ELSEVIER

COGNITION

Cognition 60 (1996) 143–171

Naming in young children: a dumb attentional mechanism?

Linda B. Smith[a,*], Susan S. Jones[b], Barbara Landau[c]

[a]Department of Psychology and Program in Cognitive Science, Indiana University, Bloomington, IN 47405, USA

[b]Department of Psychology, Indiana University, Bloomington, IN 47405, USA

[c]Department of Psychology, University of Delaware, Newark, DE 19716, USA

Received 12 December 1994, final version accepted 14 December 1995

Abstract

Previous studies have shown that young children selectively attend to some object properties and ignore others when generalizing a newly learned object name. Moreover, the specific properties children attend to depend on the stimulus and task context. The present study tested an attentional account: that children's feature selection in name generalization is guided by non-strategic attentional processes that are minimally influenced by new conceptual information presented in the task. Four experiments presented 3-year-old children and adults with novel artifacts consisting of distinctive base objects with appended parts. In a Name condition, subjects were asked whether test objects had the same name as the exemplar. In a Similarity condition, subjects made similarity judgments for the same objects. Subjects in two experiments were shown a function for either the base object or the parts. Both adults' naming and similarity judgments were influenced by the functional information. Children's similarity judgments were also influenced by the functions. However, children's naming was immune to influence from information about function. Instead, children's feature selection in naming was shifted only by changes in the relative salience of base objects and parts. The results are consistent with the idea that dumb attentional processes are responsible for young children's smart generalizations of novel words to new instances. Potential mechanisms to explain these findings are discussed.

1. Introduction

Could the smartness of young children's early word learning be the product of dumb processes? Our previous research suggests that, whatever other forms of

* Corresponding author. Fax: 812 855 4691.

PII S0010-0277(96)00709-3

categorization might be, or whatever the act of naming objects might become, young children's naming of objects is principally a matter of mapping words to selected perceptual properties. In the present paper, we examine the nature of the selective attention that underlies those mappings; and we present evidence that the smartness of children's learning of object names derives from the dumber forces that control selective attention. Indeed, in young children, the attentional processes that map names to properties may be relatively inaccessible to deliberative and strategic controls.

1.1. Children's novel word interpretations

The typical context in which children learn object names is one in which parents point to an object in view and label it. What is remarkable about very young children's word learning is that this limited information seems sufficient for the formation of a lexical category. That is, from hearing a single object named once, children spontaneously generalize that name to new instances – and they do so in a way that seems more often right than wrong (Mervis, 1987; Markman, 1989).

One experimental task that has been used to study this "smart" word generalization is a novel word interpretation task. In this task, as in the natural word-learning context, children are presented with a novel object that is named by a novel count noun (e.g., "This is a dax"). Then children are asked what other objects have the same name. Such studies have found that 2- and 3-year-old children systematically attend to specific object properties when generalizing the just heard word (e.g., for review, see Smith, 1995; Landau, 1994).

Two aspects of these results are relevant here. First, the particular features selected by young children depend systematically on the context. Shape is generally attended to when solid rigid objects are named by a count noun, but children attend to other specific properties (texture, color) when the named object has eyes (Jones et al., 1991; Landau et al., 1994) or is not rigid (e.g., Soja et al., 1991; Soja, 1992), or when the novel word is presented in a mass noun or adjectival frame (Soja, 1992; Smith et al., 1992; Landau et al., 1992). Second, systematic attention to selected properties is observed in children's novel word interpretations but not in their no-word similarity judgments (e.g., Landau et al., 1988). In sum, children's novel word interpretation is characterized by context-specific selective attention to object properties.

1.2. Smart and dumb forces on selective attention

Commenting on the findings in the novel word learning task, Gelman and Medin (1993) wrote:

> We think the evidence... shows that the significance of different dimensions does change powerfully as a function of linguistic versus non-linguistic contexts. A central question, however, is whether changes in the weighting

> of dimensions correspond to changes in perceptual experience... Although we remain agnostic on the issue, we should point out the logical possibility that the change in weighting is the result of a slower, more conscious and deliberate weighting and ignoring of different aspects of the situation

(p.164).

As Gelman and Medin point out, the focus of attention can be voluntarily controlled. For example, when looking for a box in which to wrap a present, we strategically make use of reflective and inferential processes to focus on size. However, selective attention to some properties and the ignoring of others can also be engaged involuntarily. One kind of automatic pull on attention derives from well-learned procedures and associations. For example, in the Stroop task, we cannot ignore the printed word to attend to the color of the ink; the highly practiced nature of reading has made attention to the form of the word but not its color automatic. Another kind of automatic pull derives from the attention-grabbing nature of salient properties. For example, a flash of light or a loud bang demands attention. The present hypothesis, in contrast to Gelman and Medin's (Gelman and Medin, 1993) conjecture, is that the smartness of children's selective attention in novel word interpretation derives more from the non-strategic than the strategic control of attention.

This proposal that the relevant forces on young children's attention in word learning are more reflexive than deliberative makes sense. Considerable evidence suggests that associative cues and the inherent pull of salient properties are universal aspects of attentional control and well documented in infants and children as well adults (Kruschke, 1992; Lewicki et al., 1989; MacIntosh, 1965; Younger, 1990). Just as much evidence indicates that young children's voluntary control of attention is, at best, uncertain (for review, see Aslin and Smith, 1988). As Medin and Ortony (1989) previously suggested, uncertain processes are not likely to underlie the certainty with which children learn object categories. Rather, early categorization and naming are likely to be built on less flexible, but more reliable attentional mechanisms.

We believe that well-documented, non-strategic forces on attention are sufficient to explain the extant data from the artificial word-learning task (Jones and Smith, 1993; Smith, 1995). The contextual control of feature selection is precisely the phenomenon that emerges as a result of training in attentional learning paradigms. In such studies, some cue is regularly associated with attending to some property; and the presence of that cue comes to recruit attention to the associated property (Lewicki et al., 1989; MacIntosh, 1965; Rescorla and Wagner, 1972; Younger, 1990). In learning language, children repeatedly experience specific linguistic contexts (e.g., "This is a ———" or "This is some ———") with attention to specific object properties and clusters of properties (e.g., shape or color plus texture). Thus, by this view, these linguistic contexts come to serve as cues that automatically control attention. The evidence on children's novel word interpretation also suggests that the momentary salience of object properties interacts with contextual cues and influences children's generalizations of a novel word (e.g., Smith et al., 1992). All in all, the data from artificial word-learning experiments are consistent with the idea that dumb forces on selective attention – that is, associative connections and direct stimulus pulls – underlie the seeming smartness of children's novel word interpretations.

However, these data do not show that more thoughtful or inferentially controlled selective attention is not also involved in young children's word generalizations. They do not because, with few exceptions (e.g., Gentner, 1978), past research has presented children only with a novel object and a novel name. Children have not been presented with the kinds of conceptual information that might be strategically used to guide attention in novel word generalization. Accordingly, in this research, we present that information. The key issue is this: if naming's connection to non-strategic forces on attention is privileged, then the added conceptual information should not affect novel word generalization even when that same information can be shown to guide attention in other, non-naming categorization tasks.

1.3. Appearance and function in children's categorizations

The information we provide in the experiments as a potential basis for the inferential control of attention is information about object functions. We used function as a possible guide to thoughtful feature selection for three reasons. First, the experimental control of stimulus properties requires the use of novel objects. The to-be-named objects thus will be artifacts manufactured specifically for the experiments. Considerable past research suggests that people's accessible beliefs about artifacts primarily concern function and intended use (see, for example, Tversky, 1989; Keil, 1989).

Second, the alternative hypothesis (the one we seek to disconfirm) is that deliberative processes can guide feature selection in the interpretation of a novel noun. Thus, a strong test of our hypothesis requires that we provide as a basis for children's inferences, information they could reasonably be expected to use. Many previous studies have indicated that children are highly attentive to functional information (Nelson, 1973; Baldwin et al., 1993; Cohen and Oakes, 1993; Brown, 1990).

Finally, our use of function is motivated by 20 years of research contrasting appearance and function as bases for children's early word learning (see Clark, 1973; Nelson, 1973). It was in this context that the paradigm of teaching children novel words was first used. In that first study, Gentner (1978) presented children with two complex novel artifacts that differed dramatically in their overall shape and in their constituent parts. One object was called a "jiggy" and the other a "zimbo". The zimbo had the intrinsically interesting function of delivering jelly beans. After the children had interacted with these objects, Gentner presented an object that looked like the original jiggy but that performed the function of the zimbo. Younger children (but not older children and adults) uniformly named the object according to its static perceptual properties (while at the same time taking the delivered jelly beans). Gentner concluded that while functional information might determine which words children learn, the meanings stored with the words are based chiefly on perceptual information.

The results of Gentner's study have been repeatedly upheld (e.g., Imai et al., 1994; Landau et al., 1995; Tomikawa and Dodd, 1980). These results tell us that young children name objects by their appearance, not by what they do. However, the findings to date do not tell us whether children might reason about functional information to select the particular aspects of appearance to which they will attend.

1.4. *The dumb attention hypothesis*

Young children's smart attention in novel word generalization could result from thoughtful strategically controlled attention and/or from dumber, more reflexively organized feature selection. The evidence thus far may be explained by positing only non-strategic forces on attention. The present studies are motivated by an extension of this idea. We propose that young children's systematic attention in the task of naming results from strong links between naming and the non-strategic forces on attention – links so strong that young children's selective attention in the task of naming is effectively cut off from strategic control. We test two critical predictions that follow from this proposal:

1. Attention in the task of naming will be influenced by the relative perceptual salience of object properties; and
2. Attention in the task of naming will be unaffected by information about the function of an object – even though children can use this information to guide attention in a non-naming task.

THE EXPERIMENTS

The experiments require stimulus objects composed of multiple properties any of which might be the basis for name generalization. Thus, the objects must vary on (at least) two perceptually dissociable dimensions. Further, these stimulus dimensions should be roughly comparable in their relevance for lexical categorization in natural language (and thus in their past relevance to naming) and should be plausibly related to the potential functions of an artifact. Finally, the functions that may serve to guide children's attention need to be plausible but not immediately obvious from perception nor well learned (and thus possibly providing automatic control of attention). Given these criteria, we constructed entirely novel complex artifacts that varied in their local and global properties. Sample stimuli are shown in Fig. 1. These specially constructed objects were modelled after complex artifacts in the world – things like clocks, and stoves, and cars – that have smaller, multiple parts appended to a larger simpler base. Past research has shown the local and global components of complex objects to be perceptually separable (e.g., Robertson et al., 1993); both properties are of likely relevance in the naming of

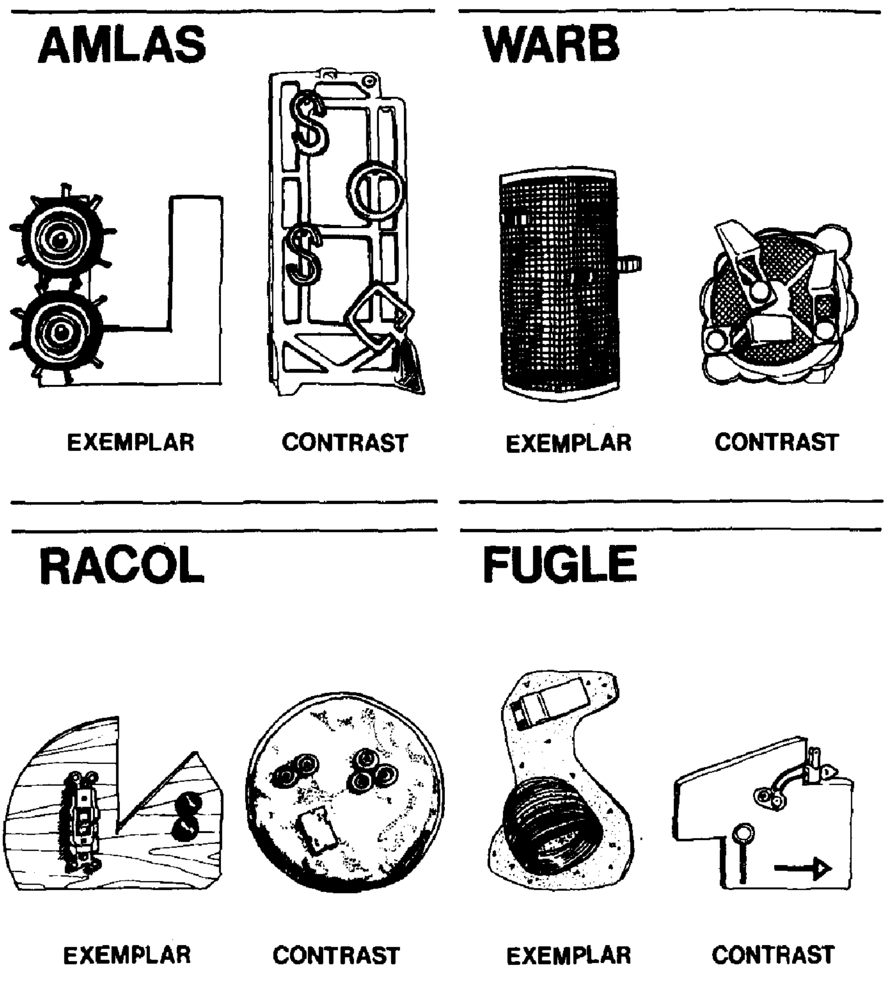

Fig. 1. Names and drawings of the four exemplar objects and their contrast objects used in Experiments 1 and 2.

real complex artifacts and both have been shown to be relevant to adults' judgments about the functions of real artifacts (Rosch et al., 1976; Tversky, 1989).

The subjects in the experiments were children between the ages of 3 and 3 1/2 years and adults. Young 3-years-olds were targeted for these experiments because previous research consistently shows strong lexically specific attentional biases at this age. Adults were included because past research suggests that adults may make use of functional information when interpreting a novel word (Landau et al., 1995). Thus it may be only young children's interpretations of novel nouns that are controlled by non-strategic attentional mechanisms cut off from more thoughtful processes.

Across the four experiments we manipulated three factors: Task, Functional information, and the Salience of the base object versus its parts. Each experiment employed a Naming task and a non-naming Similarity judgment task. In Experiments 1 and 3, no information about the function of the exemplar was presented and thus these experiments provide information about feature selection in the context of naming or similarity judgment without possibly competing information about the functional significance of specific properties. In Experiments 2 and 4, information about the intended function of the exemplar was presented. The function either required the base object but not the appended parts; or the function required the appended parts but not the base object. Finally, in Experiments 3 and 4 we increased the salience of the base objects by making them larger and thus increasing the size difference between the base objects and the appended parts.

The critical predictions are these: Children's attention in the task of naming will be influenced by the relative salience of the base objects and parts, but will be immune to influence by the information we present about function. If children's attention is strictly non-strategic in the task of naming but not in general, and if children understand the demonstrated functions and can make inferences about the properties necessary to carry out those functions, then children's judgments in the non-naming task of similarity judgment should be influenced by information about function as well as by the relative perceptual salience of the parts and base objects.

EXPERIMENT 1

2. Method

2.1. Subjects

The subjects were 24 three-year-olds and 24 college undergraduates. At each level, there were 12 males and 12 females. The mean age of the 3-year-olds was 3 years 2 months; range 3;0 to 3;4. Half the males and females at each age level were randomly assigned to the Similarity condition and half to the Name condition. The children were tested in a quiet room at their daycare and the adults were tested in the laboratory.

2.2. Stimuli

The exemplar object consisted of a larger base object of simple shape with smaller and typically moveable knobs, gears, and gadgets appended to that base object. Each exemplar was paired with a contrast object composed of a different base and different parts. All of the four exemplars and their contrast objects are shown in Fig. 1. For each exemplar, there were four test objects. One was the *Contrast object*; one was *Identical* to the exemplar object in all respects; and the other two were constructed by crossing the bases and parts of the exemplar and its contrast object, such that the *Part* test object had the parts of the exemplar on the base of the contrast object, and the *Base* test object had the parts of the contrast object on the exemplar base.

The base of the "Amlas" exemplar was 21 cm × 20 cm × 1 cm, and made of white cork board. The gears were 8 cm in diameter and red and yellow in color.

The contrast base was a green plastic frame 35 cm × 15 cm × 1.5 cm. The appended parts were four blue plastic shapes, each approximately 6 cm.

The base of the "Warb" exemplar was a chicken-wire cylinder 23 cm high and 12 cm in diameter. The parts were three metal clips approximately 3 cm in diameter. The base of the contrast object was an orange plastic sand sifter 5 cm deep and 21 cm in diameter. The contrast parts were yellow and orange plastic scoops, each about 8 cm long.

The "Racol's" base object was made of 2 cm plywood, 19 cm high and 24 cm wide. The exemplar parts were a standard light switch 9 cm in length and two black and gold faucet filters 2.5 cm in diameter. The contrast base was an 21 cm metal pie plate covered in green felt to a depth of 5 cm. The parts were five blue knobs each 2.5 cm in diameter and a white plastic razor case 6 cm long.

The base for the "Fugle" exemplar was made of cork, 20 cm tall, 13 cm at its widest part, and 2 cm thick. The parts were a hinged red wooden tab 7.5 cm in length, and a metal spring 9 cm in diameter. The contrast object was wood covered with orange contact paper 11 cm high, 16 cm wide, and 4 cm thick. The parts were a plug-in night light 5 cm long, terminals for a 9-volt battery, and two green plastic symbols 7 cm in length.

2.3. Procedure

The task consisted of four trials; each trial consisted of eight questions. On each trial, the subject was presented with one exemplar object and then asked twice about each of the four test objects: Identity, Part, Base object, and Contrast. Order of querying test objects in a trial was randomly determined for each subject. Order of the four exemplar trials was also randomly determined for each subject.

In the Similarity condition, the subject was shown the exemplar and was told "See this one? We need to find more like this... We need to find things that are like this..." With the exemplar in front of the subject, a test object was brought in view and the subject was asked: "Is this like that? Are these two alike?" The experimenter recorded either a "yes" or "no" response for each object. The exemplar being asked about remained in view through out a trial but all other objects except the test object being queried at the particular moment were not in view. If the subject asked what the objects were named or what they were used for, the experimenter answered "I don't know".

The Name condition was identical except the exemplar was named as it was presented to the subject and the subject was asked whether the name applied to test objects. The names for the four exemplars were *amlas*, *fugle*, *racol*, *warb*. Thus a trial with the amlas set would begin with the experimenter saying "This is an amlas. Can you say amlas? Yes that's it; this is an amlas. We need to find some more amlases." With the exemplar in front of the subject, a test object was then brought in view and the subject was asked "Is this an amlas?" The exemplar's name was repeated prior to asking about each test object. Each subject was tested individually in a session lasting approximately 20 minutes.

3. Results and discussion

The numbers of "yes" responses were submitted to an analysis of variance for a 2 (Age) × 2 (Task: Name/Similarity) × 4 (Test object: Identity, Part, Shape, Contrast) mixed design. The analysis revealed a main effect of Age, $F(1, 44) = 11.56$, $p < .001$. Children said "yes" more than adults. The analysis also revealed main effects of Condition, $F(1, 44) = 8.42$, $p < .005$ and Test object, $F(3, 132) = 125.54$, $p < .001$. These main effects are subsumed under a reliable interaction between Condition and Test object, $F(3, 132) = 16.33$, $p < .001$. No other interactions were reliable.

The source of the interaction is obvious in Fig. 2, which shows the mean proportion "yes" for each test object in each condition by children and adults. Post hoc analyses (Tukey's HSD $\alpha = .05$) indicate that in the Similarity condition both children and adults respond "yes" to the Identity test object more than to all other objects. As the figure shows, in the Similarity condition, subjects at both age levels maintained that the test items that were identical to the exemplar were "like" the exemplar and they judged that the other test items (all of which differed from the exemplar in some way) were not "like" the exemplar. In the Name condition, in contrast, children and adults responded "yes" to the Identity test objects and to the Part test objects but not to the Base object or Contrast test

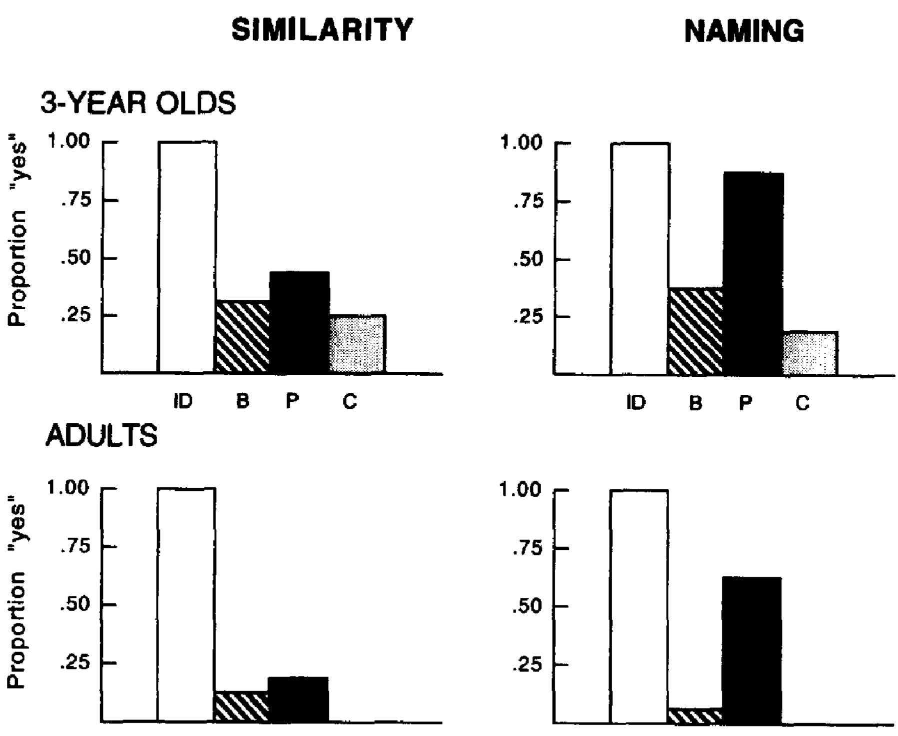

Fig. 2. Mean proportion of "yes" responses to the four kinds of test objects in Experiment 1 by children and adults in the Similarity and Naming conditions. ID, Identity; B, Base object; P, Parts; C, Contrast.

objects. This pattern of responding implicates selective attention to the appended parts when the task involves naming.

In sum, the results of Experiment 1 indicate that naming an object invites both young children and adults to selectively attend and to generalize that name to objects that are like the exemplar in appended parts. From these results, we have no basis for choosing between deliberative and non-deliberative process accounts of feature selection. The task of Naming may invite selective attention because of subjects' beliefs about words and lexical categories or because naming reflexively activates non-strategic attentional processes. Appended parts could be more important than the base object in the categorization of these stimuli because of subjects' beliefs about complex artifacts and the importance of small moveable parts for their intended use, because of well-learned associations between naming artifacts and attending to parts, or because of the intrinsic salience of shiny, moveable complex shapes relative to the static, generally less colorful, and simpler base objects. We begin to pull apart these possibilities in Experiment 2.

EXPERIMENT 2

This experiment is identical to Experiment 1 with one chief exception. We demonstrated and told children and adults about a function for each exemplar object. For half the exemplars, the function depended on the base object. For half the exemplars, the function depended on the appended parts. To ensure that children attended to the functional information and understood it, we also chose functions that could be easily performed by children and all subjects were encouraged to use the objects for the intended function.

4. Method

4.1. Subjects

The subjects were 24 3-year-olds and 24 college undergraduates. At each level, there were 12 males and 12 females. The mean age of the 3-year-olds was 3 years 3 months; range 3;0 to 3;5. Half the males and females at each age level were randomly assigned to the Similarity condition and half to the Name condition. None of these subjects participated in Experiment 1.

4.2. Stimuli, procedure, and design

The stimuli were identical to those used in Experiment 1. The only difference in procedure was that on each trial the subject was presented with an exemplar and then the functional use of the exemplar was demonstrated. Then, and prior to the presentation of any test objects, the subject was encouraged to use the exemplar to perform its function. For example, in the Name condition, with the warb exemplar, and when the parts were deemed functionally relevant, the subject was told "This is a warb. It holds pens. See you put the pens in here." The experimenter then demonstrated putting pens in each of the hooks. The pens were then removed and the subject was asked to perform the function. The Similarity trials were identical except the that the exemplar was not named: "See this, it hold pens..."

For each exemplar, there was a potential function that could only be performed given its appended parts and a potential function that could only be performed given the particular base object. These functions are listed in Table 1. Each subject received one trial with each of the four exemplars and saw only one functional use for each exemplar. For two of the exemplars, the subject was presented with the part biasing function and for two exemplars the subject was presented with the base object biasing function. The assignment of particular exemplars to part versus base object biasing was counterbalanced across subjects in a condition and age group. Thus, within subject, each child received two part-biasing trials and two base object-biasing trials and between subjects, half the subjects in each condition saw a part-biasing function for each exemplar and half saw a base object-biasing function for that same exemplar.

As in Experiment 1 each trial was composed of two questions about each of the four test objects. The functional information was presented at the beginning of each trial before any test objects were presented and again (along with the name of the exemplar in the Name condition) prior to the presentation of each test object. However, the experimenter only asked about each test object whether it had the same name as the exemplar ("Is this a warb?") or whether it was like the exemplar ("Is this one like that?") The experimenter never asked about the potential functional uses of the test objects. All props associated with the demonstrated function of the exemplar remained on the table through out a trial and the subject was allowed to attempt the function with the exemplar and all test objects at any time, but was only prompted by the experimenter to do so once, after the initial demonstration of the function, before the presentation of any test objects, and when only the exemplar was before the child.

Table 1
Functions assigned to each exemplar in Experiment 2

Exemplar (as labeled in Fig. 1)	Base object biasing function	Part biasing function
Amlas	A toy dog sits in	Drop marbles into gears to make them turn
Warb	Look through (like a telescope)	Holds pen
Fugle	Make grooves in sand or clay	Makes noise when hit on hand (parts jangle "musically")
Racol	Template for drawing angles, curves, and lines	Tone comes on when switch is flipped

5. Results and discussion

The numbers of "yes" responses were submitted to an analysis of variance for a 2 (Age) × 2 (Condition: Name vs. Similarity) × 2 (Function) × 4 (Test object) mixed design. The analysis revealed a main effect of Test object, $F(3, 132) = 320.74$, $p < .001$ and six reliable interactions: Age × Test object, $F(3, 132) = 4.03$, $p < .01$; Condition × Test object, $F(3, 132) = 10.68$, $p < .001$; Function × Test object, $F(3, 132) = 92.27$, $p < .001$; Age × Condition × Test object, $F(3, 132) = 3.28$, $p < .05$; Age × Function × Test object, $F(3, 132) = 22.31$, $p <$ 22.31; and Condition × Function × Test object, $F(3, 132) = 5.25$, $p < .002$. Tukey's HSD ($\alpha = .05$) was used for further analyses of these interactions and all differences noted below are reliable by this method.

The sources of the interactions are obvious in Fig. 3(a), which shows children's and adults' similarity judgments, and Fig. 3(b), which shows children's and adults' extensions of the novel name to test objects. Put simply, the demonstrated functions biased adults' responses *in the direction of the function* in both the Similarity and Name conditions. However, the demonstrated functions affected the 3-year-olds' performances in the Similarity condition but not in the Name condition. In the Name condition, 3-year-olds, just as they did in Experiment 1 with these very same stimuli, extended the name of the exemplar only to the two

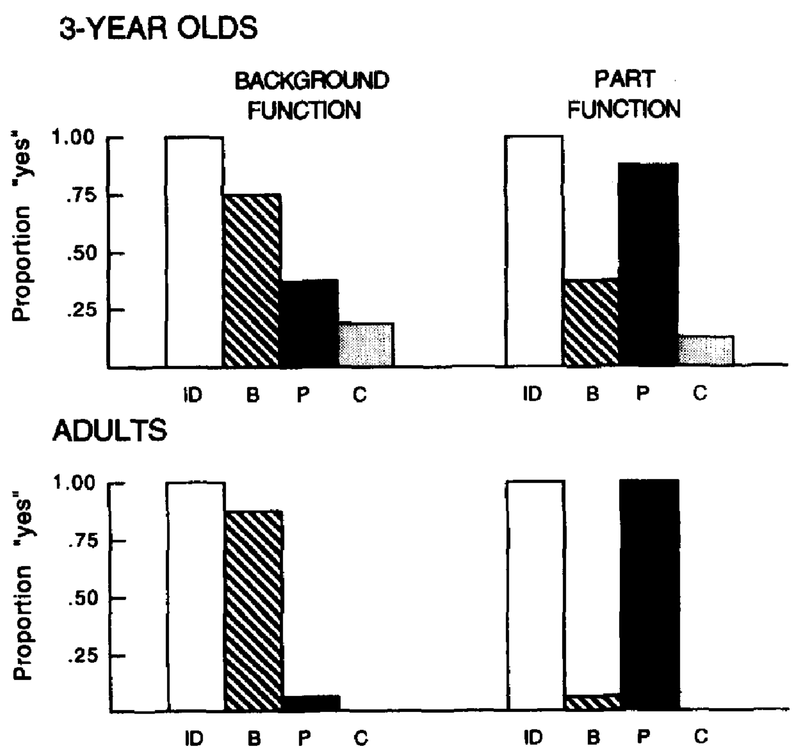

Fig. 3. Mean proportion of children's and adults' "yes" responses to the four kinds of test objects in Experiment 2: (a) in the Similarity condition when the demonstrated function depended on Base object or Parts and (b) in the Naming condition when the demonstrated function depended on Global Shape or Parts. ID, Identity; B, Base object; P, Parts; C, Contrast.

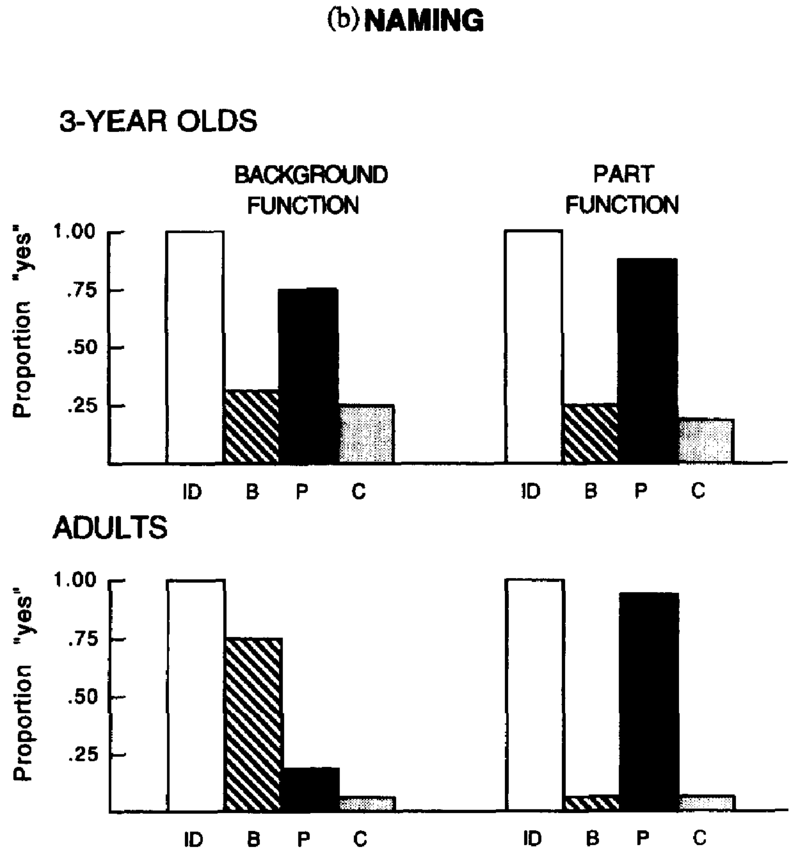

Fig. 3. (*continued*)

test objects (Identity and Part) that shared the same parts with the exemplar. Children extended the novel name to the Part test object only slightly more often when parts were functionally significant than when the base objects were (88% vs. 75%) and they extended the novel name rarely to the base test objects both when the base was functionally significant (30%) and when it was not (23%). In marked contrast, 3-year-olds in the Similarity condition performed like adults in both conditions. When the base object was functionally significant, they said the Base test objects but not the Part test objects (75% vs. 35%) were like the exemplar. When parts were functionally significant, they said that the Part test objects and not the Base ones were like the exemplar (79% vs. 30%).

The results in the Similarity condition clearly show that the demonstrated functions were understood by the children and could be used to categorize objects. The children's behavior in the Name condition shows that the children in this condition were also well aware of the demonstrated functions despite the fact that they did not use this information in generalizing the exemplar's name. Table 2 shows the proportion of times children attempted to perform the intended function in the Name and Similarity conditions for each type of test object. (Adults rarely attempted to perform these functions on test objects.) Included in this count are all attempts even if they were not successful (e.g., trying to stick pens somewhere on the contrast object for the warb). A 2 (Condition: Name vs. Similarity) $\times$ 4(Test

Table 2
Mean proportion of times children's spontaneously attempted the demonstrated function in Experiment 2 when a test object was presented in the Similarity condition and in the Naming condition for the Identity (Id), Base object (B), Part (P) and Contrast (C) test objects

	Biasing function							
	Base object				Parts			
	Id	B	P	C	Id	B	P	C
SIM	.94	.94	.19	.12	.94	.25	.88	.19
NAME	.94	.90	.31	.12	.90	.19	.88	.14

object) × 2 (Function) revealed a main effect of Test object, $F(3, 66) = 128.70$, $p < .001$ and an interaction between Function and Test object, $F(3, 66) = 133.24$, $p < .001$. But critically, there was no effect of condition. As can be seen in Table 2, children in both conditions attempted to perform the base biased functions on test objects that had the appropriate base and attempted to perform the part biased function on test objects that had the appropriate parts. Thus in the Name condition, children *at the same time* that they rejected a test object as an instance of the lexical category used that same test object to perform the demonstrated function. In the name condition, the 3-year-olds *lexically classified the objects one way and functionally classified them another way.*

These results provide strong support for Prediction 2: Young children's naming is not influenced by information that children *can use* to guide categorization in other tasks. Young children use functional information when making similarity judgments, but do not make use of that information in the task of naming.

Although these results were specifically predicted, an ad hoc account of them in terms of strategic control of attention may be constructed. That is, young children (but apparently not adults) may have such strong beliefs about the importance of small parts to the essential nature of complex artifacts that they base their inferences about naming on these properties rather than on the demonstrations by the experimenter. If this is so, if young children's attention to the appended parts of complex artifacts was uninfluenced by information about function because of children's conceptual beliefs about the importance of parts, then their attention to parts in the task of naming should also be unaffected by making the base objects more salient. In contrast, by Prediction 1 of the dumb attention hypothesis, increasing the attention-grabbing properties of the base object should cause children to selectively attend to and generalize the object's name by base object properties.

EXPERIMENT 3

Experiment 3 is identical to Experiment 1 except for the stimuli. We retained the same appended parts used in Experiments 1 and 2 but mounted these parts on base objects that were considerably larger than those used in the previous two experiments.

6. Method

6.1. Subjects

The subjects were 20 3-year-olds (mean 3 years 1 month, range 3;0 to 3;3) and 20 college undergraduates. Half the subjects at each age level were randomly assigned to the Name condition and half were assigned to the Similarity condition. There were equal males and females in each condition at each age level. None of these subjects had participated in Experiments 1 and 2.

6.2. Stimuli

The four new exemplars are illustrated in Fig. 4. For each exemplar set, the base objects for both the exemplar and the contrasting test object were changed and all were larger than the previous base objects. The names for the exemplars and the

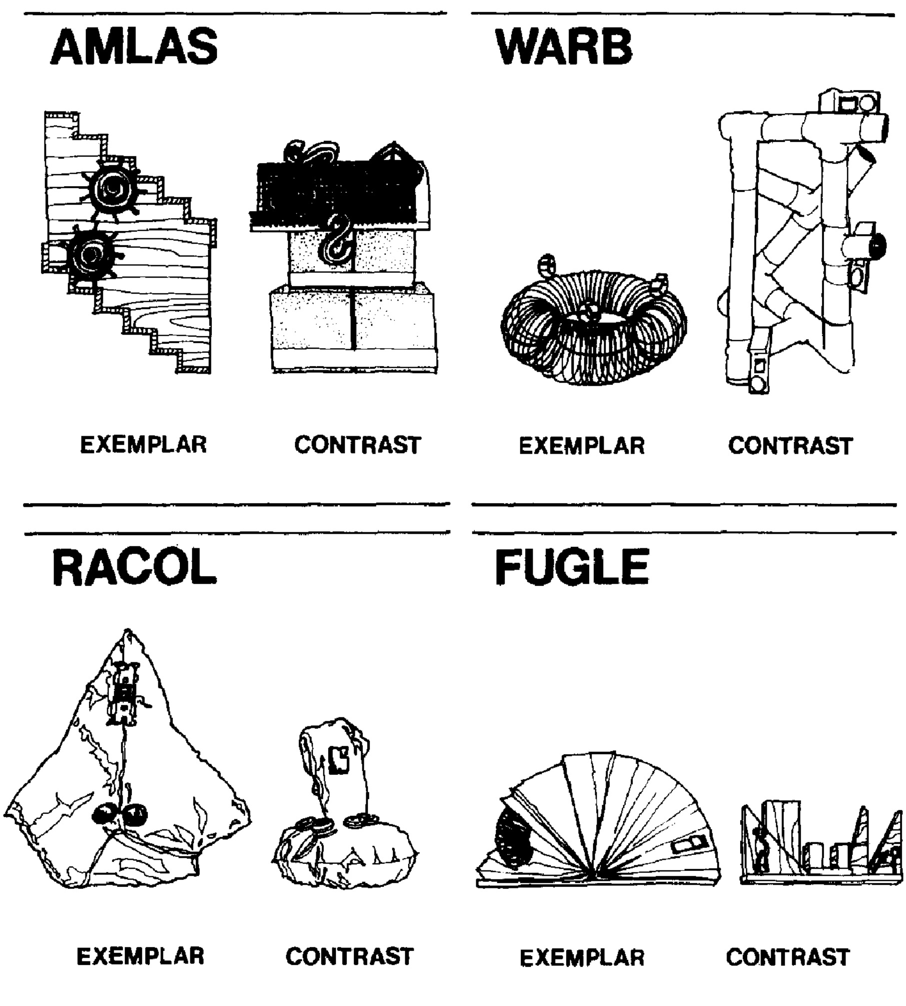

Fig. 4. Drawings of the four exemplar objects and their "names" used in Experiments 3 and 4.

parts appended to the exemplar and contrast object in each set were the same as in Experiments 1 and 2.

The "Amlas" exemplar's new base object was a 40 cm × 28 cm × 8 cm complex shape made of wood. The base for the contrast object was a grey wire mesh cave mounted on dark-blue styrofoam blocks. The overall dimensions were 28 cm × 22 cm × 12 cm.

The new base object for the "Warb" exemplar was a steel grey wire spring (a large "Slinky") 9 cm in diameter. The ends of the spring were welded together so that it formed a large circle 25 cm in diameter and a yellow plastic ring was nested in the center. The contrast base object was a pipework polyhedron 44 cm × 25 cm × 25 cm made from brown cardboard rolls.

The "Racol" exemplar's new base was a red felt pillow roughly cone-shaped and 31 cm × 25 cm × 25 cm. The contrasting base object was an air-filled purple plastic irregular cylinder 25 cm high with a base 18 cm in diameter.

The new exemplar "Fugle" base was a 20 cm high × 40 cm long yellow half circle made of thick paper and wood. The contrast base object was constructed of three triangular and three rectangular wooden blocks on a wooden platform. Overall dimensions were 17 cm × 34 cm × 6 cm.

The exemplar parts and contrasting parts were mounted in spatial locations on these base objects that approximated as closely as possible their locations on the base objects in Experiments 1 and 2. Four test objects were created for each exemplar in the same way as in Experiment 1.

6.3. Procedure

The procedure in all respects was identical to Experiment 1.

7. Results and discussion

The numbers of "yes" responses in the Name and Similarity conditions were submitted to an analysis of variance for a 2 (age) × 2 (Condition: Name/No name) × 4 (Test object) mixed design. The analysis revealed a main effect of Age, $F(1, 36) = 15.46$, $p < .001$; children said "yes" more often than adults. There was a main effect of Condition, $F(1, 36) = 7.11$, $p < .01$; subjects said "yes" more often in the Name than in the No-name condition. There was also a main effect of Test object, $F(3, 36) = 232.75$, $p < .001$ and this factor interacted with both Age, $F(3, 36) = 7.08$, $p < .001$, and Condition, $F(3, 36) = 11.89$, $p < .001$. No other interactions approached significance. Fig. 5 shows the proportion of "yes" responses at each age level in each condition for each test object. Pairwise contrasts were analyzed via Tukey's HSD ($p < .05$) and all differences cited are reliable by this method.

As is apparent in Fig. 5, the children's results are parallel to those in Experiment 1. In the Similarity condition, the children said that the Identity test object was "like" the exemplar more often than any of the other test objects. In the Naming

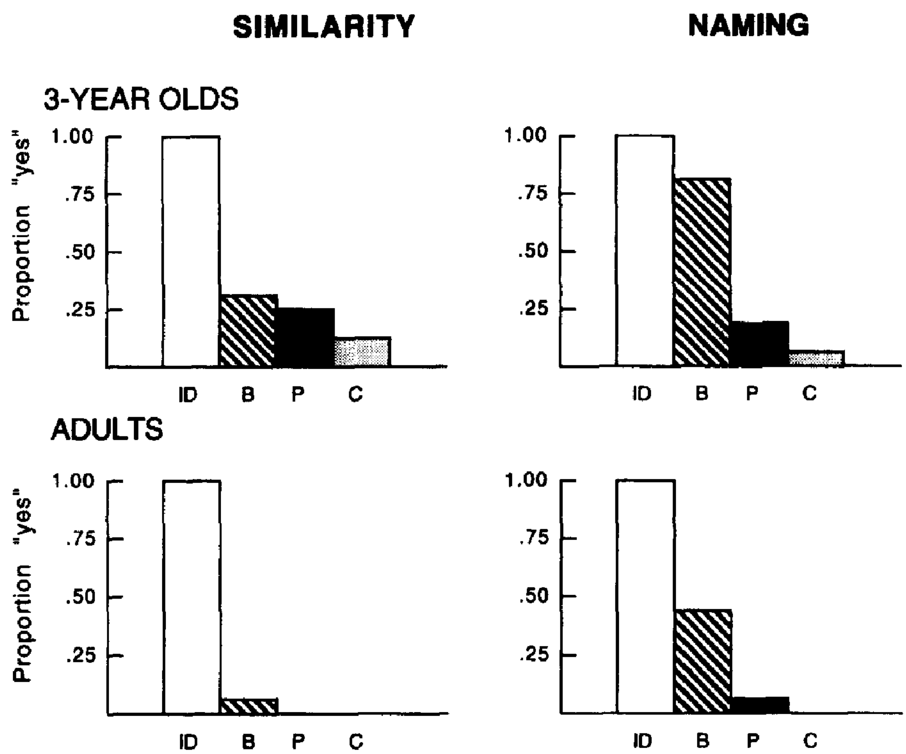

Fig. 5. Mean proportion of children's and adults' "yes" responses to the four kinds of test objects in the two conditions of Experiment 3. ID, Identity; B, Base object; P, Parts; C, Contrast.

task, however, children attended principally to the base object and extended the exemplar's name to objects with that property more than to other objects. Thus, young children's attention to appended parts in the task of naming complex artifacts is shakeable. It may not be shaken by information about function, but it is moved by increasing the salience of other competing properties.

Adults in both the Similarity and Naming tasks principally said "yes" only to the Identity test object. This conservatism in the Name condition contrasts with adults' performances in Experiment 1 and the performance of young children in both Experiment 1 and this experiment. This lack of generalization by adults in the Naming task and the restriction of the exemplars' name to only the Identical test object may reflect the compelling nature – to adults – of both the base object and the parts.

In sum, the results of this experiment provide support for Prediction 1 of the Dumb Attention Hypothesis. Naming in young children is influenced by one factor known to automatically engage attention: that is, by the perceptual salience of individual properties.

EXPERIMENT 4

In this experiment, we used the stimuli of Experiment 3, but the procedure of Experiment 2: In both the Naming and Similarity tasks, we presented information about the functions of the exemplars – functions that required either the base object or the appended parts.

8. Method

8.1. Subjects

Sixteen 3-year-olds (mean 3 years 2 months, range 3;0 to 3;6) and 16 college undergraduates participated. At each age level, 8 males and 8 females participated. At each age level, subjects were randomly assigned to either the Name or Similarity condition such that equal numbers of males and females participated in each condition. None of these subjects had participated in the first three experiments.

8.2. Stimuli, design, and procedure

The stimuli were identical to those used in Experiment 3 and the design and procedure were identical to those in Experiment 2. The Part biasing functions were the same as in Experiment 2 and the new Base object-biasing functions were: amlas – to set five small dancing objects on; warb – to hold a paper tree (in center); fugle – to make a breeze; racol – to punch in a punching back and forth game.

9. Results and discussion

The numbers of "yes" responses were submitted to an analysis of variance for a 2 (Age) × 2 (Task) × 2 (Function) × 4 (Test object) design. The analysis revealed a reliable main effect of Age, $F(1, 28) = 7.24$, $p < .02$, children said "yes" more often than adults, and a reliable main effect of Test object, $F(3, 84) = 132.64$, $p < .001$, reflecting the greater number of "yes" responses to the Identical test objects than to all other test objects. The analysis also revealed four reliable interactions: Age × Test Object, $F(3, 84) = 4.42$, $p < .01$; Function × Test object, $F(3, 84) = 32.19$, $p < .001$; Age × Function × Test object, $F(3, 84) = 8.85$, $p < .001$; and, finally, Age × Condition × Function × Test object, $F(3, 84) = 3.50$, $p < .05$.

The source of the interactions can be seen in Fig. 6. Pairwise differences were analyzed by Tukey's HSD test, and all differences cited are reliable ($p < .05$) by this method. Adults in both the Similarity and the Name conditions attended most to the object properties central to the demonstrated function: When the demonstrated function required specific parts, adults typically said test objects sharing those parts with the exemplar had the same name as the exemplar and were like the exemplar; when the demonstrated function required the properties of the base object, adults typically said test items with that base object had the same name as

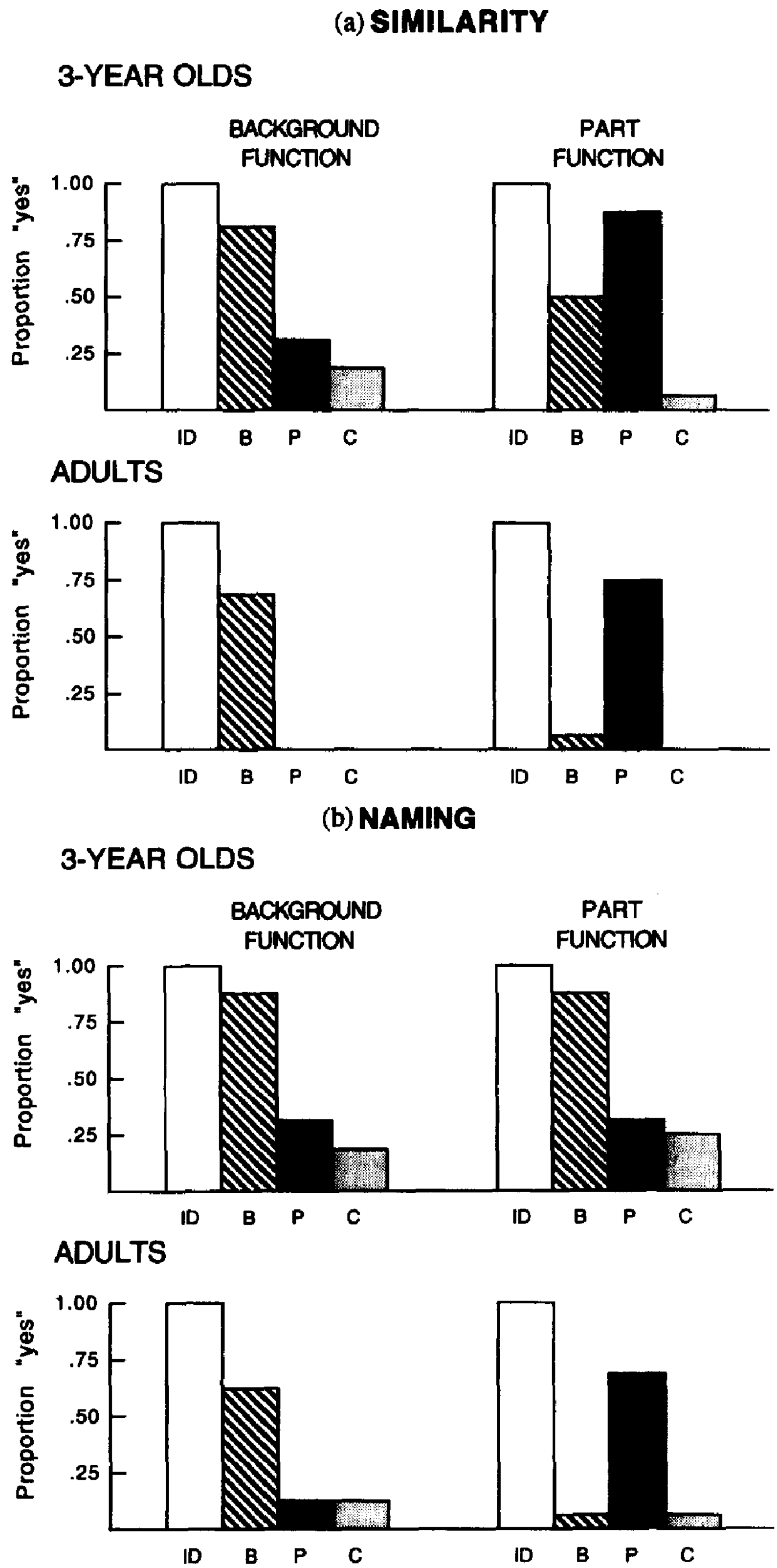

Fig. 6. Mean proportion of children's and adults' "yes" responses to the four kinds of test objects in (a) the Similarity condition and (b) the Naming condition when the demonstrated function depended on global shape and when it depended on parts. ID, Identity; B, Base object; P, Parts; C, Contrast.

the exemplar and were like the exemplar. However, adults sometimes restricted the name extensions to the test object identical to the exemplar, again showing somewhat more conservative judgments than in Experiment 2.

The children's pattern of performance in the Similarity condition was similar to the adult pattern in that same condition in that children said test objects that could perform the demonstrated function were like the exemplar more than test objects that did not have the requisite property. However, as predicted, functional information had no effect on children's lexical categorizations. Regardless of whether the exemplar's function involved the larger base or the appended parts, the children extended the exemplar's name principally by base object – just as they did in Experiment 3 when no function was demonstrated.

As in Experiment 1, there is clear evidence that children were well aware of the functional information and its dependence on either the base object or parts in the Naming as well as the Similarity task. Table 3 gives the proportion of times children in the Name and Similarity conditions attempted to perform each function on test objects. In both conditions, they did so reliably more often when the test objects possessed the critical property than when they did not ($F(3, 60) = 98.31$, $p < .001$). But this information was not used when generalizing a newly learned object name to novel objects.

Again, it is notable that adults' judgments were more conservative given these stimuli than they were given the stimuli in Experiments 1 and 2 – even with relevant functional information. Some adults spontaneously commented on their difficulty in making decisions; as one put it "There are just too many possibilities. I can imagine lots of different meanings." Perhaps the attentional processes of adults are influenceable by so many inferential, strategic, and perceptual processes that sometimes there is no *one* compelling solution. Young children seem not to be faced with this problem.

GENERAL DISCUSSION

The four experiments tested two key predictions of the dumb attention hypothesis: that young children's extensions of novel names for novel objects (1) would be influenced by direct pulls on attention – in particular, by the relative salience of perceptual features; and (2) would *not* be influenced by inferences

Table 3
Mean proportion of times children spontaneously attempted the demonstrated function in Experiment 4 when a test object was presented in the Similarity condition and in the Naming condition for the Identity (Id), Base object (B), Part, (P) and Contrast (C) test objects

	Biasing function							
	Base object				Parts			
	Id	B	P	C	Id	B	P	C
SIM	.90	.89	.09	.06	.92	.08	.88	.09
NAME	.94	.90	.13	.04	.90	.10	.91	.05

based on functional information. The results support both predictions. In Experiment 1, young children named complex artifacts by their small appended parts, a result that could signal either the greater perceptual salience of parts or deliberative thought about their importance. Subsequent experiments showed that whatever the processes that took children so strongly to the parts in the first place, they are processes unaffected by knowledge of function but readily affected by perceptual salience.

In Experiments 2 and 4, the functional information that children ignored when naming objects was competently used by them when making similarity judgments. Moreover, the very same children who did not use functional information when extending the exemplar's name showed knowledge of that information in their actions on the test objects. It is as if the knowledge that controlled children's hands as they performed the functions was disconnected from whatever processes controlled their word generalization (see Alibali and Goldin-Meadow, 1993; Goldin-Meadow et al., 1993 for possibly related phenomena). Finally, the failure to use functional information when naming objects was specific to the young children in our experiment; adults' lexical generalizations were clearly influenced by functional information.

10. Two processes of feature selection

One way to gain insight into the implications of these results is to think about the two tasks independently. What processes might yield the pattern observed for children in the similarity judgment task? What processes might yield the pattern observed for children in the naming task?

Children's performances in the similarity judgment task are consistent with the idea of inferentially driven feature selection. When presented with these novel, rather odd stimuli in the absence of functional information, and asked whether one object was like another, young children did not selectively attend to either the local or global similarity. Since there was no information provided from which one could infer which properties were relevant to the similarity judgment, this non-selectivity makes sense (Medin and Ortony, 1989). Our results also indicate that in the same similarity judgment task, when novel functional information was supplied, children used that information. When we presented functions that depended critically on either local or global properties, the children made their likeness judgments specifically in terms of those functionally relevant properties. Apparently, children attended to the function, understood its dependence on a specific property, and made the inference that this property was therefore important to whether one object was "like" another. These functions were novel and not well-learned associates of the object properties nor of the task of similarity judgment. Thus, children's ability to use this information is consistent with Gelman and Medin's (Gelman and Medin, 1993) idea of a feature selection process that is deliberative and strategic.

But critically, children's performance in the naming task did not look like this at all. First, children's attention was highly selective in all naming conditions – even with these same odd stimuli. Second, information about the named object's function had no influence on the choice of objects to which that name was generalized. Third, and in contrast to the lack of effect of functional information, manipulations of the salience (i.e., the relative size) of the stimulus properties did influence children's naming. This finding that children name by appearance and not by function is consistent with previous results (Gentner, 1978; Tomikawa and Dodd, 1980; Imai et al., 1994; Landau et al., 1995; but see Kemler Nelson, 1995). The key finding here, however, is that the choice of perceptual properties for lexical categorization is not affected by potentially relevant functional information that children can use in another task. It is this fact that suggests that the attentional processes underlying the generalization of a novel name are in some way segregated from those that organize attention in other tasks.

11. Four hypotheses

The observed pattern of findings is consistent with our original hypothesis; children's name generalizations are so strongly linked to non-strategic forces on attention that other potentially useful guides to attention have no effect. One specific aspect of our results suggests that we look for the mechanism linking naming to dumb attentional processes, not in what is perceived, but rather in what is stored in memory with the novel name. The children in the task of naming were clearly aware of the functional information. What needs to be explained, then, is why they did not associate the object name with properties relevant to the object's function, even when that information was noticed. We offer four hypotheses.

Hypothesis 1: It's a matter of timing. One possibility is that the establishment of a connection between property and name is a matter of timing. For the name and property to be connected, attention to both may need to be simultaneous. When the name is heard, it may be linked to the property most demanding of attention at that moment. In the present experiments, the functional information that demonstrably pulled attention to specific properties was presented after the object was named. If we had pulled children's attention to specific properties using functional information at or prior to the presentation of the name, children might have extended the name on the basis of the functionally relevant property.

One result that would seem to directly contradict this hypothesis has been reported by Baldwin (1993). In her experiment, 19- to 20-month-old children were familiarized with two novel toys which were then removed from view and hidden in separate containers. While looking into one container, the experimenter named one hidden toy. When both objects were placed back on the table and the child was asked to get an object by the previously supplied name, the child more often chose the first than the second toy. That is, they chose the toy which they heard named while it was hidden in a container but which they never saw go into the container and only some time after naming saw removed from the container. These results suggest that temporal contiguity is not necessary for the mapping of names to objects and thus to specific object properties. One alternative interpretation of the data is that since the named object was not in view, these very young children linked the name to a direction of attention (e.g., to the left). Alternatively, temporal contiguity between naming and the selection of an object property may be sufficient though not necessary. Further, when the named object is in view, the mapping of the name to the currently attended property may be so strong that it blocks association of the name to a subsequently attended functional property. In light of these possibilities, the role of temporal contiguity in early word learning merits further study (see also Akhtar et al., in press; Smith and Samuelson, in press).

Hypothesis 2: Coherent units are stored with names. A second possibility is that the property selected for storage with the name must be an already cohesive unit. In the present experiments, both the base object and the appended parts are likely perceptual units (Tversky, 1989). The perceptual information provided by the functional demonstration, in contrast, is a complex event including the highlighted property, the action, and the consequences of that action. If this analysis is correct, our results may mean that such a complex event is not easily mapped to words. Although such an event clearly provides a reasonable basis for making inferences about relevant properties in the similarity task, it may not isolate a suitably coherent unit for initial storage with the word. This possibility raises the question of whether our results would have been the same if we had used familiar functions that had been repeatedly experienced in association with specific object properties. Such past associations between a function and a property might be sufficient to directly isolate a relevant perceptual unit that could subsequently be stored with a name. This idea is consistent with Kemler Nelson's (Kemler Nelson, 1995) recent finding that, in a word generalization task, older pre-school children used function to select the relevant object part for naming. In her experiment, these parts (e.g., paintbrushes that were part of a more complex object) were strong real world associates of the demonstrated function (e.g., painting). This hypothesis is also consistent with the findings of Merriman et al. (1991) which indicate that prior perceptual learning affects novel word generalizations.

Hypothesis 3: It's a matter of looking at the object. A third possibility is that the performance differences between naming and similarity judgments emerge because of a special link between naming and looking at individual objects. Baldwin (Baldwin, 1991;Baldwin, 1993; Baldwin and Markman, 1989) has shown that when an adult names an object (using child-directed prosodic cues), the young child will look directly at the object at which the adult is looking. This directed and focused attention on a single whole object, rather than on what it is doing or on what is being done with it, may be a key factor in recruiting automatic attentional processes that select the property to be stored with the object name (see also Roberts and Jacob, 1991; and Roberts, 1994). Perceptually based feature selection may not be engaged in the similarity task because attention is more diffuse and not centered on just one object. Thus, in the similarity task, feature selection may have no direction until extra-object contextual and conceptual information is supplied.

Hypothesis 4: Naming activates non-linear attentional processes. A fourth possible clue to the processes that exclude functional information from children's naming is suggested by the data themselves. In all the experiments, children generalized the novel name to objects that were different from the exemplar; and in all experiments they did so consistently by picking out either the global or local properties as relevant. They did not have to do this. They could have generalized the name only to objects identical to the exemplar; they could have generalized the name to any object that at least had something in common with the exemplar (forming a disjunctive category of same-in-part *or* same-in-base); or they could have generalized the name haphazardly. They did none of these. Instead, as has been consistently reported in novel noun learning tasks, they generalized selectively. This fact suggests that naming somehow activates a non-linear transformation of attention weights – pushing those above some threshold to near maximum values, and those below some threshold to near zero. In Experiments 1 and 3, with these highly novel and unusual stimuli, only differences in salience could create what might be initially small differences in attention weights. Thus, it may be important that in Experiments 1 and 3 the property that was slightly (though not reliably) more weighted by one group of children in making similarity judgments is the same property that was stored by another group of children with the name. Such transformations could similarly magnify the attentional effects of associative cues (e.g., between the perception of rigidity and attention to shape) that by themselves might yield only small differences in attention weights. The result would be highly systematic and rule-like – that is, "smart" – word learning biases.

Clearly, the four hypotheses are not mutually exclusive: the four processes they describe might work in combination to create non-strategic but certain selective attention specific to the task of naming. Clearly, all four hypotheses are also empirically undetermined: but they contribute by setting an agenda for future research.

12. The utility of non-thoughtful maps between words and properties

We believe that non-strategic naming organized by automatic attentional processes may be the best way to learn object names, at least in the early stages of language learning. Naming that is based on selective attention to a single property makes a just-learned word generalizable and immediately productive. Precisely because one object property but not others is linked to the name, children will systematically extend the newly learned name to objects different from the exemplar (see also Barsalou, 1993). The results of Experiments 3 and 4 show just how important this selectivity is for generalizing a name to new instances. In these experiments, the stimuli offered a multitude of possibly relevant features to which the name might refer. Adults whose naming is perhaps more contemplative were reluctant to generalize the exemplar name to objects that were not identical to the exemplar. In contrast, young children's attentional systems, by whatever mechanism, latched on to one property and the children systematically generalized the just-heard novel noun to objects discriminably different from the exemplar. Highly selective non-thoughtful children may thus be better learners of object names than more thoughtful adults.

The potential power of dumb attentional processes in guiding word generalizations is also underscored by the children's highly organized judgments despite the unusual stimuli. Children had little knowledge of these stimuli, yet nonetheless were systematic in their naming. In many naturalistic name learning contexts, very young children may also have little relevant conceptual knowledge, yet our results suggest they would still have the wherewithal to systematically generalize a novel object name. Linking a new word to a property by non-thoughtful attentional processes will start the learning of a word in the right direction if adults tend to name objects for young children when the lexically relevant properties of those objects are most salient. Research on how parents name objects suggests that this is a reasonable assumption (Mervis et al., 1992).

13. Knowledge and naming

Do dumb attentional processes only organize the *start* of learning an object's name? As children learn more about a particular lexical category and the objects that are members of that category, are their generalizations increasingly controlled by conceptual knowledge and decreasingly controlled by appearance? It is likely that the answer to these questions is yes. The evidence from adults in the present experiments and other findings in the literature (see Landau, 1994; Keil, 1989, 1994 for reviews) suggest that in some contexts at least, older children's and adults' naming is strongly influenced by conceptual knowledge. There is recent evidence, however, that *young* children's naming is principally controlled by perceptual processes – even when the categories are well known.

The evidence derives from Imai et al.'s (Imai et al., 1994) study of how children extend a novel name among familiar objects. Imai et al. taught 3- and 5-year-old children nonsense words in "dinosaur talk" for pictures of well-known objects like a birthday cake. They then asked children whether the dinosaur term would also refer to a same shaped object – in this example, a wide-brimmed hat; to a taxonomically related object – a pie; or to a thematically related object – in this example, a birthday gift. Children in both age groups – who knew well what cakes, hats, gifts, and pies are – primarily chose the same shaped object. The shape bias in extending a new name for a familiar object was strongest – in fact, overwhelming – in the 3-year-olds.

In a second task, Imai et al. used the same stimuli but asked the children a different question. They asked 3- and 5-year-old children to indicate the test object that "goes with" the exemplar. In this task, children at both age levels consistently chose the thematically related object: in this example, they put the birthday gift with the birthday cake. These results are in many ways like the present ones. Children are asked two different questions, and they provide two different kinds of answers. And in Imai et al.'s (Imai et al., 1994) study, as in the present one, children's answers in the naming task are based on the objects' appearance. Thus, early naming may be tightly tied to appearance even for categories of objects about which a good deal is known.

The young children in the present study (and also those in Imai et al., 1994) are impressive in their flexible use of different kinds of information for different tasks. These findings fit suggestions by Barsalou (Barsalou, 1987; Barsalou, 1993; see also Jones and Smith, 1993) that some kinds of categorizations may not derive from stably represented concepts, but rather from loosely related bits of knowledge that are pulled together on line. In these terms, the 3-year-old children in the present study created different on-line solutions to the tasks of naming, similarity judgment, and actions on the objects.

The idea that different kinds of categories are created on-line to fit specific tasks helps reconcile a number of contrasting findings (and resulting debates) in the literature. There is much evidence to suggest that young children are highly attentive to and knowledgeable about functions and actions (e.g., Baldwin et al., 1993; Brown, 1990; Cohen and Oakes, 1993). And thus some have suggested that children's concepts, and their basis for naming things, originates in function (Nelson, 1973). There is also considerable evidence to suggest that young children know that objects with different surface appearances may be essentially the same thing and share deep similarities: and there is evidence to suggest that, at least in some contexts, naming takes children away from appearances to expectations of deeper similarities (Gelman and Markman, 1986; Gelman and Markman, 1987). However, there is also considerable evidence – including the evidence here – that young children generalize object names by appearance. The importance of Barsalou's suggestion is that early generalizations of object names may be principally perceptual and controlled by automatic attentional processes even if other forms of categorization are not.

14. What develops

In the present study, the perceptual features children attended to when naming were uninfluenced by information about function. In contrast, adults used the functional information to select the lexically relevant properties (see also Landau et al., 1995). There are two possible accounts of this developmental difference. First, adults may simply have more conceptual knowledge that is pertinent to the naming of objects. After all, adults have many lexical items such as "democracy" or "justice" which cannot be based on what objects look like. Thus, naming in general for them may have become more conceptually laden. Second, adults may be using inferences about relevant properties to voluntarily override more automatic attentional pulls. Indeed, adults' attention when naming concrete objects may, like children's, be rapidly organized by dumb attentional processes. However, adults may routinely inhibit their first impulse while slower, more deliberative and analytic processes are brought into play. Resolution of these alternatives requires further empirical work.

15. Conclusion

We began this paper by contrasting two forces on feature selection. One is voluntary, strategic, deliberative, and based on inferences and conceptual knowledge. The other is more rudimentary, controlled by well-learned associations and stimulus salience. Both kinds of processes probably play important roles in human category learning. However, the present results suggest that for young children hearing an object named for the first time, feature selection is accomplished by the simpler attentional processes. This proposal may help explain the extraordinary language learning abilities of young children with very limited conceptual knowledge.

Fodor (1987) argued that "dumb", "informationally encapsulated" cognitive processes were needed to solve Hamlet's problem of "how to tell when to stop thinking" (p. 26). He argued that in those cases in which certainty of outcome was crucial, it was better to have a device that operated on only some of the information and in prescribed ways. Young children in their initial interpretations of novel words may be guided by just such a device. The processes that constitute that device may not be encapsulated by Fodor's strict criteria; but the present findings suggest that they may be dumb and, thereby, certain. Given that an adult is attending to a concrete object and producing a novel name, children may interpret the novel name as referring to "whatever it is about the object that most demands attention." An attentional device that produces this result may work well enough to *start* a child's learning of a specific object name.

Acknowledgments

We thank Salma Abugidieri for the invention of the stimuli and the collection of the data. We also thank Janis Jones for illustrating the stimuli. We are grateful to the children, parents and staff at the Cherry Hill Nursery School, Penny Lane Day Care, and Bloomington Developmental Learning Center for their participation. This research was supported by NICHD (PHS R01 HD28675).

References

Akhtar, N., Carpenter, M., & Tomasello, M. (in press). The role of discourse novelty in early word learning. *Child Development*.

Alibali, M.W., & Goldin-Meadow, S. (1993). Gesture–speech mismatch and mechanisms of learning: What the hands reveal about a child's state of mind. *Cognitive Psychology, 25*, 468–520.

Aslin, R.N., & Smith, L.B. (1988). Perceptual development. *Annual Review of Psychology, 39,* 435–474.

Baldwin, D. (1991). Infants' contribution to the achievement of joint reference. *Child Development, 62,* 875–791.

Baldwin, D. (1993). Early referential understanding: Infants' ability to recognize referential acts for what they are. *Development Psychology, 29,* 832–844.

Baldwin, D.A., & Markman, E.M. (1989). Establishing word–object relations: A first step. *Child Development, 60,* 381–398.

Baldwin, D., Markman, E.M., & Melartin, R.L. (1993). Infants' ability to draw inferences about nonobvious object properties: Evidence from exploratory play. *Child Development, 64,* 711–729.

Barsalou, L. (1993). Flexibility, structure and linguistic vagary in concepts: Manifestations of a compositional system of perceptual symbols. In A.C. Collins, S.E. Gatherede, M.A. Conway & P.E.M. Morris, (Eds.), *Theories of memories* (pp. 29–101). Hillsdale, NJ: Erlbaum.

Barsalou, L.W. (1987). The instability of graded structure: Implications for the nature of concepts. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 101–140). New York: Cambridge University Press.

Brown, A.L. (1990). Domain-specific principles affect learning and transfer in children. *Cognitive Science, 14,* 107–133.

Clark, E.V. (1973). What's in a word: On the child's acquisition of semantics in his first language. In T.E. Moore (Ed.), *Cognitive development and the acquisition of language.* New York: Academic Press.

Cohen, L.B. and Oakes, L.M. (1993). How infants perceive a simple causal event. *Developmental Psychology, 29,* 421–444.

Fodor, J.A. (1987). Modules, frames, fridgeons, sleeping dogs, and the music of the spheres. In J.G. Garfield (Ed.), *Modularity in knowledge representation and natural language understanding* (pp. 25–36). Cambridge, MA: MIT Press.

Gelman, S., & Markman, E. (1986). Categories and induction in young children. *Cognition, 23,* 183–208.

Gelman, S.A., & Markman, E.M. (1987). Young children's inductions from natural kinds: The role of categories and appearances. *Child Development, 58,* 1532–1541.

Gelman, S.A., & Medin, D.L. (1993). What's so essential about essentialism? A different perspective on the interaction of perception, language, and concrete knowledge. *Cognitive Development, 8,* 113–139.

Gentner, D. (1978). A study of early word meaning using artificial objects: What looks like a jiggy but acts like a zimbo? *Papers and Reports on Child Language Development, 15,* 1–6.

Goldin-Meadow, S., Alibali, M.W. and Church, R.B. (1993). Transitions in concept acquisition: using the hand to read the mind. *Psychological Review, 100,* 279–298.

Imai, M., Gentner, D., & Uchida, N. (1994). Children's theories of word meaning: The role of shape similarity in early acquisition. *Cognitive Development, 9,* 45–76.

Jones, S.S., & Smith, L.B. (1993). The place of perceptions in children's concepts. *Cognitive Development, 8,* 113–140.

Jones, S., Smith, L., & Landau, B. (1991). Object properties and knowledge in early lexical learning. *Child Development, 62,* 499–516.

Keil, F.C. (1989). *Concepts, kinds, and cognitive development.* Cambridge, MA: Cambridge University Press.

Keil, F. (1994). Explanation, association, and the acquisition of word meaning. In L.R. Gleitman & B. Landau (Eds.), *Lexical acquisition.* Cambridge, MA: MIT Press.

Kemler Nelson, D.G. (1995). Principle-based inferences in young children's categorization: Revisiting the impact of function on the naming of artifacts. *Cognitive Development, 10,* 347–354.

Kruschke, J.K. (1992). ALCOVE: An exemplar-based connectionist model of category learning. *Psychological Review, 99,* 22–44.

Landau, B. (1994). Object shape, object name, and object kind: Representation and development. In D.L. Medin (Ed.), *The psychology of learning and motivation* (Vol. 31). San Diego, CA: Academic Press.

Landau, B., Leyton, M., Lynch, E., & Moore, C. (1994). Perception, object kind, and object naming. Unpublished manuscript.

Landau, B., Smith, L., & Jones, S. (1988). The importance of shape in early lexical learning. *Cognitive Development, 3*, 299–321.

Landau, B., Smith, L.B., & Jones, S.S. (1992). Syntactic context and the shape bias in children's and adult's lexical learning. *Journal of Memory and Language, 31*, 807–825.

Landau, B., Smith, L.B., & Jones, S. (1995). Object shape, object function, and object name. Unpublished manuscript.

Lewicki, P., Hill, T., & Sasak, I. (1989). Self-perpetuating development of encoding biases. *Journal of Experimental Psychology: General, 118*, 323–338.

MacIntosh, N.J. (1965). Selective attention in animal discrimination learning. *Psychological Bulletin, 64*, 125–150.

Markman, E.M. (1989). *Categorization and naming in children: Problems of induction*. Cambridge, MA: MIT Press.

Medin, D., & Ortony, A. (1989). Psychological essentialism. In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 179–195). New York: Cambridge University Press.

Merriman, W.E., Schuster, J.M., & Hager, L. (1991). Are names ever mapped onto preexisting categories? *Journal of Experimental Psychology: General, 120*, 288–300.

Mervis, C.B. (1987). Child-basic object categories and lexical development. In U. Neisser (Ed.), *Concepts and conceptual development: Ecological and intellectual factors in categorization*. Cambridge, UK: Cambridge University Press.

Mervis, C.B., Mervis, C.A., Johnson, K.E., & Bertrand, J. (1992). Studying early lexical development: The value of the systematic diary method. In C. Rovee-Collier & L. Lippsitt (Eds.), *Advances in infancy research* (Vol. 7, pp. 291–379). Norwood, NJ: Ablex.

Nelson, K. (1973). Some evidence for the cognitive primacy of categorization and its functional basis. *Merrill-Palmer Quarterly, 19*, 21–39.

Rescorla, R.A., & Wagner, A.R. (1972). A theory of Pavlovian conditioning: Variations in the effectiveness of reinforcement and nonreinforcement. In A.H. Black and W.F. Prokasy (Eds.), *Classical conditioning* (Vol. II). New York: Appleton-Century-Crofts.

Roberts, K. (1994). Categorical responding in 15-month-olds: Influence of the noun-category bias and the co-variation between visual fixation and auditory input. *Cognitive Development, 10*, 21–41.

Roberts, K., & Jacob, M. (1991). Linguistic vs attentional influences on nonlinguistic categorization in 15-month-old infants. *Cognitive Development, 6*, 355–375.

Robertson, L.C., Egly, K., Lamb, M.R., & Kerth, L. (1993). Spatial attention and cuing to global and locals levels of hierarchical structure. *Journal of Experimental Psychology: Human Perception and Performance, 19*, 471–488.

Rosch, E., Mervis, C., Gray, E., Johnson, D., & Boyes-Braem, P. (1976). Basic objects in natural categories. *Cognitive Psychology, 8*, 382–439.

Smith, L.B. (1995). Self-organizing processes in learning to learn words: Development is not induction. In C. Nelson (Ed.), *Basic and applied perspectives on learning, cognition, and development*. Minnesota Symposium on Child Psychology (Vol. 28, pp.1-32). Mahwah, NJ: LEA.

Smith, L.B., Jones, S.S., & Landau, B. (1992). Count nouns, adjectives, and perceptual properties in children's novel word interpretations. *Developmental Psychology, 28*, 273–286.

Smith, L.B., & Samuelson, L. (in press). Perceiving and remembering: Category stability, variability, and development. In K. Lamberts & D. Shanks (Eds.), *Knowledge, concepts, and categories*. Cambridge, UK: Cambridge University Press.

Soja, N. (1992). Inferences about the meanings of nouns: The relationship between perception and syntax. *Cognitive Development, 7*, 29–46.

Soja, N., Carey, S., & Spelke, E. (1991). Ontological categories guide young children's inductions of word meanings: Object terms and substance terms. *Cognition, 38*, 179–211.

Tomikawa, S.A., & Dodd, D.H. (1980). Early word meanings: Perceptually or functionally based? *Child Development, 51*, 1103–1109.

Tversky, B. (1989). Parts, partonomies, and taxonomies. *Developmental Psychology, 25*, 983–995.

Younger, B. (1990). Infants' detection of correlations among feature categories. *Child Development, 61*, 614–621.