

Children's Attention to Rigid and Deformable Shape in Naming and Non-Naming Tasks

Larissa K. Samuelson and Linda B. Smith

In four experiments with three-year-olds ($N = 67$), we investigate children's understanding of the differential importance of shape for categorization of solid rigid objects with fixed shapes and solid but deformable objects with shapes that can be changed. In a non-naming task we find that young children categorize rigid and deformable things differently and know that material is important for deformable things and shape for rigid things. In two naming tasks, however, children generalize names for both solid and deformable objects by shape similarity and disregard rigidity. To understand this pattern of results we examine a corpus of early-learned nouns and the kinds of rigid and nonrigid things named by nouns in that corpus. The results suggest that names for categories of solid, rigid objects in which instances are similar in shape dominate children's early noun vocabularies. We suggest that children's novel word generalizations for deformable things may be overgeneralizations of this dominant pattern.

INTRODUCTION

Young children are skilled learners of object names. After hearing a *single* object named, they commonly generalize that name to other category members in ways that seem right (or nearly so) to adult speakers of the language (Golinkoff, Mervis, & Hirsh-Pasek, 1994; Imai & Gentner, 1997; Markman, 1989; Smith, 1995; Waxman, 1994). Often these seemingly correct generalizations of newly learned object names are based on the shape of the named object (Clark, 1973; Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988; Smith, Jones, & Landau, 1992). Why is shape so important in children's object name generalizations? We seek insight into this question by comparing contexts in which young children are more and less likely to form categories by shape. Our starting point is informed by previous findings that the degree to which children generalize a noun to new instances by shape depends on the properties of the named exemplar; specifically, children categorize novel objects by shape most consistently when the named object possesses a fixed and rigid shape (Dickinson, 1988; Imai & Gentner, 1997; Samuelson & Smith, 1999; Soja, 1992; Soja, Carey, & Spelke, 1991; Subrahmanyam, Landau, & Gelman, 1999).

The relevant data derive from novel noun generalization tasks in which the child is presented with a novel entity and told its name, for example, "this is a dax." The child is then presented with novel test items and asked whether the newly learned name applies, for example, "is this a dax?" or "show me the dax." When the named object is a solid, rigid artifact, children 30 months old and older consistently and robustly generalize the name to new instances by

shape and ignore color, texture, and size (Imai & Gentner, 1997; Landau et al., 1988; Smith, Jones, & Landau, 1996; Soja et al., 1991). When, however, the named object is made from nonsolid substances such as sand or shaving cream, young children are less likely to attend to shape and more likely to generalize the name of the novel entity by material (Dickinson, 1988; Soja et al., 1991).

Several of these studies have examined the link between these stimulus effects and the syntactic frame in which the novel noun is presented. In general, count noun syntactic frames ("This is a ____") are associated with solid things named by shape, and mass noun syntactic frames ("This is some ____") are associated with nonsolid substances named by material (Samuelson & Smith, 1999). Syntax, however, does not appear as potent a force on children's category generalizations as stimulus properties in that when even the syntax used in the novel word generalization task is manipulated, children are still more likely to generalize names for solid objects, as compared with nonsolid substances, by shape. For example, shape responding is higher for solid objects than nonsolid substances when the names are presented in a neutral syntactic context (Soja et al., 1991), and when solid objects are named by mass syntax and nonsolid ones by count syntax (Soja, 1992). Further, children learning a language without count/mass syntax also show higher levels of shape responding with solid objects (Imai & Gentner, 1997). Accordingly, we began these studies with a focus on the stim-

ulus effects—their origin and their nature. We specifically ask if the rigidity of an object's shape is a crucial cue.

Previous studies have concentrated on the solid/nonsolid distinction (Imai & Gentner, 1997; Samuelson & Smith, 1999; Soja, 1992; Soja et al., 1991); that is, how children generalize names for solid objects made out of rigid materials such as wood and hardened clay compared with how they generalize names for piles of nonsolid, and thus also nonrigid, substances such as hand cream or hair gel. There is some indication that rigidity itself may matter, that the strength of children's bias to attend to material when naming a solid but deformable object (something made of sponge) may be more variable or weaker compared with their bias to attend to shape when naming a solid thing with a rigid shape (see Kobayashi, 1997; Samuelson & Smith, 1999). Children's categorizations of deformable materials have not, however, been systematically examined. This is the goal of the present experiments. We ask these questions: Does a rigid shape cue children to categorize by shape? Does a nonrigid and deformable material cue children to categorize by material? Are these stimulus effects evident in non-naming categorization tasks as well as naming tasks?

It makes sense that the rigidity of an object's shape might serve as a potent cue to categorization even before and perhaps independently of language. The functions and propensities of rigidly shaped objects—of keys and tables and hammers, for example—depend crucially on their shape. In contrast, the functions and propensities of nonrigidly shaped things—of paper and sponge and blankets—often depend on the material they are made of and less on their shape. Moreover, and perhaps most crucially, when children interact with a rigidly shaped object, they do not change that object's shape. When, however, children interact with an object made of a nonrigid material, their actions are likely to change the object's shape (at least temporarily). If this reasoning is right, then children's understanding of the differential importance of shape for categorizing rigid things and material for categorizing nonrigid things might be independent of language and thus evident in categorization tasks other than those involving the learning and generalization of object names.

Many previous studies of young children's artificial noun learning have included non-naming control tasks (e.g., Gelman & Coley, 1990; Imai et al., 1994; Landau et al., 1988; Waxman, 1990). The key result of these experiments is that in non-naming control tasks children do not categorize systematically and, more specifically, they do not categorize rigidly shaped

things differently from nonrigidly-shaped things (Soja et al., 1991). In brief, children's focused attention to shape in the context of rigid objects and their increased attention to material in the context of non-solid (and thus also nonrigid) objects is specific to the task of generalizing an object name. This fact has been interpreted as indicating that children's systematic generalizations of novel names to new instances is due to knowledge specifically about how words map to categories (Hall, 1994; Markman & Hutchinson, 1984; Smith, 1995; Soja et al., 1991; Waxman & Hall, 1993).

This conclusion may be premature, however. The non-naming control task used in many previous studies has been a similarity judgment task (e.g., Imai et al., 1994; Landau et al., 1988; Smith et al., 1996; Waxman & Hall, 1993). In the typical version of this task, the child is presented with a target object and is then asked to choose which of two test objects "goes with" or "is like" the exemplar. It is possible that the lack of stimulus effects and systematic categorization found previously is due only to the incomprehensibility (and purposelessness) of the similarity judgment task from the child's point of view. That is, children may not understand requests to "get another one" or one that "goes with" or "is like" the exemplar because these words are nonspecific and atypical of adult-child interactions (see Bauer & Mandler, 1989; see also Deak & Bauer, 1995, for a similar point). The possibility that young children simply don't understand the non-naming control tasks used in previous studies fits the fact that children's category judgments in this task often do not deviate from chance (e.g., Imai et al., 1994; Landau et al., 1988; Smith et al., 1996; Waxman & Hall, 1993).

In addition, the common use of a forced-choice procedure in non-naming control tasks may undermine their sensitivity. In the usual non-naming control task (e.g., Imai et al., 1994; Landau et al., 1988; Smith et al., 1996; Waxman & Hall, 1993), children are presented with an exemplar and two (or sometimes three) objects all of which match the exemplar in some way, for example in shape only, color only, or material only. Children are forced to pick a match that "goes with" the exemplar on each trial. Such a procedure cannot discriminate between the possibility that children think more than one kind of similarity is highly relevant and the possibility that children think none of the presented similarities is highly relevant. Further, although such a procedure should measure consistent preferences for matches along one dimension, it may be insensitive to attentional biases that are present but weak. That is, children may have a weak preference to attend to material

with nonrigid stimuli but not clearly demonstrate this bias because it cannot overcome other pulls on attention because of the differential salience of the stimuli and the fact that all the stimuli match on at least one dimension.

For these reasons, we chose to use a different non-naming task to ask whether rigid objects cue categorization by shape and nonrigid objects cue categorization by material. We chose a property generalization task in which the child is asked whether objects share a property, that is, "this (the exemplar) rolls, does this (test object) roll?" We chose this task for two reasons. First, because the stimuli do not need to be named in this task, we can look at children's attention to shape and material when categorizing rigid and nonrigid stimuli independently of the influence of naming. Second, other researchers, particularly Gelman (Gelman & Markman, 1986, 1987) have used the property generalization task in a variety of studies and have shown that quite young children generalize properties to new instances in highly systematic ways that depend on the kind of thing judged (see also Carey, 1985; Gathercole & Min, 1997; Keil, 1994; Kobayashi, 1997). Thus, the property generalization task appears to be understandable to young children.

The goal of the following four experiments was to test two hypotheses: (1) that children attend to shape more in the context of rigid things (as compared with nonrigid things) and to material more in the context of nonrigid things (as compared with rigid things), and (2) that these stimulus-specific attentional biases occur in non-naming categorization tasks as well as in naming tasks. We specifically examine children's categorizations of solid things made out of rigid materials such as wood and solid-but-nonrigid things made out of deformable materials such as sponge. The subjects in Experiments 1 through 3 were 36-month olds because attentional biases in noun learning are highly reliable, robust, and differentiated by object kind at this age (Dickinson, 1988; Jones & Smith, 1993; Landau et al., 1988; Smith et al., 1996). Experiment 1 examined children's attention to shape and material given rigid and deformable things in a non-naming categorization task that asked children to generalize the properties of an exemplar to new instances. Experiments 2 and 3 examined children's generalizations of novel nouns used to name rigidly and nonrigidly shaped things. Finally, Experiment 4 sought insight into the pattern of results across the first three experiments by examining a corpus of early-learned nouns and the kinds of rigid and nonrigid things named by nouns in that corpus.

EXPERIMENT 1

In this experiment we ask whether 3-year-old children understand that shape is the more crucial similarity among rigid objects and material is the more crucial similarity among nonrigid things. We address this question by asking children to generalize a property that is true of an exemplar object to test objects in a property generalization task. We were specifically interested in three issues.

The first issue is whether rigidity *itself* influences non-naming categorizations. If children are told about a property of some exemplar will they be more likely to generalize that property to same-shaped things when the exemplar is rigid and to same-material things when it is nonrigid? To answer this question, we told children about properties that were *arbitrarily* related to the shape or material of the named thing. For example, for one stimulus set we told the children that the exemplar object had a sticker on the back and then asked them which other test objects also had a sticker on the back. If the fact that an object is rigid, in and of itself, heightens attention to shape and if the fact that an object is nonrigid, in and of itself, heightens attention to material, then children should generalize the property "has a sticker on the back" from one rigid thing to others by shape but from one nonrigid thing to others by material.

The second issue addressed by this experiment concerned children's understanding of rigidity and deformability. Do they make inferences about properties of rigid things more readily if those properties are causally linked to shape? Do they make inferences about properties of deformable things more readily if those properties are causally linked to the nonrigidity of the material? We addressed this issue in Experiment 1 by telling children about properties that were principally related to the shape or the material of some of the exemplars. For example, on some trials children were told that a rigid exemplar could roll, a shape-based property, and were asked whether each test object could also roll. On other trials, children were told that a nonrigid exemplar could be squished, a material-based property, and were asked whether each test object could also be squished. If children's experiences with rigid and nonrigid materials in the world have led them to expect shape to be crucial for rigid things and material to be crucial for deformable things, then property generalizations that are linked to the shape of a rigid thing and to the material of a nonrigid thing might be more readily made than generalizations about more arbitrary properties.

The third issue addressed by this experiment was whether demonstrations that emphasized the deform-

ability of nonrigid materials would increase children's attention to material and decrease their attention to shape. We addressed this issue by asking subjects to generalize properties under two conditions: one in which the property was demonstrated and one in which it was not. If children are told *and shown* that a nonrigid material "squishes," will they be better able to then attend to and generalize the property of "squishing" to new instances that match the exemplar in material than if they are only *told* that an object could squish?

In sum, a property generalization task was used in this experiment. The complete design included three factors: Rigidity (rigid or deformable exemplars), Relatedness (related or arbitrary property), and Demonstration (demonstration or no-demonstration of the property). Rigidity and Relatedness were manipulated within subjects and Demonstration was manipulated between subjects.

Method

Participants. Thirty-two 36-month-olds (*range* = 35,8–38,14, *M* = 36,10) were recruited from birth announcements in local newspapers. All children were from middle-class, English-speaking families. Seven females and fifteen males were randomly assigned to each of the two test conditions—no demonstration and demonstration—with approximately equal numbers in each condition. Eight additional children began the study but did not contribute data because they did not meet our conservative criteria for understanding the task (see below). In addition, one child did not finish the task because of fussiness.

Stimuli. The training stimuli consisted of familiar objects: The exemplar was a plastic egg and the test objects were an identical egg, a small basket, a rubber ball, a package bow, a red wooden block, a plastic pumpkin, and a plastic flower.

The experimental stimuli consisted of the four sets of specially constructed novel objects depicted in Figure 1. Each stimulus set contained an exemplar and six test objects. The exemplars for Sets 1 and 3 were made of rigid materials, whereas the exemplars for Sets 2 and 4 were made of deformable materials. The exemplar for Set 1 was a 14.0-cm × 3.8-cm green wood barbell shape with a bumpy texture. The exemplar for Set 3 was an 8.3-cm-diameter blue ball with pegs inserted into it made of clay. The exemplar for Set 2 was a 14.0-cm-tall × 5.7-cm-wide yellow "V" shape made of sponge. The exemplar for Set 4 was an 11.4-cm × 9.5-cm pink polygon-shaped plastic beanbag. In each stimulus set there were two test objects that were the same shape as the exemplar but a different

color and made from a different material, two test objects that were the same color as the exemplar but a different shape and made from a different material, and two test objects that were made from the same material as the exemplar but a different color and shape.

The exemplar from each stimulus set had two generalizable properties; one—the related property—that was related to either its shape or material and another—the arbitrary property—that was not related to its shape, color, or material. The related properties of the rigid exemplars highlighted their shape. For example, the related property for Set 1 was rolling and the related property for Set 3 was fitting into a puzzle (see Figure 1). The related properties of the deformable exemplars highlighted their material. For example, the related property for Set 2 was squishing and the related property for Set 4 was folding. The arbitrary properties, used for both the rigid and deformable sets, were having a small design that glowed in the dark or a sticker on the back.

Design. Each child saw two deformable sets—one assigned a related property and one assigned an arbitrary property—and two rigid sets—one assigned a related property and one assigned an arbitrary property. The particular sets assigned related and arbitrary properties were counterbalanced across children in both conditions.

Procedure. Because we employed a "yes/no" rather than a forced choice task we instituted two design components to ensure that children understood that they could answer some questions "yes" and other questions "no." First, the experiment began with a series of training trials to ensure that the children understood the task. On the first training trial of the *no demonstration* condition children were introduced to a stuffed bear, told that the bear "wants things like this," and shown a plastic egg (the training exemplar). The experimenter then said "Know what? This opens and there's a rabbit inside," but the experimenter did not open the egg. With the exemplar in view, a test stimulus was presented and the child was asked, "Does this open?" Each child was presented with a maximum of eight randomly ordered training trials that included two presentations of the test object identical to the exemplar and one presentation of each of the other test objects. To continue, children were required to answer correctly four consecutive training trials. These training trials were followed by experimental trials for each stimulus set. As a second measure to ensure that children understood the task, we required that on the experimental trials proper children said "no" to at least one question. That is, we required that children refused to generalize the property to at least one test object. Data from children who





























Stimulus Set	Set 1	Set 2	Set 3	Set 4
Related Property	rolls	squishes	fits in puzzle	folds
Name	Rif	Wug	Zup	Dax
Exemplar	 green bumpy wood	 yellow sponge	 blue clay	 pink plastic bean bag
Same Shape	 pink sponge  purple Styrofoam	 dk red wood  green mesh-covered wood	 green sponge  yellow wax	 yellow sponge  dk green clay
Same Color	 green bean bag  green Styrofoam	 yellow Styrofoam  yellow bean bag	 lt. blue Styrofoam  lt. blue plastic bean bag	 pink Styrofoam  pink wood
Same Material	 yellow bumpy wood  blue bumpy wood	 blue sponge  green sponge	 purple clay  red clay	 cream plastic bean bag  blue plastic bean bag

Figure 1 Stimuli used in Experiments 1, 2, and 3.

did not pass the training trials or did not say “no” to at least one test object during the experimental trials were not included in the analyses.

In the experimental trials for the *no demonstration* condition, children were introduced to a stuffed animal, told that the animal only “wants things like this,” and shown one of the four exemplar objects. Children were then told, *but not shown*, either the related property for that exemplar or an arbitrary property. Each of the test objects from the corresponding stimulus set was then presented, one at a time, and the children were asked if each test object also possessed the mentioned property. For example, the child might hear on the first trial, “See this, Nathan (the animal) only wants things like this. Do you know what? This can roll!”

Then for each test object the child was asked “Can this roll?” After each of the six test objects for one stimulus set were presented, the child was introduced to a new stuffed animal and another exemplar. Order of exemplars and test objects was randomly determined and counterbalanced across participants. Each child heard about one related property for a rigid exemplar and one related property for a deformable exemplar. For the remaining two exemplars (one rigid and one deformable) the participants were told about arbitrary properties. Which exemplars had related and arbitrary properties was counterbalanced across children.

The procedure for the *demonstration* condition was identical to that for the *no-demonstration* condition, except that the properties were demonstrated for the

children. Thus, in the training trials the egg was opened to reveal the rabbit hiding inside and children were asked if each training test object could open. Also, on the first experimental trial, the child might hear "See this, Nathan (the animal) only wants things like this. Do you know what? This can roll!" as the experimenter rolled the exemplar. Then, for each test object, the child was asked "Can this roll?"

Results and Discussion

The number of "yes" responses to test objects that matched the exemplar in shape, color, and material were recorded for each child. A Demonstration (no-demonstration versus demonstration) \times Rigidity (rigid versus deformable exemplars) \times Relatedness (related versus arbitrary properties) \times Test Object (shape, color, or material match) ANOVA revealed a significant main effect of Test Object, $F(2, 60) = 21.97, p < .001$, a highly significant Rigidity \times Test Object interaction, $F(2, 60) = 24.48, p < .001$, and a significant Relatedness \times Test Object interaction, $F(2, 60) = 3.90, p < .05$. These effects were subsumed by a significant three-way interaction between Rigidity, Relatedness, and Test Object, $F(2, 60) = 13.37, p < .001$. The ANOVA revealed no significant main effects or interactions involving the demonstration factor; therefore, the results depicted in Figure 2 are collapsed across this factor. As can be seen in the figure, children's property generalizations were based on the kind of

property to be generalized *and* on whether the objects in question were rigid or not. Children generalized properties by *shape* more when the exemplar was rigid than nonrigid and by *material* more when the exemplar was nonrigid than rigid. In addition, rigidity affected children's property generalizations more when the properties to be generalized were related to the exemplar's shape or material rather than arbitrarily related to the characteristics of the exemplar.

Planned comparisons confirmed that, as predicted, when the exemplar was rigid, children generalized both arbitrary properties (e.g., has a sticker on the back) and shape-based related properties (e.g., rolls) to test objects that were the same shape as the exemplar at levels exceeding that expected by chance, arbitrary properties, $t(31) = 2.55, p < .01$, and related properties, $t(31) = 9.76, p < .001$. Similarly, and also as predicted, when the exemplar was nonrigid, children generalized both arbitrary properties and material-based related properties to test objects that were made of the same material as the exemplar at levels exceeding that expected by chance, arbitrary properties, $t(31) = 1.96, p < .05$, and related properties, $t(31) = 3.30, p < .01$. The number of "yes" responses to test objects that matched the exemplar in color were not greater than expected by chance in any condition.

Thus, rigidity appears to act as a cue—directing children to categorize by shape in the case of a rigid exemplar and by material in the case of a nonrigid exemplar. Interestingly, this cueing effect appears to de-

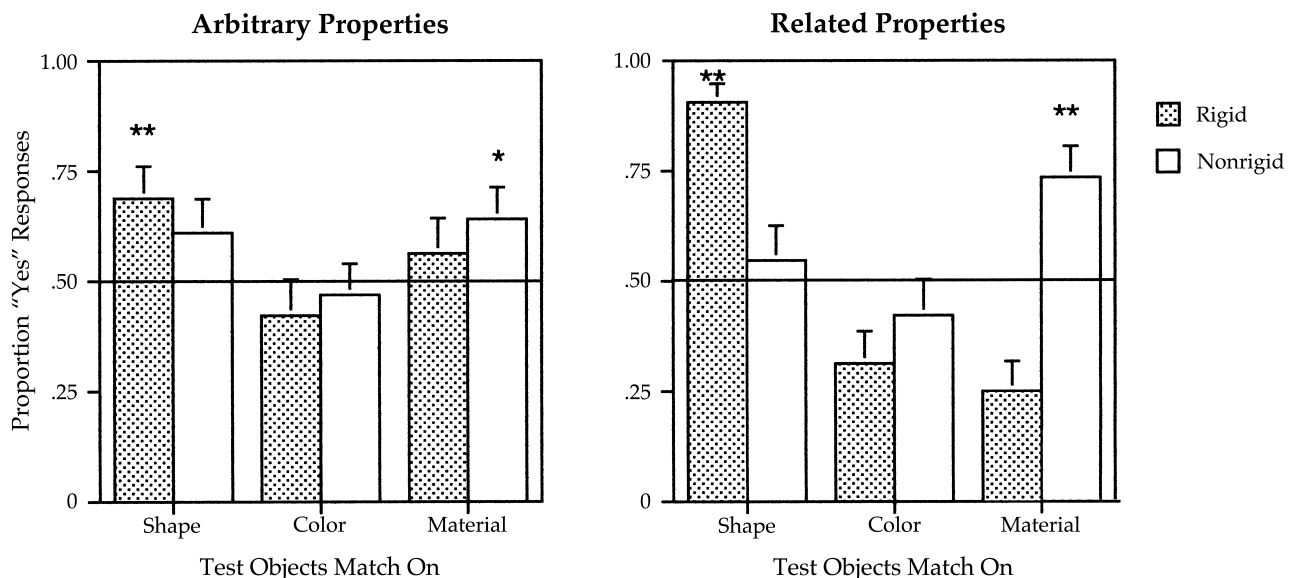


Figure 2 Results of Experiment 1. Proportion of "yes" responses to test objects that matched the exemplar on shape, color, or material for rigid and deformable exemplars when generalizing arbitrary or related properties. Bars represent standard errors. Chance responding for each test object equals .50. * $p < .05$, ** $p < .01$ difference from chance.

pend on the rigidity of the exemplar but not the rigidity of the test object. When we examined children's individual responses to the shape-matching test objects for both sets with rigid exemplars, we found that children generalized the properties to both the shape-matching rigid and shape-matching nonrigid test objects equally often, Set 1, $\chi^2(1, N = 32) = .22, ns$, and Set 3, $\chi^2(1, N = 32) = .42, ns$. One cannot ask the parallel question for nonrigidity because the material-matching test objects necessarily match the exemplar in deformability as well as material. It appears, however, that nonrigidity cues attention to material and not to rigidity per se in that children rejected the deformable color-match test object equally as often as the rigid color-match test object for both sets with nonrigid exemplars, Set 2, $\chi^2(1, N = 64) = 1.64, ns$, and Set 4, $\chi^2(1, N = 64) = .24, ns$.

Overall then, rigidity does influence children's non-naming categorizations. This is so even when the properties to be generalized are arbitrarily rather than meaningfully related to shape and material. In addition, the results suggest that children know something about the kinds of properties that are related to shape and those that are related to material. Even without demonstrations, on the basis of only the words, children knew that rolling was a shape-based property and squishing was a material-based property.

EXPERIMENT 2

The results of Experiment 1 suggest stimulus effects on attention that do not require the context of *lexical* category formation: Rigid objects cue attention to shape and nonrigid, deformable objects cue attention to material. The motivating question for Experiment 2 was how these stimulus effects are integrated into the task of name learning. Will the task of generalizing a novel name to new instances amplify and exaggerate these stimulus effects such that rigid objects are uniformly named by their shape and nonrigid objects by their material? In a previous study, Smith et al. (1996) speculated that naming might create highly systematic selective attention in just this way—by magnifying preexisting attentional biases and allocating attention in an all-or-none manner to whatever object property attracted (for whatever reason) the most attention. If this is so, then given the results of Experiment 1, we should expect selective attention to shape when generalizing the names for the rigid exemplars used in the previous experiment and selective attention to material when generalizing names for the nonrigid exemplars.

In this experiment we named both the rigid and nonrigid exemplars with novel nouns presented in

the carrier phrase "This is a _____." We chose to use this count noun frame for two reasons: First, material-based categories of deformable things such as pillow or towel are named by count nouns in English. Second, our use of count noun syntax provides a strong test of the idea that naming *itself* magnifies preexisting, stimulus-based attentional biases.

Method

Participants. Fifteen 36-month-olds (*range* = 35,24–36,24, *M* = 36,4) were recruited from birth announcements in local newspapers. The six females and nine males were from middle-class English speaking families and none had participated in Experiment 1. Data from three children were excluded from the analyses, two because the children did not finish the experiment and one because the child said "yes" on all experimental trials.

Stimuli and procedure. The stimuli were identical to those used in Experiment 1. The experiment began with a series of training trials to familiarize the children with the experimental task and setting. The training trials were followed immediately by the experimental trials. The procedure was similar to the procedure used in Experiment 1. The child was introduced to a stuffed bear and shown a plastic flower (the training exemplar). The child was told, "This is a flower. The bear only wants flowers." The child was then shown the training test objects (identical flowers and objects that differed in all aspects from the flower such as a paper bow or a straw basket). With the exemplar in view, the child was asked one at a time about each test object "Is this a flower?" A child was said to have passed training if he or she made four consecutive correct responses. All children did so.

Experimental trials were structured like the training trials. A new toy animal and one of the four exemplars in Figure 1 were introduced. The child was told that the exemplar "was a _____" and that the toy animal "only wants _____s" (e.g., "the bunny only wants daxes.") The child was then asked about each test object for each exemplar "Is this a _____?" The nonsense names used for each exemplar are listed in Figure 1.

Results and Discussion

The mean proportion of times children generalized the novel name to each kind of test object is shown in Figure 3. Each child's responses were submitted to an analysis of variance for a Rigidity (rigid versus nonrigid) \times Test Object (shape, color or material match) repeated measures design. The analysis yielded a

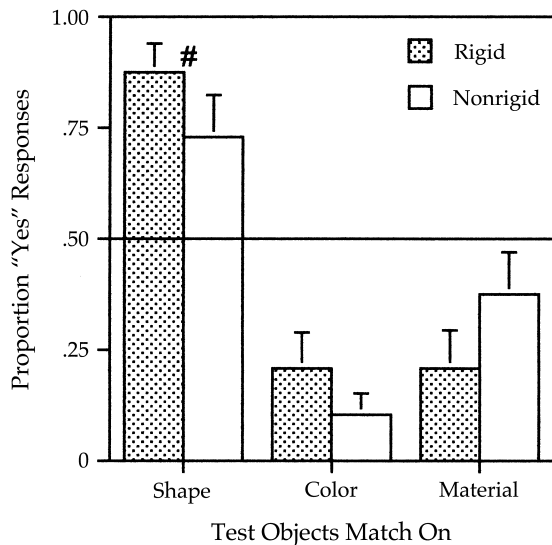


Figure 3 Results of Experiment 2. Proportion of "yes" responses to test objects that matched the exemplar on shape, color, or material for rigid and deformable exemplars in the novel word generalization task. Bars represent standard errors. Chance responding for each test object equals .50. # $p < .05$ difference between "yes" responses to rigid and nonrigid same-shape test objects.

main effect of Test Object, $F(2, 22) = 35.24, p < .001$, and a reliable interaction between Rigidity and Test Object, $F(2, 22) = 3.93, p < .05$. As is apparent in Figure 3, children generalized the novel name most often to objects the same shape as the exemplar, but they did so reliably more often when the exemplar was rigid than when it was nonrigid, Tukey's HSD, $p < .05$. The reliable interaction suggests again that a rigid object promotes attention to shape. Nonetheless, the main result—and the unexpected one—was that children overwhelmingly interpreted the novel name as referring to objects of a particular shape *both* when the exemplar was made of solid rigid materials and when it was made of deformable materials. For both the nonrigid and rigid exemplars, generalizations of the novel name to the same-shape test objects far exceeded the level expected by chance, whereas generalizations of the name to the same-material test object—even in the case of a nonrigid exemplar—did not exceed chance.

The results of Experiment 1 tell us that even in non-naming tasks, the fact that an object is rigid biases attention to shape and the fact that an object is nonrigid biases attention to material. The results of the present experiment indicate, however, that naming overrides these stimulus effects and pulls attention strongly to shape even when the exemplar is nonrigid. Together these results indicate that chil-

dren think material is important when making inferences about the properties of nonrigid things, but they do not think that material is important in naming such things. Clearly the task of naming does not simply amplify preexisting stimulus effects but instead strongly recruits attention to shape *in spite* of those biases. We sought further evidence for this conclusion in Experiment 3.

EXPERIMENT 3

In this experiment, we combined multiple competing pulls on attention in an effort to test the strength of the link between naming and attention to shape. Specifically, we added the demonstrations employed in the property generalization task of Experiment 1 to the naming task of Experiment 2. If we name a nonrigid object and at the same time demonstrate by squishing or folding that it is made of deformable material, will children generalize the name by shape or by material?

Method

Participants. Twenty 36-month-olds ($range = 35,25-38,16, M = 36,18$) were recruited from birth announcements in local newspapers. All children were from middle-class, English-speaking families. Two children were excluded because they failed to make at least one "no" response during the testing trials. Two additional children were excluded from the study, one for failure to follow instructions and another because of experimenter error. Thus, data from sixteen children (8 boys and 8 girls) were included in the analyses.

Stimuli. The four sets of stimuli from Experiments 1 and 2 were used. The novel names from Experiment 2 were used with the generalizable properties from Experiment 1 (see Figure 1).

Procedure. As in Experiments 1 and 2, the experiment began with a series of training trials to familiarize the children with the task and experimental setting. The training procedure and stimuli were identical to those used in the previous experiments.

The experimental trials began by introducing the child to a stuffed animal. The child was told that the animal only "wants things like this" and was shown one of the four exemplar objects. The exemplar was then named for the child and the child was shown one of the properties used in Experiment 2. Each of the test objects from the corresponding stimulus set was then presented, one at a time, and the child was asked if each test object could also be called by the same name as the exemplar. For example, for Set 1

each query about a test object would be as follows: "See this (exemplar), this is a rif, it rolls (roll object), is this (test object) a rif?" After each of the six test objects for one stimulus set were presented, the child was introduced to a new stuffed animal and another exemplar. Order of exemplars and test objects was randomly determined and counterbalanced across subjects. Each child saw one related property for a rigid exemplar and one related property for a deformable exemplar. For the remaining two exemplars (one rigid and one deformable) children saw arbitrary properties. Which exemplars had related and arbitrary properties was counterbalanced across subjects.

Results and Discussion

The mean proportion of "yes" responses to test objects that matched rigid and nonrigid exemplars in shape, color, or material given demonstrations of related and arbitrary properties are shown in Figure 4. These data were analyzed by a Rigidity (rigid versus nonrigid) \times Test Object (shape versus color versus material) \times Relatedness (related versus arbitrary properties) repeated measures ANOVA. The analysis revealed reliable main effects of Rigidity, $F(2, 15) = 10.89$, $p < .005$, and test object, $F(2, 30) = 35.32$, $p = .001$, and reliable Rigidity \times Relatedness, $F(1, 15) = 6.99$, $p < .05$, and a Rigidity \times Test Object, $F(2, 30) = 6.09$, $p < .01$ interactions. As can be seen in the figure, overall, chil-

dren generalized the novel names to test objects that matched the exemplar in shape more often than to test objects that matched the exemplar in color or material. The level of shape responding, however, was influenced by the rigidity of the exemplar and the demonstrated properties. Specifically, when the exemplar was nonrigid, the generalizations of the novel name to same-shape test objects decreased. Also, there was a larger difference between name generalizations from rigid and nonrigid exemplars when a property related to the shape or material of the exemplar was demonstrated compared with when an arbitrary property was demonstrated. In all conditions, however, the name was generalized to same-shape test objects more than to same-color or same-material test objects. Further, the name generalizations to same-material test objects never exceeded chance levels. Rigidity and shape-based properties may increase attention to shape, but deformability and material-based properties do not systematically push attention away from shape and to material in a naming task.

These results bolster the conclusions from Experiments 1 and 2: In non-naming tasks, a rigid object pushes attention to shape and a nonrigid object to material, but the act of naming *itself* appears to recruit attention to shape. If the countering cues of nonrigidity (pushing for material), and naming (pushing for shape) are put in competition, naming (at least with these stimulus items, count noun syntax, and 36-month-olds) wins.

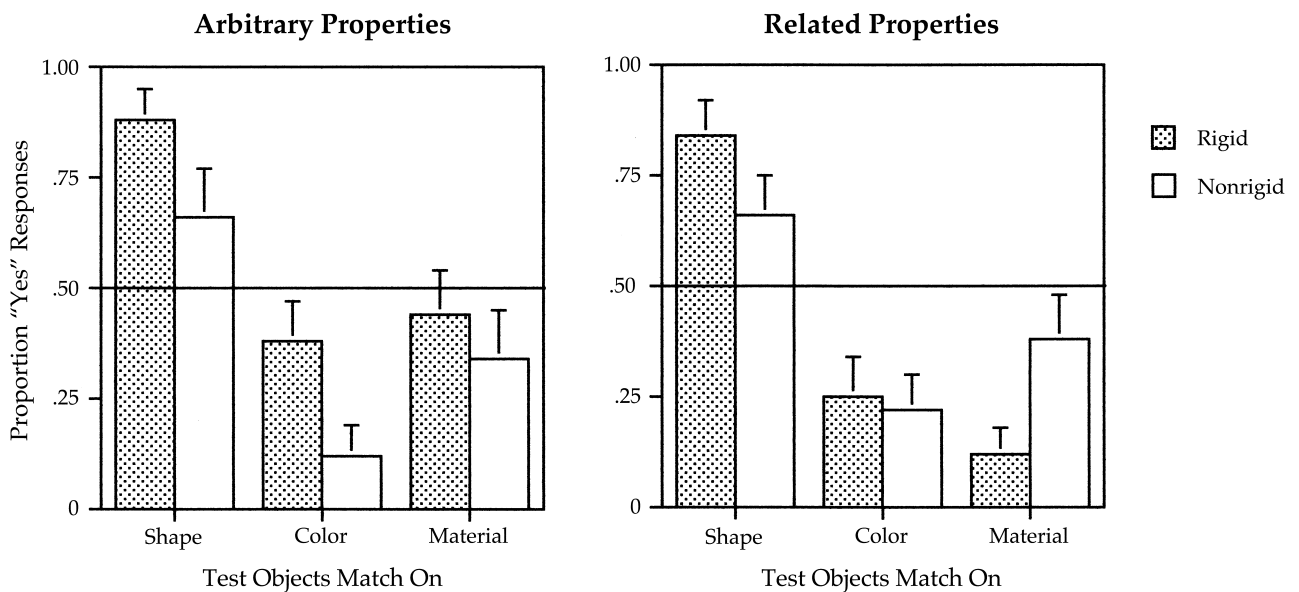


Figure 4 Results of Experiment 3. Proportion of "yes" responses to test objects that matched the exemplar on shape, color, or material when generalizing a name from rigid and deformable exemplars with demonstrations of arbitrary or related properties. Bars represent standard errors. Chance responding for each test object equals .50.

EXPERIMENT 4

If the fact that an object is nonrigid promotes attention to material in non-naming tasks and does so because material is the key property in determining the deformability of an entity, why do children interpret names for such things by their shape? The fact that rigidity failed to control children's categorizations in the naming tasks of Experiments 2 and 3 suggests that something specific to the context of learning and using a novel name may be the source of children's attention to shape when generalizing a name for a nonrigid thing. Thus, we look to the structure of the words children learn early for insights into why, in naming tasks, categories are formed differently than they are in non-naming tasks.

The experiment was motivated by the larger idea that children's interactions with deformable things promotes attention to material but their history of naming things promotes attention to shape. Within this larger idea, we consider two hypotheses: First, children may generalize names for nonrigid things by shape but form nonlexical categories for those same things by material because most of the real nouns that young children have learned name nonrigid things by shape. Alternatively, common nouns (the ones children learn early) may typically name rigid things by shape and nonrigid things by material, but children may learn so many more names for rigid things that they (at least initially) overgeneralize the bias to form lexical categories by shape to the nonrigid objects.

In addition, we sought evidence under both of these hypotheses for the role of count noun syntax in children's generalization of novel names for deformable things by shape. Under the first hypothesis, if early vocabularies include count nouns as names for deformable things in shape-based categories, then children's novel noun generalizations may reflect quite accurately what they know about how deformable things are named. Under the second hypothesis, we might find that categories of deformables are organized by material but principally named by count nouns, a fact that might encourage children to overgeneralize what they know about naming rigid things to naming deformable things. A third possibility, contrary to our intuitions, is that most of the names for deformables are mass nouns.

The goal of Experiment 4 was to provide insight into these possibilities by examining the kinds of nouns children typically know early. Do children know many nouns that label categories of deformable things? What kinds of similarities are characteristic within such categories—similarities in material, in shape? How is count/mass syntax related to rigidity

and category organization in the nouns children learn early? To answer these questions, we studied a corpus of 148 nouns—artifact and food terms—taken from the toddler form of the MacArthur Communicative Development Inventory (Fenson et al., 1994). This form of the MCDI is a parental checklist of words known by 50% of children at age 30 months. The MCDI was developed from extensive studies of parents' reports of the words children produce and laboratory measures of children's vocabulary. Thus, these nouns serve as a reasonable proxy for the kinds of nouns young children typically know. We asked adults to make judgments about the rigidity and category similarity of referents of each noun. Although adult intuitions about such category organizations are likely to be imperfect, they are also likely to be correlated with the real properties of common instances of common nouns. Moreover, such judgments have been shown to predict adults' performance in various kinds of categorization tasks (Malt, 1994; Rosch & Mervis, 1975; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976) and also to predict children's performances in novel noun learning tasks (Samuelson & Smith, 1999).

One set of judgments was made about the rigidity and invariance of the shape of referents of each noun. Participants answered three questions about instances of each named category. Three individuals made these intensive but objective judgments. These answers were then used to classify each noun into one of four categories according to the stability of shape—rigid, deformable, malleable, and transient. A second set of judgments concerned the similarities in shape, material, and color of instances named by each noun. Because we are interested in the within-category similarities that are sufficiently true about the categories of things named by each noun to matter in the experiences of individual children, we set a conservative criterion of 85% agreement between the fourteen adult participants who made these judgments. In addition, each of the 148 nouns were classified as a count noun, a mass noun, or ambiguous in syntactic class.

In sum, the question motivating this experiment is this: Why do children categorize objects made of deformable materials by material in non-naming tasks but by shape in naming tasks? We sought insight into the findings of the first three experiments by examining the kinds of nominal categories typically known by young children.

Method

Participants. The participants were 14 undergraduates recruited from an advanced seminar who re-

ceived credit in the course for their judgments. These participants made judgments of similarity in shape, color, and material among instances of a nominal category. One additional undergraduate student (who did not participate in the judgments of within-category similarities) and the two experimenters judged the stability of shape of items in the named categories. A second additional undergraduate student (who did not participate in either of the other judgments) and one of the experimenters classified each noun by syntax.

Materials. The studied corpus consisted of 148 nouns—all the object and substance terms on the MCDI, or more specifically, all the nouns in the vehicles, toys, food and drink, clothing, small household items, and furniture categories. The only nouns on the MCDI that were excluded were those concerning animate beings and abstract or relational terms. We excluded nouns referring to people, animals, and body parts because of previous evidence suggesting that three-year-olds categorize (and reason about) animate things (and their depiction) differently than they do inanimate things (Jones & Smith, 1993, 1998; Jones, Smith, & Landau, 1991; Keil, 1994). In addition, we excluded nouns referring to abstract or relational categories (e.g., *friend*, *story*). Booklets containing the 148 nouns from the MCDI were constructed. Each booklet contained instructions for the particular judgment (category organization, rigidity, or syntax) and the list of words.

Procedure. The two experimenters and a third participant made independent judgments of the stability of the shape of instances of each category by answering three questions about the stability of the shape: (1) Does the shape of the object change when pressure is applied? (2) Does the shape change remain after pressure is removed? and (3) Does the object take the shape of a container? For these rigidity judgments, the participants were instructed to think of a typical instance of each named category as it is usually experienced. Thus, the judges were to think of things that were typically experienced as aggregates, for example, salt, sugar, popcorn, as aggregates and not in terms of the individual units. Answers to the three questions for the rigidity judgments were made directly on computer spreadsheets. We defined “rigid” things as those for which the answer was “no” to all three questions, “deformable” things as those for which the answer to Question 1 was “yes” but the answers to the remaining questions were “no,” “malleable” things as those for which the answers to Questions 1 and 2 were “yes” but the answer to Question 3 was “no,” and “transient” things as those for which the answer to Question 3 was “yes” (regardless of the answers to Questions 1 and 2).

The instructions to the 14 undergraduate participants in the judgments of category similarity were presented both verbally and in writing. They were told to think of instances of each named category and then indicate (“yes”/“no”) whether those instances were similar in shape, color, and material. Thus, participants made independent judgments of within-category similarity on shape, color, or material and therefore could judge a noun as referring to objects that were similar on any one of these dimensions, any combination of these dimensions, or none of these dimensions. Judgments were made on scantron sheets for later analysis.

One of the two experimenters also classified each noun as count, mass, or ambiguous in syntactic class according to its use in everyday discourse. The ambiguous syntax category was included because many nouns can occur in either syntactic frame, for example, “two cakes” but also “some cake.” To check the reliability of these classifications, an undergraduate student who was naive to the experimental hypotheses also classified 134 of the nouns according to syntactic class. Agreement between the two judges was 93%. In cases of disagreement, the judgment of the experimenter was taken as the final classification.

Results and Discussion

The judges of the stability of shape agreed on the classification of 138 of 148 nouns as referring to rigid, deformable, malleable, or transiently shaped things. The ten items that led to disagreements were *egg*, *food*, *game*, *garbage*, *light*, *medicine*, *money*, *present*, *trash*, and *vitamins*. These items were excluded from all subsequent analyses. Table 1 shows the number of nouns judged to fall into each rigidity category and provides examples of each. As is apparent, among the early words that young children know, there are many more nouns naming things with rigid shapes than things with deformable or malleable shapes. In addition, there are also more names for objects with rigid shapes than names for transient things (nonsolid substances and aggregates) that take the shape of the container in which they are placed, $\chi^2(1, N = 138) = 92.66, p < .001$.

Table 1 also shows the number of nouns in each rigidity category that were count nouns, mass nouns, or nouns ambiguous in syntactic class. Two things are clear in the table. First, among the nouns young children learn early, there are many more count nouns than mass nouns or nouns ambiguous in syntax. Second, syntax corresponds to rigidity quite well among the nouns that children learn early. In the studied corpus, most of the names for rigid things are count nouns and most of the names for transient things are

Table 1 The Total Number of the 138 Noun Categories Classified into Each of the Four Rigidity Categories, Number of Count Nouns, Mass Nouns, and Nouns Ambiguous in Syntax, and Examples of Words Classified into Each Rigidity Category

Classification	Rigid	Deformable	Malleable	Transient
Total number	81	20	6	31
Count nouns	69	12	0	9
Mass nouns	6	4	5	18
Ambiguous nouns	6	4	1	4
Examples	Apple Fork Tractor Toothbrush	Bread Jell-O Napkin Pillow	Butter Cheese Ice cream Play-Doh	Applesauce Juice Noodles Salt

mass nouns. Also, among these early-learned nouns, most of the names for deformable things are count nouns.

The 138 nouns classified into the four rigidity categories and the three syntactic categories were classified as being shape-based, material-based, or color-based if 85% of the undergraduate participants (that is, 12 of 14 participants) agreed that instances of the named category were characteristically similar on the queried dimension. Recall that individual categories could be categorized as presenting similarities on more than one (or on none) of these properties. For example, *milk* was categorized as material- and color-based because 85% of the participants judged instances of the category to be similar on both of these properties. *Airplane* was judged to be only shape-based by the same criteria, and *clock* was judged to refer to objects not characteristically similar in color, shape, or material.

Figure 5 presents the number of shape-, material-, and color-based categories for each of the four levels of rigidity. The kinds of within-category similarity are not distributed equally across the four kinds of rigidity. Nominal categories of rigidly shaped things overwhelmingly refer to objects that are similar in shape, $\chi^2(3, N = 138) = 15.67, p < .01$. In contrast, among these 138 early artifact and food categories, nominal categories of malleably shaped objects and transiently shaped entities tend to name things that are similar in material, $\chi^2(3, N = 138) = 33.01, p < .001$. Nominal categories of deformable entities fall in between, some naming by shape, some by material, and some naming categories of things similar in both shape and material (e.g., *donut*, *muffin*, *pillow*, *towel*).

Putting all the data together gives the following picture of the relation between rigidity, syntax, and category organization in young children's noun vocabularies. Children learn many more names for rigid objects than deformable, malleable, or transient enti-

ties early in vocabulary development. They also learn many more count nouns than mass nouns, and count nouns typically name rigid things in categories well organized by similarity in shape. Deformables make up a smaller segment of the corpus, but a majority of these categories are material based and named by count nouns. These results thus favor the second hypothesis: Children's generalizations of names for deformables by shape appear to be an overgeneralization of what they know about naming rigid things.

GENERAL DISCUSSION

In their everyday lives, children interact with rigid and nonrigid things in ways that seem likely to foster attention to the shape of rigid things and the material of deformable things. The first experiment presents

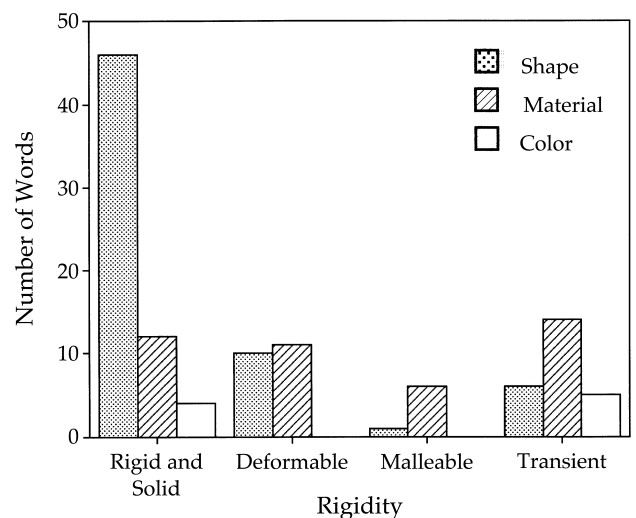


Figure 5 Number of nouns classified as referring to categories of rigid and solid, deformable, malleable, and transient entities that were also classified as referring to categories organized by similarities in shape, material, or color.

evidence for this in a non-naming task. Young children categorize rigid and nonrigid things differently and know that material is important for deformable things and shape for rigid things. Thus, the answer to our first question—are there stimulus effects in non-naming categorization tasks as well as in naming tasks—is “yes.” The results of Experiments 2 and 3, however, show that there are also language effects that do not correspond with these stimulus effects. The 3-year-olds in these experiments generalized newly encountered names for novel rigid objects by shape. In this case, then, the task of naming agrees with, and indeed accentuates, the link between a rigid object and categorization by shape. The 3-year-olds in these experiments, however, also generalized a newly encountered name for novel *nonrigid* objects by shape. The task of naming in this case contradicts and seems to override the link between nonrigidity and categorization by material. Clearly, naming and categorization for other purposes do not always coincide. There are three possible explanations for this discrepancy.

Categorization in Naming and Non-Naming Tasks

One possible explanation for the discrepancy in children’s categorization in naming and non-naming tasks is that children’s (and adults’) categorizations in different kinds of tasks do not generally correspond. That is, when people categorize objects they may do so on the basis of the purpose of the particular task and thus the object properties they use to form categories may vary with the task. This suggestion fits Barsalou’s proposal that categories are on-line constructions that bend to fit the purpose at hand (Barsalou, 1983; see also Smith & Samuelson, 1997). Thus, when generalizing properties from one object to another, people generally, perhaps not just 3-year-olds, may emphasize the characteristics of objects that are pertinent to how they are used or could be used. At the same time, people generally, not just 3-year-olds, may principally name or refer to objects by their shape (see Landau, Jones, & Smith, 1992).

A second possibility is that the contrasting results of Experiment 1 on one hand and Experiments 2 and 3 on the other indicate that the task of naming does not tap as directly into children’s knowledge about deformable things as does the task of property generalization. This may be because there are surface similarities across the task of naming—the prosody, the experimenter’s gestures, the syntactic frame (“This is a _____.”)—that may, because of their repeated association with categorization by shape, capture attention in the context of naming, even when the object is nonrigid.

A third and related possibility is that the noncorrespondence between 3-year-olds’ property generalizations and their name generalizations is a fact about 3-year-olds. The pattern of results found across the experiments presented here may result from the fact that 3-year-olds are at a particular point on the developmental trajectory of category and word learning. Before children know many words, they may figure out that for rigid things shape is a potent cue to categorization and for nonrigid things material is the important cue. Our analysis of the nouns children learn early suggests that these correspondences may be true in the world; adults judged categories of nonrigid (deformable and malleable) things to be material-based more frequently than they judged categories of rigid things to be material-based. The problem for 3-year-olds may be that they know very few names for categories of deformable things and know very many names for categories of rigid things. Thus, at this stage in word learning, what children know about naming rigid things may be temporarily overgeneralized to the naming of deformable things.

These last two possibilities suggest that there may be a curvilinear trend in children’s tendency to categorize and name nonrigid things by material. When children know few words of any kind they may, in naming tasks as well as in non-naming tasks, attend to the material of nonrigid things. Our analysis of the corpus of early-learned nouns in Experiment 4 suggests that as these children begin to learn more words the correspondence between rigid things and naming by shape will dominate their noun vocabularies. It is possible that this could influence both how they interpret new words and how they perform in non-naming categorization tasks. As these children learn even more words, however, they will accrue evidence that deformable and rigid things are named differently. Thus, when they know many words of many kinds children may again name and generalize the properties of nonrigid objects by material.

What Is the Role of Syntax?

Most of the names for deformables in early vocabularies are count nouns, but most of the count nouns in early vocabularies name rigidly shaped things in categories well organized by shape. What role, then, does count noun syntax play in recruiting children’s attention to shape when generalizing a name for a deformable thing? We hypothesize that count noun syntax contributes by causing children to conceptualize deformable things similarly to rigid things (at least at this age). Along the continuum from rigid to transiently shaped entities, deformables are like rigid

things in two ways: They are solid and they are typically named by count nouns. Thus, count noun syntax may foster children's overgeneralization of what they know about naming rigid things to deformable things.

Interestingly, count noun syntax may play this causal role whether it is used in the novel noun generalization task or not. This question, whether children would generalize names for deformables by material if they were named according to neutral syntax, needs to be addressed in future research. By analogy to previous results investigating the role of syntax in children's naming of solid and nonsolid things (see especially Imai & Gentner, 1997), we suspect in-task count syntax may not be required. Empirical support for this idea may be found in a recent study by Gathercole and Min (1997). They presented children with a novel name in a neutral syntactic frame, that is, "This is my dax," and demonstrations of a property related to either the shape or material of novel objects. They found that English-speaking children generalized the novel names by shape, even after seeing a demonstration of a material-based property. Thus, the most potent effect of syntax may be due to the statistical structure of early noun vocabularies: A small segment consists of material-based categories of deformables named by count nouns, a much larger segment consists of shape-based categories of rigid things also named by count nouns.

The idea that the common syntactic structure of names for deformables and rigid things encourages children to conceptualize them in the same way is reminiscent of Imai and Gentner's (1997) explanation of English-speaking and Japanese-speaking children's generalizations of names for solid but simply shaped things. In their cross-language study, English-speaking and Japanese-speaking children differed principally in their treatment of simply shaped things: English-speaking children treated them like objects, generalizing names to new instances by shape; Japanese children treated these simple shapes more like substances, generalizing names to new instances by material. The experimental task used neutral syntax. Imai and Gentner argued, however, that the count/mass distinction in English encouraged English-speaking children to treat all solid things—simply shaped and complexly shaped—in the same way.

One way to examine whether count syntax causes children to conceptualize deformables as more like rigidly shaped things would be to examine how children who are learning a language without a count/mass distinction name generalize names for deformables. Gathercole and Min (1997) offer some relevant data on this topic. They compared Korean- and English-

speaking children in a naming task including actions on objects that highlighted deformability and material. They found that English-speaking children always generalized the novel names by shape, regardless of the demonstrated properties. In contrast, Korean-speaking children's generalizations were influenced by the demonstrated properties such that following a demonstration of a shape-based property, names were generalized by shape, and following a demonstration of a material-based property, names were generalized by material.

Why, then, do children categorize deformables by material but form lexical categories by shape? The results of Experiment 4 and previous research all suggest that the linguistic structure of the language being learned, and in particular the count/mass distinction in English, may push children's attention to shape in naming tasks even though material is the more meaningful property in non-naming tasks (see Gathercole & Min, 1997 for a similar point).

Real Words and Novel Word Generalization

The idea that children's novel word generalizations are themselves the product of children's developmental histories of naming may also help explain the discrepancy between the real words children know and how they interpret novel words. The corpus of nominal categories we analyzed in Experiment 4 was taken from the MCDI and thus consisted of nouns that are known by 50% of children at age 30 months. It therefore seems likely that the 36-month-old children in Experiments 2 and 3 knew the names of such deformable things as *towel*, *bread*, and *pillow* and that they knew that material matters for membership in these categories. This suggests that what these children know about real names for real deformable things does not coincide with how they interpret a novel noun used to name a deformable thing.

This may point to a potentially important difference between what children know about specific nouns and how they generalize a novel noun after hearing it used to refer to a single object. Children's knowledge about the extension of specific nouns may be based on specific evidence about those categories, that *apples* are similar in shape and material, that *balls* are similar in shape only, or that *pudding* is similar in material only, for instance. In contrast, when a novel noun is paired with just one exemplar, children do not have specific evidence about the new category. In this case, then, the relevant level of knowledge may be a statistical generalization across the specific categories children do know. Thus, children's novel noun generalizations may initially reflect, not specific knowledge

about the specific object being named, but rather the most general truth about how the nouns they know map onto categories. Furthermore, because children learn many more names for rigid things in shape-based categories, their novel noun generalizations for *nonrigid* things may be overgeneralizations from this dominant statistical regularity. The developmental task, then, may consist of distinguishing the contexts over which specific regularities apply—learning when to generalize a name by shape and when to do so by material or other important properties. And, learning names for different kinds of things may be a driving force in making these distinctions.

A Bias for Learning Names for Rigid Shapes

If the nouns on the MCDI are a reasonable proxy for the kinds of categories that children learn early, then the results of Experiment 4 suggest that young children know many more names for things with rigid shapes than they know names for other concrete kinds. Taken together, the results of the four experiments suggest a tight link between naming by shape, categorizing by shape, and rigidity. It is possible that this is because things with rigid shapes present more coherent and thus more easily learnable category cues. This idea fits Gentner's natural-partitions hypothesis (Gentner, 1982; Gentner & Boroditsky, in press). She has suggested that nouns dominate early vocabulary learning because early nouns name objects that are easily individuated by a perceptual system tuned to pick out objects that retain their shape over movement and other transformations. Thus, names for solid things with bounded shapes may be acquired earlier than names for more deformable entities with variable shapes for the same reasons that (by Gentner's hypothesis) object names are acquired earlier than relational terms; that is, because object names refer to perceptually stable wholes. By Gentner's hypothesis, then, the dominance of names for rigidly shaped things suggested by the results of Experiment 4 may have a prelingual basis in perception (see also Samuelson & Smith, 1999; Xu, 1997, for further discussions of related ideas). What the present results suggest is that this bias to learn names for things with rigid shapes may lead children to name by shape even when the objects are not rigid but instead deformable.

Conclusion

Novel word generalization tasks are not the only tasks in which children show knowledge about how different kinds of things are categorized. When presented with a non-naming categorization task that is

purposeful, 3-year-old children show clear expectations about how rigid versus nonrigid things are categorized. Rigid objects that match in shape are expected to share other properties. Likewise, nonrigid objects that match in material are expected to share other properties. But when 3-year-olds generalize names for novel rigid and nonrigid things, they overwhelmingly do so by shape. Our examination of the kinds of nominal categories characteristically known by young children suggests several explanations for these results. One that seems worthy of pursuit is that early in vocabulary development children learn many names for things with rigid shapes and initially generalize what they know about naming these rigid objects to naming other kinds of things.

ACKNOWLEDGMENTS

Data from Experiments 1 and 2 were presented at the April 1995 meeting of the Society for Research in Child Development. Data from Experiments 1, 2, and 3 were presented at the August 1996 meeting of the Cognitive Science Society. This research was supported in part by NIH grant HD28675 to the second author. The authors wish to thank Jolene Hayworth, Kimberly Johnson, and Lisa Montague for their help with data collection and the parents and participants for their time and effort. Thanks also go to Susan Jones, Catherine Sandhofer, and John Spencer for invaluable discussions of the data and ideas contained in this manuscript and for comments on an earlier draft.

ADDRESSES AND AFFILIATIONS

Corresponding author: Larissa K. Samuelson, Department of Psychology, University of Iowa, 11 Seashore Hall E, Iowa City, IA; e-mail: larissa-samuelson@uiowa.edu. Linda B. Smith is at Indiana University, Bloomington, IN.

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