exemplar but were decorated with a single, uniform color. The same-shape small difference item, was made of wood and shaped identically to the exemplar but was painted blue. The same-shape large difference item was identical in shape to the exemplar but was crafted from wire mesh painted a dull red and so presented a quite different overall appearance. The final two test items had the same coloration—that is, speckled—as the exemplar, but differed from it in shape. The same-coloration small-difference item was made of wood but was zigzag shape and painted with bright green, red, blue and white spatters. The same-coloration large-difference item was an irregular circular beanbag. The cloth cover was painted with the same bright green, red, blue, and white spatters as the exemplar.

Notice that while the small-difference items differ on only one dimension from the exemplar (shape or coloration), the large-difference

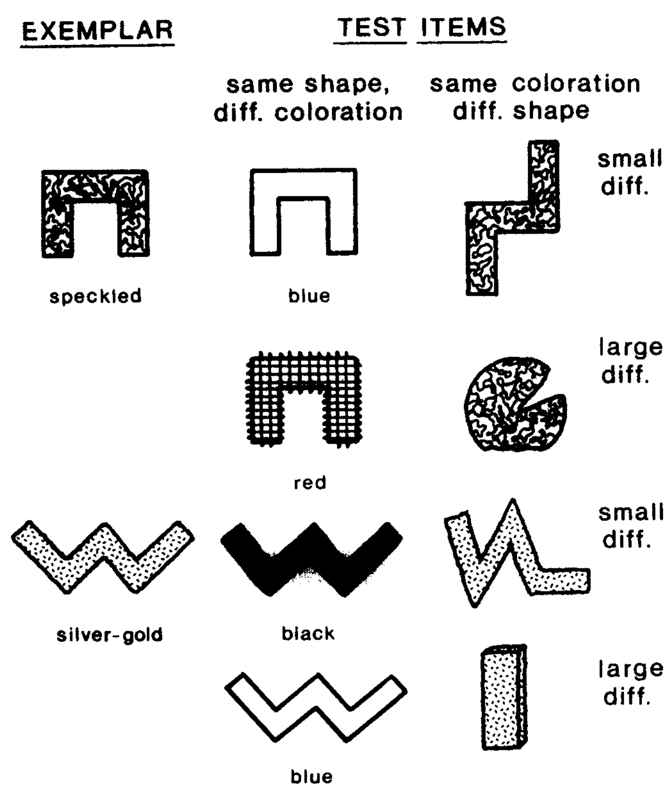


*Figure 1.* Exemplars and test items for the three experiments. (Top half—Experiment 1; bottom half—Experiments 2 and 3. Small diff. = small difference; large diff. = large difference.)

items differ on one of these same dimensions plus the surface texture (and material substance) of the object. The purpose of the large-difference items is to test the limits of the shape bias. If, for example, children selectively attend to shape when interpreting novel count nouns and this is a useful word strategy in the real world in which objects vary simultaneously on many dimensions, then children should extend a novel count noun to new items that differ dramatically from the exemplar along several dimensions as long as the novel item is the same shape as the exemplar item. We increased the dissimilarity of the large-difference items to the exemplar by adding a change in surface texture because recent research indicates that surface texture, in some contexts at least, is a highly salient dimension to young children (Jones et al., 1991; Landau et al., 1990; Smith & Heise, in press).

Thus, there were three possible kinds of systematic classification: (a) by sameness in shape, (b) by sameness in coloration, or (c) by overall similarity (classifying small-difference but not large-difference items with the exemplar).

*Design and procedure.* There were three between-subject tasks. Each was structured similarly and differed principally in the words used to instruct the child as to his or her task. In each task, the child was shown the exemplar and was then asked to judge each of the 5 test items 3 times. These 15 test trials were presented in one of two orders that were randomly determined with the constraint that an item could not immediately follow itself.

In the similarity task, the procedure began with the introduction of a child to a bear (about 10 cm tall) who sat next to the exemplar. The exemplar was shown to the child and was given to the child to hold. The child was told that this object belonged to the bear, and the child was then asked to set the exemplar down in front of the bear where it remained in view throughout the experiment. Pointing to the exemplar, the experimenter said, "The bear wants to find all the things that are like this. Here, look at this (showing the first test item). Is this like this one (pointing to the exemplar)?" The child was required to answer yes or no. This question, with slight variations, was repeated for each test item until the child responded. Individual test items in this condition and all others were removed from view after the child's judgment was made.

In the count noun extension task, the child was introduced to the bear, shown the exemplar, and asked to place it in front of the bear. Pointing to the exemplar, the experimenter said, "Do you know what this is? This is a dax. The bear likes this one because it is a dax. He wants you to find all the daxes for him. Here look at this (showing the first test item). Is this a dax?" The child was required to answer yes or no. This question was repeated for all test items.

In the adjective extension task, the child was introduced to the bear and shown the exemplar, and the exemplar was put in its place in front of the bear. Pointing to the exemplar, the experimenter said "Here, look at this. This is a dax one. The bear likes this one because it is a dax one. Can you help the bear find all the dax ones? Here look at this. Is this a dax one?" This question was repeated for all test items.

Table 1
*Proportion of Yes Responses in Experiment 1*

| | | Same shape | | Same coloration | |
|---|---|---|---|---|---|
| Condition | ID | Small diff. | Large diff. | Small diff. | Large diff. |
| Similarity | .93 | .73 | .23 | .79 | .21 |
| Count noun | .93 | .89 | .81 | .29 | .12 |
| Adjective | .89 | .75 | .58 | .52 | .38 |

*Note.* diff. = difference.

## Results and Discussion

*Group analyses.* The mean proportion of times that children said yes (to the questions "Is it like–a dax–a dax one?") for each of the five test items in each condition is given in Table 1. A one-way analysis of variance (ANOVA) indicated that children said yes equally often to the ID test item—the item identical to the exemplar in all aspects—in each of the three tasks.

The number of yes responses for the remaining four items was submitted to an ANOVA for a 3 (instruction) × 2 (same dimension: shape–coloration) × 2 (magnitude of difference) mixed design. This ANOVA yielded reliable main effects of same dimension, $F(1, 45) = 14.96$, $p < .001$, $MS_e = 1.331$, and magnitude of difference, $F(1, 45) = 32.50$, $p < .001$, $MS_e = 0.653$, and reliable interactions between instruction and same dimension, $F(2, 45) = 7.19$, $p < MS_e = .002$, and instruction and magnitude of difference, $F(2, 45) = 7.56$, $p < .001$ $MS_e = 0.875$. These interactions were analyzed further by Tukey's HSD method for post hoc comparisons and all differences cited below are reliable at the .05 level by this method (critical difference between proportions chosen equals .13).

The two interactions appear caused by the differing degrees to which sameness of shape and overall similarity control children's performances in the three tasks. In the nonlexical similarity condition, children's judgments of whether the test items were like the exemplar were controlled by overall similarity. Children maintained that small-difference items were like the exemplar considerably more often than large-difference items, and they did so equally often when the dimension that was the same was shape and when it was coloration. Children's judgments were quite consistent in this task, suggesting that they understood their task but did not find shape to be more potent than coloration.

In the noun condition, children's judgments of whether a test item was a dax were controlled by the shape of the item. Children agreed that an item was a dax if it was the same shape as the exemplar and maintained that an item was not a dax if it was a different shape, and they did so regardless of the magnitude of difference between the test item and the exemplar on other dimensions. Clearly, the shape bias is a robust and replicable phenomenon.

In the adjective condition, children said yes to items that were the same shape as the exemplar reliably more often than to items that had the same coloration, and they said yes to small-difference items more than to large-difference ones. Relative to the similarity condition, then, the presence of a novel adjective weakly increased selective attention to shape (and decreased the importance of coloration). But relative to the count noun condition, there were reliably fewer same-shape choices when the magnitude of difference was great and reliably more same-coloration choices when the magnitude of difference was small. Thus, both sameness in shape and overall similarity seem to matter in the adjective condition. The pattern of performance in this condition was between the highly focused attention to shape in the noun condition and categorization by overall similarity in the similarity condition.

*Individual analyses.* How well do these group analyses correspond to the behaviors of individual children? This question is prudent in all investigations because it asks whether our summary statistics describe any psychological reality in actual individuals. This question, slightly rephrased, is also theoretically important in the context of language learning. Language is a shared system of communication. On hearing a novel word, the issue for all listeners is to determine the meaning the speaker has in mind. The assumption in both speakers and listeners is that target meaning is the one usually, typically, and most obviously meant in that context (e.g., Austin, 1962; Grice, 1957; Searle, 1969). A second relevant question, then, is not just whether individual performances look like the group average performance, but how much variability is there between children in their individual interpretations of novel words? Do these young listeners all come to the same few conclusions about the likely referent of a novel count noun or a novel adjective?

We addressed this question by examining scatterplots of individual performances separately on the small-difference and large-difference trials. Each child made three judgments of four items that differed from the exemplar in some way. The small-difference plot shows each child's judgments of the two unique items that differed from the exemplar by only a small amount on either shape or color. The basic idea behind the scatterplot is to show how these judgments of these two unique types compared with each other for each child. Thus, in the small-difference plot, each child is given a score for saying yes to an item that is the same shape (but different coloration from the exemplar) and a score for saying yes to the item that is the same coloration (but different shape), and these are plotted in bivariate space shown on the right hand side of Figure 2. The large-difference plot shows each child's judgments of the two unique test items that differed from the exemplar by a large amount; each child's score for saying yes to the item that is the same shape (but different coloration and texture) is plotted against the child's score for saying yes to the item that is the same coloration (but different shape and texture).

So, in the first scatterplot (small-difference, similarity task), a child who maintained on all three trials that the small-difference same-shape item was like the exemplar and who maintained on all three trials that the small-difference same-coloration item was like the exemplar is represented by a dot in the upper right-hand corner of the scatterplot (i.e., coordinates 3,3). A child who (with perfect consistency) said that the same-shape item was like the exemplar and that the same coloration item was not, would be represented by a point in the lower right-hand corner (coordinates 3,0). A child who maintained that the same-coloration item was like the exemplar but the same-shape item was not would be represented by a point in the upper left-hand corner (coordinates 0,3). Finally, a child who maintained (with perfect consistency across trials) that both small-difference test items were not like the exemplar would be represented by a point in the lower left-hand corner of the scatterplot (coordinates 0,0). In looking at the scatterplots, the questions are: (a) Where are most children located? (b) What is the spread between individuals? and (c) How do location and spread vary across conditions?

As is apparent in the scatterplots of performances in the similarity task, most children judge the small-difference items to be like the exemplar regardless of the matching dimension.

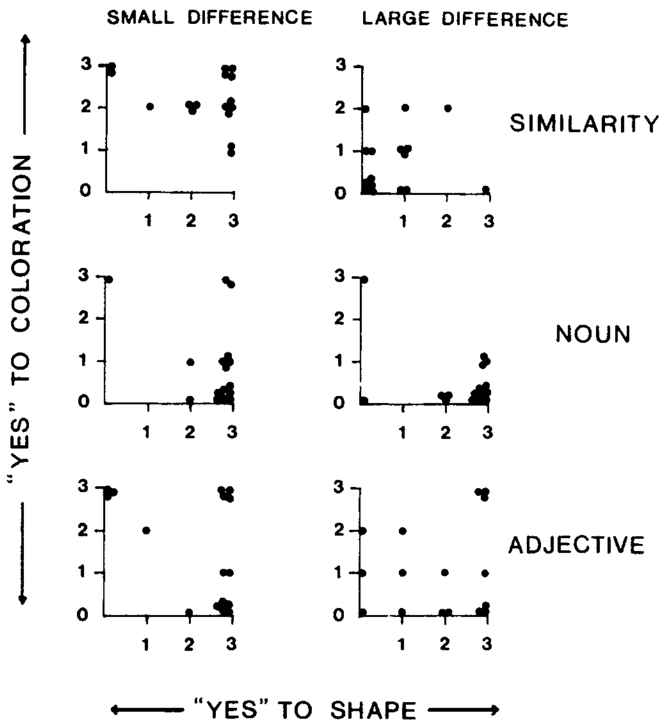


*Figure 2.* Scatterplots of individual performances in Experiment 1. (Each individual's number of yes responses to same-coloration test items is plotted against that individual's yes responses to same-shape items separately for small-difference and large-difference items.)

There is little spread in the individuals' performances with the exception of 3 children who selectively attended to coloration. Most children judge large-difference items to be unlike the exemplar regardless of the matching dimension. Thus, in the similarity task, individual children's judgments are principally controlled by the overall similarity of the test item to the exemplar.

The scatterplots in the count noun condition are intriguing in their compactness. For both small-difference and large-difference items, children uniformly maintain that test items are to be called a dax if they possess the same shape as the exemplar. Only 4 of 16 children systematically violated this interpretation: One selectively attended to coloration throughout the experiment, one extended the term to same-shape items as long as they did not also differ in texture (i.e., extended the term to small-difference same-shape items but not large-difference ones), and two extended dax to test items that were the same shape or that differed only slightly in shape from the exemplar (i.e., that extended the term to all same shape items and to the same-coloration small-difference items). Thus 3 of the 4 "violators" of the shape bias nonetheless were individuals who took similarity in shape to be critical to the meaning of a dax. Presumably, then, if the 16 children in this condition were brought together, 15 of them would be able to communicate reasonably well with each other about daxes—an ability derived from the single experience of hearing a single object labeled *a dax*.

The scatterplots in the adjective condition present the most disparate performances. Some children extended the adjective to test items by overall similarity, some by shape, some by coloration, and some by one dimension for small-difference items only. Whereas young children all tend to do the same thing in the similarity task (i.e., group by overall similarity) and show remarkable consistency in interpreting novel count nouns, they disagree considerably about the potential meaning of a novel adjective.

### *Conclusion*

The results in this experiment provide new information about the shape bias. First, the results show the shape bias to be a lexical effect. Children systematically attend to the overall similarity of objects in the similarity task but systematically attend to shape in the count noun task. In this study, then, the presence of a novel count noun did more than move children from chance-level performance in the baseline no-word task to greater consistency in the word task. Here, the presence of a novel count noun moved children from one systematic classification scheme (overall similarity) to another (shape). Second, the results show the shape bias to be stronger in children's interpretations of novel count nouns than novel adjectives. This result is consistent with the idea that the shape bias originates in children's knowledge about how count nouns refer to objects in basic level categories.

## Experiment 2

The central question of Experiment 2 is this: If coloration is made perceptually more salient than shape, will 3-year-olds still consistently attend to shape when interpreting a novel count noun? If the presence of a novel word just causes a generalized increase in selective attention but not an increase in attention to any one perceptual dimension, then in the presence of a novel word children should attend to the most perceptually salient property of the labeled object. If, however, the shape bias results from what children know about how count nouns refer to categories of concrete things, then the shape bias for count nouns, but perhaps not for adjectives, should withstand a greater salience of coloration over shape.

### *Method*

*Subjects.* The subjects were forty-eight 3-year-old children (mean age 38 months, range 35 months to 43 months) recruited and assigned to instruction conditions in the same way as in Experiment 1. None of the children in this experiment had participated in Experiment 1.

*Stimuli and procedure.* All aspects of this experiment were identical to Experiment 1 with the exception of the stimuli, which are illustrated in the bottom half of Figure 1. The exemplar was an elongated W approximately 11 cm long and 1.5 cm thick made from wood. It was covered in a mixture of silver and gold glitter. The small-difference same-shape test item was an identical shape that was covered in black glitter. The large-difference same-shape item was the same elongated W painted a matte midblue; this item did not have the same bumpy surface as the glitter-covered exemplar. The small-difference same-coloration test item was made by compacting one leg of the elongated W and stretching out the other (see Figure 1). This item was also covered in a mixture of silver and gold glitter. The large-difference same-coloration item was a rectangular piece of wood that was 12 cm tall and 2.5 cm wide. This item was covered with silver and gold glitter, and then clear plastic was melted over the glitter so that the surface presented a smooth (nonbumpy) sheen.

### *Results and Discussion*

The silvery-gold color of the exemplar was noticed and spontaneously commented on by all the children. Table 2 shows the mean proportion of yes responses to each of the five test items in each instruction condition. Children in all conditions almost always maintained that the ID test item was like the exemplar or could be referred to by the same terms.

Children's numbers of yes responses to the remaining four test items were submitted to an ANOVA for a 3 (instruction) × 2 (same dimension) × 2 (magnitude of difference) mixed design. The ANOVA revealed main effects of same dimension, $F(1, 45) = 18.93$, $p < .001$ $MS_e = 1.42$, and magnitude of difference, $F(1, 45) = 31.48$, $p < .001$ $MS_e = 0.563$. The ANOVA also yielded reliable interactions between instruction and same dimension, $F(2, 45) = 27.75$, $p < .001$ $MS_e = 0.982$, and between same dimension and magnitude of difference, $F(1, 45) = 4.82$, $p < .03$ $MS_e = 0.982$. These results were further analyzed using Tukey's HSD test for post hoc comparisons; all contrasts reported below are reliable at the .05 level (critical difference between proportions equals .11).

In the similarity condition, children said that small-difference items were like the exemplar more than large-difference items both for items that had the same coloration and for items that were the same shape as the exemplar. However, children said that same-coloration items were like the exemplar more than they said that same-shape items were and they did so both for the small-difference and large-difference items. This result indicates that we were successful in making the coloration of the items more salient than their shapes in a context not involving novel words.

Despite the increased perceptual salience of coloration, children in the count noun task again attended to shape. They called items *a dax* if they were the same shape as the exemplar regardless of the magnitude of other differences, and they refused to call items that differed in shape (but had the same salient coloration) a dax. There was a slight (and statistically reliable) tendency for children to extend a dax more to same-coloration items that were similar in shape than to the same-coloration item that differed greatly in shape (and texture); however, as is apparent in Table 2, such extensions were, in absolute terms, rare. The results in this condition show that the shape

Table 2
*Proportion of Yes Responses in Experiment 2*

| | | Same shape | | Same coloration | |
|---|---|---|---|---|---|
| Condition | ID | Small diff. | Large diff. | Small diff. | Large diff. |
| Similarity | .93 | .58 | .38 | .88 | .52 |
| Count noun | .98 | .89 | .83 | .27 | .15 |
| Adjective | .93 | .88 | .71 | .72 | .29 |

*Note.* diff. = difference.

bias in the context of a novel count noun is quite robust and not a simple salience effect.

A shape bias was again evident in the adjective task. However, as in Experiment 1, performance was intermediate between that of children in the similarity and count noun conditions. In the adjective task, children said yes to same-shape items more than children in the similarity condition but less than children in the noun condition; they said yes to same-coloration items more than children in the noun condition but less than children in the similarity condition.

Individual children's interpretations are shown in the scatterplots of Figure 3. The critical issues in looking at the data this way are the locations of individuals, their scatter, and changes in location and scatter across conditions. Relative to Experiment 1, children's similarity judgments were made more variable by increasing the salience of coloration. Although most children said both small-difference items were like the exemplar, there were considerable differences between subjects on the large-difference items. Moreover, many individual children's judgments are located in the center of the scatterplot indicating that they said a unique item was like the exemplar on some trials but not like it on others. It is not surprising that increasing the salience of one dimension disrupted young 3-year-olds' similarity classifications. Research on perceptual classification (see Smith, 1989) indicates that at this age children generally attend to all varying dimensions and have considerable difficulty in attending selectively to any one dimension. A highly salient single dimension apparently perturbs young children's classification by overall similarity but is insufficient for systematic classification by that single salient dimension.

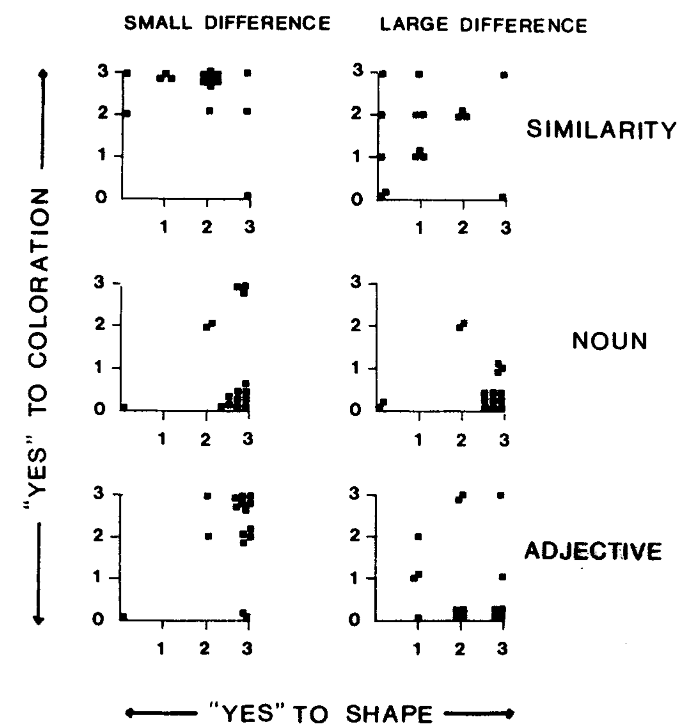


*Figure 3.* Scatterplots of individual performances in Experiment 2 (plotted as in Figure 2).

However, increasing the salience of coloration did not disrupt children's selective attention to shape in the context of a novel count noun. A count noun is apparently a more potent force on children's attention to the perceptual properties of objects than the relative salience of the properties themselves. As in Experiment 1, most children in the novel noun condition (10 of 16) required a test item to have exactly the same shape as the exemplar to be called a dax; these children said yes to the one small-difference item that was the same shape as the exemplar and the one large-difference item that was the same shape. Two additional children extended a dax to items that were at least similar in shape to the exemplar. (Both small-difference items and the one large-difference item that shared shape with the exemplar.) For 75% of the children (12 of 16), then, the interpretation of a dax was not at all problematic; the term referred to a category organized by similarity in shape.

Children's interpretations of the novel adjective were variable. Most children in this condition extended the novel adjective to the small-difference items; these two objects are similar overall to the exemplar (and thus at least similar in shape). Many children also extended the adjective to the large-difference item that was the same shape as the exemplar. For these children a dax one apparently meant "sort of the same in shape." However, there were considerable individual differences between children in their judgments of the two large-difference items.

Notice the difference in patterns of responding in the adjective condition and the similarity condition. In both conditions, children classified small-difference items with the exemplar. However, children in the similarity condition favored matching coloration over matching shape with large-difference items. This is seen in the location of individuals above the diagonal toward the upper left of the scatterplot. In contrast, many children in the adjective extension condition tended to favor shape when labeling the large-difference items; this is seen in the cluster of children in the lower right-hand corner of the scatterplot. Thus, children's judgments in the novel adjective condition were not simply the same as their uninstructed judgments in the similarity condition. Instead, for some children, there appears to be a weak shape bias that may be dependent on children's knowledge that count nouns refer to categories organized by shape or to their knowledge that adjectives can refer to odd shapes as well as other object properties.

In sum, the results of this experiment show that the shape bias in children's interpretations of novel count nouns is sufficiently robust to withstand the increase in salience of coloration. The results also suggest that a weak shape bias influences children's interpretation of novel adjectives.

## Experiment 3

Can the weak shape bias in the context of adjectives be overcome by strong evidence pointing to another relevant property? A shape bias would not work to the disadvantage of adjective acquisitions if it were easily disrupted by contexts that pointed to the communicative relevance of other properties. Of course, for the shape bias to continue to play its helpful role in count noun acquisitions, it would have to remain unshakable in those same contexts when the novel word was a count noun. We tested this idea in the final experiment by further increasing the perceptual and contextual salience of coloration over shape. The empirical question was whether we could obtain a bifurcation in children's interpretations of novel nouns and adjectives. Would children take a novel noun to refer to the shape of objects even in a context that very clearly emphasized the importance of coloration? And in that same context, would children take a novel adjective to refer to the emphasized property?

We addressed this question by using the same stimuli as in Experiment 2. However, the bear and the exemplar object were placed in a small chamber (a cave) that was painted black. The exemplar and bear were illuminated by a light shining into the cave from a small hole in the roof. Testing was done in a darkened room. The result of these changes was that the silvery-gold exemplar sparkled and glowed—a useful property for objects to have in the dark.

## *Method*

*Subjects.* The subjects were forty-two 3-year-olds (mean age 38 months, range 35 to 42 months). The children were recruited in the same manner as those in Experiments 1 and 2. Equal numbers of males and females were randomly assigned to the three instruction conditions as follows: similarity, 10 children; count noun extension, 16 children; adjective extension, 16 children.

*Stimuli and procedure.* The stimuli and procedure were identical in all respects to Experiment 2 with the exception that the bear, the exemplar, and the test items were presented in a cave. The cave was made from a cardboard box 18 cm high, 25 cm wide, and 20 cm deep. It was painted black on the inside and outside. A 5-cm hole was cut through the top of the box; a 100-watt bulb encased in a small black box was set on the top of the box such that the bulb shone only into the cave. The test room was dimly illuminated by one overhead fluorescent light. On each test trial, the test item was brought into view outside the cave and then placed in the cave next to the exemplar. At this point, the question appropriate to the similarity, count noun, or adjective condition (like–a dax–a dax one) was asked.

## *Results and Discussion*

Table 3 shows the mean proportions of times that children said yes to the question of whether the test item was like the exemplar, was a dax, or was a dax one in the three conditions. All children in this experiment said yes 100% of time when asked about the ID test item—the item identical to the exemplar. Children's numbers of yes responses to the remaining test items were submitted to an ANOVA for a 3 (instruction) × 2 (same dimension) × 2 (magnitude of difference) mixed design. The ANOVA revealed a main effect of magnitude of difference $F(1, 39) = 6.42$, $p < .02$, $MS_p = 0.462$ and reliable interactions between instruction and same dimension, $F(2, 39) = 21.73$, $p < .001$, $MS_e = 0.462$; instruction and magnitude of difference, $F(2, 39) = 4.52$, $p < .02$, $MS_e = 0.329$; same dimension and magnitude of difference, $F(1, 39) = 3.97$, $p < .05$; and between instruction, same dimension, and magnitude of difference, $F(2, 39) = 3.31$, $p < .05$, $MS_e = 0.329$. These interactions were analyzed by means of Tukey's HSD method; all reported differences are reliable at the .05 level. The critical difference between proportions equals .12.

These post hoc comparisons indicate that in the similarity condition, same coloration items were said to be like the exemplar more than same-shape items and small-difference items were said to be like the exemplar more than large-difference items. This effect of magnitude of difference was particularly pronounced for the same-shape items. Clearly, our cave manipulation increased the salience of coloration. Note, however, that an effect of overall similarity remained.

In the count noun condition, children once again attended selectively to shape, extending dax to new objects that were the same shape as the exemplar, but not to objects that differed in shape. The contrast between the small-difference and large-difference items is reliable for the same-shape items and, in the opposite direction for the same-coloration items. The rise in the selection of the large-difference same-coloration item over the small-difference same-coloration item is caused by 2 boys who always maintained the small-difference item was not a dax but who also always selected the large-difference same-coloration item as a dax. We suspect that their behavior was motivated by their attraction to the particular item and by its (in their view) similarity to a sword. Both boys verbally suggested that the bear could use the item as a sword. These small similarity or item effects notwithstanding, children in the count noun task overwhelmingly attended to shape and ignored the differences in coloration.

The pattern of performances in the adjective task is directly opposite to that in the count noun task. Here children called a test item *a dax one* if it had the same coloration as the exemplar. They only rarely extended the term to items that were the same shape as the exemplar but different in coloration. In this condition, the effects of magnitude of difference did not reach statistical significance. Apparently, children know something specific about adjectives that makes their interpretation differ from that of novel count nouns in certain contexts.

Figure 4 provides the scatterplots of individual children's performances in the three conditions. Children in the similarity condition show the most diversity in their performances. This is not surprising because the salience manipulations were designed to disrupt their preferred perceptual classification strategy of attending to all dimensions equally. Our success in increasing the salience of coloration is clearly evident in some children's judgments. There is a cluster of children in the upper left-hand corner of both the small-difference and large-difference plots; these are children who maintain that only the same coloration items are like the exemplar. Other children, however, show other patterns. There is greater uniformity with

Table 3
*Proportion of Yes Responses in Experiment 3*

| | | Same shape | | Same coloration | |
|---|---|---|---|---|---|
| Condition | ID | Small diff. | Large diff. | Small diff. | Large diff. |
| Similarity | 1.00 | .40 | .03 | .73 | .60 |
| Count noun | 1.00 | 1.00 | .88 | .23 | .35 |
| Adjective | 1.00 | .29 | .27 | .77 | .69 |

*Note.* diff. = difference.

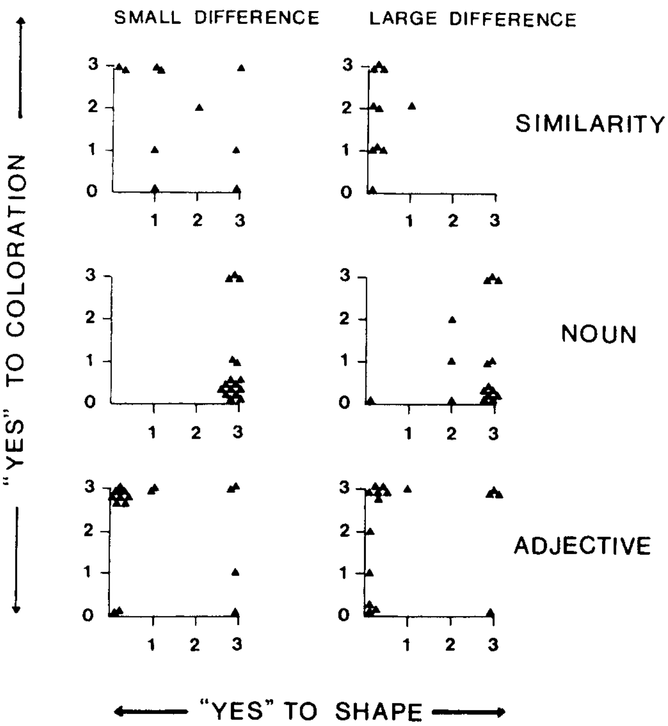


*Figure 4.* Scatterplots of individual performances in Experiment 3 (plotted as in Figure 2).

the large-difference items than with small-difference items; with the large-difference items most children attend selectively to coloration.

The uniformity of children's interpretations in the count noun task are again remarkable. Eleven children (at least two thirds of the time for each item) extended a dax to same-shape stimuli regardless of the magnitude of difference but did not extend a dax to same-coloration items. Two additional children extended a dax to items that were at least similar to the exemplar in shape. (The remaining 3 children include the two boys with an interest in swords and 1 child who extended "a dax" to new items according to their overall similarity.) The consistency with which children assumed that a novel count noun referred to a category organized by shape in a context that pushed very strongly for attention to another dimension provides compelling evidence for a unique connection between count nouns and the dimension of shape in early language learning.

In contrast to the findings in Experiments 1 and 2, the performances of the children in the adjective condition in this experiment show considerable organization. Half of the children consistently interpret a dax one as referring to coloration regardless of the magnitude of difference. However, the force of shape in novel adjective interpretations can still be seen clearly in the patterns of interpretation shown by some children. One child interpreted a dax one as referring to objects that were the same shape as the exemplar, and another interpreted a dax one as referring to objects at least similar in shape to the exemplar. The other 4 children showed patterns of performance not observed in the other experiments and conditions: 2 children refused to extend a dax one to any test item but the one identical to the exemplar, and 2 extended a dax one to all test items (i.e., they said everything was a dax one). Perhaps these children's interpretations were "paralyzed" by the competition between two equally strong forces on attention to dimensions: generalization of the noun-shape bias and the contextual and perceptual potency of coloration. We explore the idea of competing multiple forces on attention and the interpretation of novel words in the General Discussion.

In sum, the data from this final experiment provide strong support for the hypothesis that children within several months of their third birthday know something about the differences between adjectives and count nouns. They know that count nouns typically refer to categories organized by shape and thus when they confront a novel count noun, they extend that novel word to new items on the basis of shape. Very young children also have implicit knowledge that allows them to interpret count nouns and adjectives differently in at least some contexts.

## General Discussion

We began this research with two questions. First, is the shape bias specific to words? Second, is the shape bias specific to count nouns?

The answer to the first question is yes. The shape bias is a lexical effect. Across all three experiments with stimuli that varied considerably in the relative salience of shape and coloration, young 3-year-olds consistently interpreted novel count nouns as referring to sets of objects of the same shape. When other children were presented with the same stimuli and asked to make similarity judgments, shape was not the dominant dimension of perceptual comparison. Instead, responses were jointly controlled by overall similarity or by the most salient dimension. Thus, young children's interpretations of novel count nouns are not isomorphic to their perceptual classifications of objects, and the presence of a novel count noun does not simply amplify an existing preference for a particular perceptually based organization. Instead, the presence of a novel word can qualitatively change how children group objects.

The present findings also indicate that the shape bias in naming is not produced as a general task-organizing effect of hearing any word. Many individual children in the similarity condition who heard no word nevertheless produced highly organized grouping responses. The same stimuli in the presence of a novel word in an adjectival frame disorganized some children's performances. Thus, it is the presence of a novel count noun—not just any word—that systematically and consistently organizes children's attention.

Furthermore, count nouns organize children's attention in a specific direction—namely, toward comparing objects by shape. Even in Experiment 3, children interpreted a count noun as referring to objects with the same shape, despite the presence of another shared property—coloration—that was obviously much more perceptually salient than shape.

This finding is pertinent to recent questions raised by Nelson (1988) as to the direction of the relation between novel words and their potential meanings. Nelson has suggested that, more often than not, children map new words onto whatever is already the focus of their attention when the new word is heard.

The present data argue the opposite order of events, at least for count nouns, and at least for children 3 years of age. In Experiment 3, the noun directed children's attention, specifically, the noun took children's attention away from a focus on coloration (evidenced in the similarity condition) and directed it instead to the shape of the named exemplar.

The shape bias in the context of count nouns is robust and reliable—so much so that the data could be interpreted as evidence of a count noun → shape principle. That is, the data are consistent with the notion that there is a count noun → shape rule represented somewhere in the mind of the child that is invoked whenever the child hears a new word in a count noun frame. This conclusion may be justified. But just what does it mean? If there is such a rule, how does it develop? How is it implemented? These questions gain clarity from consideration of the adjective data. Can we write a rule to explain how 3-year-olds interpret novel adjectives?

### *A Rule for Adjectives?*

Previous investigators have suggested that young preschoolers appreciate the semantic distinction between nouns and adjectives (e.g., Gelman & Markman, 1985; Taylor & Gelman, 1988), but the evidence for these suggestions has been weak. Experiment 3, however, provides unambiguous evidence that 3-year-old children do know something about the differences between count nouns and adjectives. But what do they know?

One possibility suggested by Gelman and Markman (1985) is that children expect nouns to label categories of whole objects and adjectives to label salient within-category distinctions. We can fit the most-salient-within-category-distinction rule to these data only if we assume that the category was all of the objects (i.e., the exemplar and all of the test objects). The rule, then, predicts that adjectives will be interpreted as referring to the most salient dimension that distinguishes among all the objects. Our results suggest that this rule interpreted in this way is wrong. Children interpreted adjectives sometimes as referring to shape and sometimes as referring to coloration, but their choices did not always follow children's similarity judgments, which they should have if salience was all that mattered. Specifically, performances in the similarity task indicate that coloration was more salient than shape in Experiment 2, yet children in the adjective condition of that experiment attended to shape more than to coloration.

A second possibility is that children interpret adjectives as referring to a within-category distinction, but reserve shape for between-category distinctions. In other words, children might believe that adjectives must be about within-category distinctions other than shape. This possibility predicts that an adjectival frame would push children away from shape as a referent and toward other distinguishing properties. This prediction does not fit the data: Children in the present experiments always made fewer shape-based groupings in the adjective conditions than in the noun conditions, but they also made more shape-based groupings when given an adjective than when given no word at all in Experiments 1 and 2. Thus, the presence of a novel adjective seemed to move children in these experiments toward shape (even in Experiment 2, when coloration was more salient). A novel adjective moved children away from shape only in Experiment 3 when the adjectival frame was combined with an extremely salient other property.

### *Multiple Information Sources*

The remaining alternative is to take at face value the fact that adjectives seem to have effects intermediate between the effects of nouns and the effects of nonlexical matching instructions. Children's performances in the adjective conditions are in some ways like children's performances in the count noun conditions and in other ways like children's performances in the similarity conditions. In fact, the results in the adjective conditions look like what would happen if multiple competing forces—some shared with the count noun condition, some with the similarity condition—were simultaneously brought to bear on children's attempts to determine the meaning of a novel adjective. Thus, there may be no rule for adjectives. The children's interpretations of novel adjectives may have emerged in context and may reflect the combined effects of multiple information sources.

There are at least three kinds of information sources in our experimental context (and in other experiments of this type) that might direct children's attention to one dimension or another. There are the objects themselves, with their more and less salient perceptual properties. There are the task instructions, with and without syntactic cues to different word meanings (nouns pushing for shape matches, adjectives pushing, perhaps, for contrasts within shape-based categories). Beyond these deliberately manipulated information sources, there is the situation itself. It is useful to consider this last source of information about a novel word's meaning in some detail.

The situation consists of a child interacting with an adult who in both word conditions is directing the child's attention to an object and saying "This is a . . ." The evidence suggests that there is something about the introduction of a novel word (regardless of whether the word is a count noun or an adjective) in the presence of novel objects that causes a majority of young children to attend to the same perceptual properties of objects. Thus, this situation in and of itself may be a critical source of information for children.

Importantly, the existing evidence suggests that a novel word in the context of "This is a . . ." and in the presence of a novel object does not always direct children's attention to the same object properties. Soja, Carey, and Spelke (1991) recently reported that a novel word in the presence of mounds of nonsolid substances (e.g., hand cream mixed with gravel) took 2-year-olds' attention to substance and not to shape. Jones et al. (1991) found that a novel count noun caused 3-year-olds to attend to both shape and texture when grouping novel objects with eyes. Apparently, the effect of a novel word depends on the nature of the stimuli being labelled. And, critically, the effect of a new word in a "This is a . . ." context is not simply to take children's attention to shape.

What, then, is the mechanism by which a novel word in some stimulus contexts directs attention to shape and in other contexts directs attention to some other dimension? How is this general word effect related to the more specific count noun effect? We suggest that a novel word activates existing bundles of connected features and properties. For concrete objects, these bundles of features may include connections between the invariant aspects of shape that hold over movement transformations and haptic qualities of rigidity. For nonsolid objects such as mounds of hand cream, these bundles of features may include connections between texture, color, squishiness, and the noninvariance of shape. We suggest that novel labels activate these bundles and direct attention to the dimensions that have mattered in the past for naming entities with those specific bundles of features. So, the child will have learned that when adults label rigid, bounded objects, the child should attend to shape and that when adults label nonbounded substances, the child should attend to texture and color. It should be noted, however, that the bundles of features that can be linked to a labeling → attended dimension relation are not restricted to the sets of features that distinguish between ontological kinds such as objects versus substances. Jones et al.'s (1991) results showing that naming activates attention to texture and shape when objects have eyes suggest that the link between labeling and attention can accrue over smaller bundles of correlated features. Indeed, such word-attention strategies may emerge given experience with any regular relationship between naming, correlated features, and a critical dimension.

These ideas suggest the following interpretation of performances in the adjective conditions of the present experiments. In the adjective condition, children must integrate three sources of information that are not always in agreement. First, they are faced with a labeling situation and a concrete object. This novel word context directs attention to shape. Second, the objects themselves have perceptual properties with different saliences that tug attention in one direction or another. Third, there is the adjectival syntactic frame, which may push children away from shape. Depending on the particular mix of these three information sources, the child may attend to shape, coloration, or both dimensions. Our data suggest that for 3-year-olds, the syntactic frame alone is not yet strong enough to overcome the pull toward shape exerted by the novel word and concrete object effect unless supported by the extreme salience of another object property-like coloration. Perhaps with further development—with the learning of many adjectives that refer to distinctions within categories of same-shaped objects—the syntactic frame may become enough of a force by itself to direct attention away from shape even without the support of a salient competing dimension (see Landau et al., 1990).

The view that the interpretation of a novel word emerges in context from the assembly of multiple situational and learned pulls on attention can apply to the case of novel count nouns as well as to novel adjectives. By this account, children in the count noun conditions of the present experiments were pushed to shape by both the labeling situation and the syntactic cues. This combination of forces appears to be very strong because even the perceptual pull of highly salient coloration in Experiment 3 did not shift children away from shape.

Thus, we are suggesting that the shape bias with count nouns that appears so rule governed in all of our experiments may be the emergent product of a combination of forces. Does this mean that there is no count noun → shape principle—no rule represented in the mind of the individual to constrain the possible meanings of count nouns? This is a complex question that turns on what counts as having such a principle. We suspect that *with development*, the semantic force of syntactic information may become such a strong force on attention (in the context of novel objects and newly encountered words) that only this factor effectively matters. If this were so, we might want to conclude that older children and adults have principles for word interpretation. However, by our account, such principles develop in the context of working out the relations between words and objects. In the beginning, the young child's attempts to interpret novel words will be guided by combinations of multiple forces on interpretation. Her successes and failures will then feed back on those forces to change the relative weightings of the different associations activated in word-learning contexts. It is in this way, we suggest, that syntactic frame may come to matter most. It is in this way that count noun principles, and perhaps adjective principles, develop.

By this multiple forces account, children's decisions about the meanings of novel words should be perturbable in specific, predictable ways. For example, even though the count noun → shape relation appears to be very strong by 3 years of age, it may be possible to disrupt children's shape-based groupings in the presence of a novel noun by changing the situational or perceptual forces on their attention. However, if 3-year-olds have already developed a sufficiently strong link between the syntactic frame of count nouns and shape—that is, if they already have a count noun → shape principle, then changes in the labeling context or in the other perceptual properties of objects may not affect their interpretation.

Figure 5 provides insight into the kind of empirical work suggested by the multiple-forces account. The figure summarizes the data of the present three experiments and plots hypothetical data. The real data are indicated by heavy solid and dashed lines. These functions plot the proportion of total yes responses that are yes responses to same-coloration items as a function of the salience of coloration over shape. (The ordering of the three experiments on the salience of coloration over shape is determined by the proportion of yes responses to same-coloration items in each experiment's similarity task.)

The plots of children's attention to coloration over shape across the three experiments shows that the shape bias for count nouns is highly resistant to the effects of increasing the salience of coloration across the range of coloration salience examined in these experiments. If this resistance is caused by 3-year-olds already having developed a principle-like count noun → shape connection, then 3-year-olds should interpret count nouns as referring to categories of same-shaped objects regardless of how highly salient another property becomes and regardless of the situation in which the new count noun is heard. This prediction is illustrated by the (lighter) straight-line extension of the noun data. Thus, for example, a novel count noun should be extended by shape even if casually introduced in conversation (i.e., if the labeling context is weakened) and even with paper stimuli with highly salient coloration (i.e., where the relative salience of shape is diminished). If these results were obtained with 3-year-olds, it would be important to test younger children to see if, as we predict, their count noun → shape bias was malleable.

Alternatively, 3-year-old children's interpretations of novel count nouns may still show the combined effects of multiple forces on attention. This possibility would be indicated by experimental manipulations that perturbed the count noun-shape bias. The prediction from this account, illustrated by the

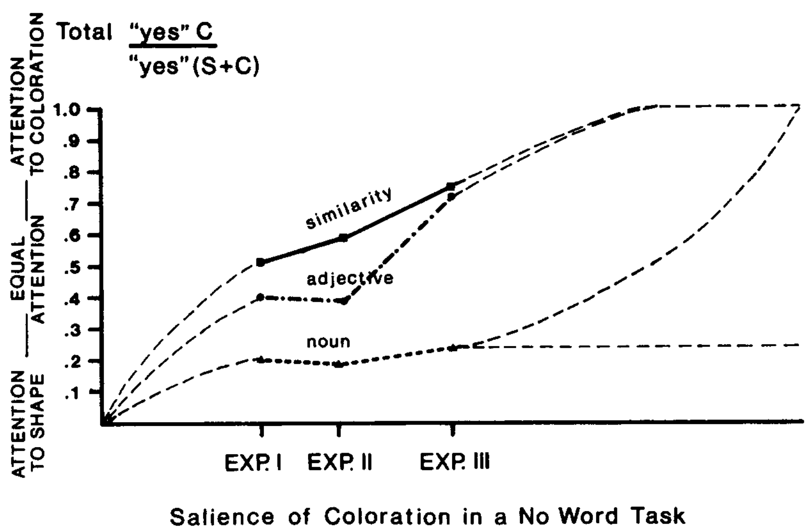


*Figure 5.* Attention to coloration over shape as a function of the salience of coloration in the three conditions across the three experiments and theoretical projections from those data. (EXP = experiment.)

upward curving line extending from the obtained results with nouns, is that at some relatively higher value of coloration's perceptual salience, or with some change in the situational context, even 3-year-old children might tend to interpret a novel count noun as referring to the coloration, rather than the shape, of the labeled object. Thus, in our hypothetical experiment with paper stimuli, the casual context in which the word was introduced and the paper shapes would only weakly recruit attention to object shape. The count noun syntax would still push for shape. But the forces for attention to shape in this case might be outweighed by the perceptual pull of the highly salient coloration of the stimuli, and children might extend the word across different paper shapes with the same coloration.

The point of our hypothetical experiments is not to propose that some single manipulation could be found that would cause a shift in the count noun → shape relation. If we presented paper stimuli painted shades of grey in a strong word-learning context, we might well find that children would categorize by shape. The point is that for both count nouns and adjectives, children might be directed to likely word meanings by the interaction of different kinds of existing knowledge along with the immediate perceptual input, rather than by the application of a rule. Thus, our claim is that word-learning principles may describe the performance of children in word-learning experiments, but may have no representation as principles in the children's minds.

This view of how children learn the meanings of words turns Quine's problem on its head. For with this multiple-forces view, explaining children's word-learning no longer turns on the philosophical question of how children are constrained or prevented from entertaining all logically possible hypotheses about the meaning of a word. Instead, as Nelson (1988) and Fischer and Bullock (1981) have argued, the research task is to identify the forces that push children towards particular solutions to the problem of meaning, to determine how those forces interact in word-learning contexts, and to document how those interactions lead to developmental change in children's knowledge of language.

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