Developmental Psychology
1997, Vol. 33, No. 6, 1074–1090

0012-1649/97/$3.00

Setters and Samoyeds: The Emergence of Subordinate Level Categories as a Basis for Inductive Inference in Preschool-Age Children

Sandra R. Waxman, Elizabeth B. Lynch, K. Lyman Casey, and Leslie Baer
Northwestern University

Basic level categories are a rich source of inductive inference for children and adults. These 3 experiments examine how preschool-age children partition their inductively rich basic level categories to form subordinate level categories and whether these have inductive potential. Children were taught a novel property about an individual member of a familiar basic level category (e.g., a collie). Then, children's extensions of that property to other objects from the same subordinate (e.g., other collies), basic (e.g., other dogs), and superordinate (e.g., other animals) level categories were examined. The results suggest (a) that contrastive information promotes the emergence of subordinate categories as a basis of inductive inference and (b) that newly established subordinate categories can retain their inductive potential in subsequent reasoning over a week's time.

One of the most remarkable aspects of early cognitive development is children's capacity to form categories of objects and to use these categories as a basis for inductive inference. Although initial attempts at object categorization may rely heavily on perceptual commonalities among objects (Gentner & Waxman, 1994; Waxman & Markow, 1995), children and adults hold strong expectations that members of object categories also share deep, underlying commonalities that go beyond those available from perceptual inspection (Atran, 1990; Gelman, Coley, & Gottfried, 1994; Gelman & Medin, 1993; Gelman & Wellman, 1991; Medin, 1989; Medin & Ortony, 1989; Murphy & Medin, 1985; Shipley, 1993). These expectations are directly related to inductive power. Once a deep, nonperceptual property is projected onto a given individual, this property is typically extended to other members of that object category. For example, if we discover that one paramecium has a digestive tract, we infer that this property is true of all paramecia. This tendency to project a newly discovered property of an individual object onto other members of its category is essential in extending the limits of knowledge beyond direct observation. It also promotes cognitive stability and coherence in the face of the diversity among objects (Rips, 1975; Smith & Medin, 1981).

There is now considerable evidence that preschool-age children share with adults the expectation that category members share deep resemblances and that categories serve as a basis for inductive inference. In an elegant series of studies, Gelman and her colleagues (Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Gelman & O'Reilly, 1988; Gelman, 1988) have demonstrated that preschool-age children use basic level categories as a guide in induction. For example, children as young as 2 years 6 months of age will project an enduring property from one object to another on the basis of category membership, even when category membership conflicts with perceptual appearance.

However, one limitation of virtually all research on the development of inductive inference is that it has focused on categories at the basic level. To the best of our knowledge, there are only two exceptions. In one, Shipley (1992) reported that preschool children are more likely to use basic level than subordinate level categories as the range of inductive inference. In the other, Gelman and O'Reilly (1988) reported that preschool children are more likely to use basic level than superordinate level categories as the range of inductive inference. These findings are consistent with claims regarding the developmental primacy of basic level categories (Mervis, 1987; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), and, with the position that although basic level categories may initially be perceptually based, they rapidly acquire conceptual power (see Gentner and Waxman, 1994; Shipley, 1993; Waxman, in press, for evidence that the conceptual power of the basic level derives, at least in part, from infants' and children's experience with objects and their names).

However, the conceptual power and inductive strength of familiar basic level categories present children with a potential challenge: How do children come to partition these rich and inductively powerful basic level categories into subordinate level categories that have inductive potential? This question serves as the focus of the three experiments reported here.

A review of recent literature suggested that two factors—the *type of information* and the *structure of the information*—are

Sandra R. Waxman, Elizabeth B. Lynch, K. Lyman Casey, and Leslie Baer, Department of Psychology, Northwestern University.

This research was supported by National Institutes of Health Grant HD28730. We are grateful to the children, parents, and teachers from the Baby–Toddler Nursery, Central Evanston Childcare, Child Care Center, Discovery Preschool, and the School for Little Children for participating in these studies and to Katherine Maggs for her assistance in data collection. We are indebted to Douglas Medin, Lance Rips, John Coley, Laura Namy, and Evan Heit for comments and discussion.

Correspondence concerning this article should be addressed to Sandra R. Waxman, Department of Psychology, Northwestern University, 2029 Sheridan Road, Evanston, Illinois 60208-2710. Electronic mail may be sent via Internet to s-waxman@nwu.edu.

likely to influence children's establishment of subordinate level categories as an inductive base. Consider first the type of information. Our willingness to extend a property (applied to one individual) to other individuals appears to depend on our knowledge about the property itself as well as our knowledge about the object category to which it has been applied (Coley, 1995; Goodman, 1955/1983; Heit & Rubinstein, 1994; Osherson, Lopez, Smith, & Wilkie, 1990; Rips, 1975; Shipley, 1993; Sloman, 1994). Two aspects of properties are especially relevant in this regard: property endurance and property generalizability. Some properties (e.g., *has an aorta*) are *enduring* characteristics of an individual that apply to that individual over time; other properties (e.g., *stubbed its toe*) are *transient* characteristics that are only temporarily applicable to that individual. In addition, some properties (e.g., *has an aorta*) are likely to be *generalizable* beyond one individual to other members of a kind; others (e.g., *stubbed its toe*) are unlikely to be generalizable. These property dimensions tend to be correlated for children as well as adults. For example, by 4 years of age, children are more likely to generalize an enduring property (e.g., *has a spleen inside*) than a transient state (e.g., *is dirty; is having a bath*) to other members of a familiar object category (Gelman, 1988; Gelman & Coley, 1990; see the control studies in Experiment 2 for additional empirical support for these claims).

Thus, our expectations about the generalizability and endurance of a given property will guide our judgments in induction tasks. However, these findings do not speak directly to the issue of the contribution of these property dimensions when a child is faced with the task of establishing *new* conceptual distinctions. In the experiments reported here, we examined the contribution of generalizable, enduring properties as compared with nongeneralizable, transient properties in children's establishment of new subordinate level categories within a known basic level category. We suspected that the projection of generalizable, enduring properties would convey to the children that the perceptual distinctions evident among the subordinate kinds corresponded to deep, enduring conceptual distinctions. We suspected that nongeneralizable, transient properties would not invoke the expectation of underlying conceptual distinctions to the same extent.

Consider next the structure in which information can be presented. Several independent programs of research have suggested that contrastive information plays a crucial role in category formation (Callanan, 1990; Gelman, 1988; Macario, Shipley, & Billman, 1990; Shipley & Kuhn, 1983; Waxman, Shipley, & Shepperson, 1991). For example, providing preschoolers with contrastive information about distinct subordinate level categories (e.g., that collies help shepherds take care of sheep but that setters help hunters find birds) facilitates subsequent classification at the subordinate level (Waxman et al., 1991). Similarly, contrastive information appears to permit children to infer which types of properties characterize a class of objects at a given hierarchical level (Shipley, 1993; Shipley & Kuhn, 1983). Finally, Callanan (Callanan, 1990; Callanan & Oakes, 1992) has demonstrated that parents spontaneously introduce contrastive information when teaching their preschool-age children about new object categories.

In the current series of experiments, these findings are taken one step further to examine the role of contrastive information in preschoolers' establishment of subordinate level categories as an inductive base. Contrastive information was predicted to be more effective than noncontrastive information in this endeavor.

To test these predictions, in each of three experiments, preschool-age children were taught a novel generalizable property (e.g., helps us find sheep) about an individual target object (e.g., a collie), and then the range of objects to which children extended that property was examined. In Experiment 1, we establish that for the stimuli used in this series of experiments, the basic level (e.g., dog), and not the subordinate level (e.g., collie), serves as the natural range of inductive inference for preschoolers. In Experiment 2, we ask how children begin to partition these psychologically rich basic level categories and whether newly emerging subordinate level categories hold any unique inductive potential. Of particular interest was the assessment of the kinds of training that would promote the establishment of subordinate (as opposed to basic) level categories as a basis for induction. The contributions of the type of information (generalizable, enduring vs. nongeneralizable, transient) and the structure of information (contrastive vs. noncontrastive) in the emergence of the subordinate level as an inductive base were examined. In Experiment 3, this line of research was pursued to examine (a) the status of the newly emerging subordinate level categories in reasoning about additional properties and (b) the longevity of children's use of the subordinate level as an inductive base.

In sum, the current experiments were designed to advance the existing developmental research on categorization and induction in three ways. First, previous developmental work on induction has focused almost exclusively on the inductive power of familiar basic level categories (but see Gelman & O'Reilly, 1988; Shipley, 1992). This series of experiments represents the first systematic examination of the emergence of subordinate level categories as an inductive base. Second, although previous developmental work has identified some circumstances under which children succeed in classifying objects into subordinate level categories (Callanan, 1985, 1990; Johnson & Mervis, 1994; Mervis, Johnson, & Mervis, 1994; Waxman et al., 1991), those studies did not address whether these categories had any inductive potential. We therefore ask whether newly formed subordinate level categories function merely as perceptually based groupings or whether they have the conceptual status to serve as a basis for children's inductive inferences. Finally, this paradigm permits us to ascertain whether these newly established subordinate level categories are sufficiently stable to support subsequent reasoning about additional properties at a later point in time.

EXPERIMENT 1

The goal of the first experiment is to gauge the strength of children's inductive inferences to categories of familiar objects at various hierarchical levels.

Method

Participants

Twelve children (5 boys and 7 girls) from Chicago suburban area preschools participated. The mean age of the children was 3 years 10

Table 1
Experiments 1 and 2: Complete List of Stimuli

	Training phase (Experiment 2 only)		Test phase (Experiments 1 & 2)				
Stimulus set	Information	Practice	Target	Subordinate	Basic	Superordinate	Inanimate
Dog	2 setters vs. 2 samoyeds	1 setter vs. 1 samoyed	1 collie	2 collies	Setter, samoyed, coonhound, pug, Welsh terrier	Caribou, condor	Sneaker
Butterfly	2 whites vs. 2 blues	1 white vs. 1 blue	1 fritillary	2 fritillaries	White, blue, monarch, *Heliconias huebneri*, *Kallima inachis*	Beetle, ferret	Teacup
Fish	2 triggerfish vs. 2 goatfish	1 triggerfish vs. 1 goatfish	1 parrotfish	2 parrotfish	Triggerfish, goatfish, pennantfish, turkeyfish, mackerel	Lobster, armadillo	Sunglasses

months, ranging from 3 years 6 months to 4 years 2 months. Two children who extended the target fact from an animate target object to an inanimate test object in all three stimulus sets were replaced (see below).

Stimuli

Thirty-three color photographs of individual objects were selected from nature magazines and books. Three sets of 11 cards each were created (see Table 1 for a complete list of stimuli). Each set featured a familiar basic level category: dogs, butterflies, or fish. Each set consisted of 1 target card (e.g., a collie) and 10 test cards that varied in their relation to the target: Two depicted members of the same subordinate level kind (e.g., 2 other collies), 5 depicted members of the same basic level kind (e.g., a setter, a samoyed, a coonhound, a pug, and a Welsh terrier), 2 depicted members of the same superordinate level kind (e.g., a caribou and a condor), and 1 depicted an unrelated, inanimate object (e.g., a sneaker). The inanimate test card was included to provide an index of the child's attention to the induction task. The photographs in each set varied in image size, orientation, body position, and background. In addition, 2 cards with line drawings (1 depicting a square, the other a circle) were used in the warm-up exercise (see below).

Procedure

Children were tested individually in a quiet room of their preschool, seated at a table across from the experimenter. The session began with a warm-up exercise that was immediately followed by the induction task.

Warm-Up Exercise

The purpose of this exercise was to provide children with an opportunity to answer the experimenter's questions aloud and to reinforce that "yes" and "no" were both acceptable answers to the questions that she would pose. The experimenter explained that she would show the child some cards and would ask some questions about them. She explained that the answer could be either "yes" or "no." She explained further that whenever the child was unsure, the child should "take their best guess." The experimenter then revealed a line drawing of a circle and asked, "Is this a circle?" She then showed a line drawing of a square and asked, "Is this a circle?" All children answered both questions correctly and were praised for answering "yes" and "no."

Induction Test

The experimenter initiated the induction test by placing the target object (e.g., the collie) directly in front of the child. She drew the child's attention to the card and then described an enduring characteristic of the individual object that was not observable from direct inspection (e.g., "This one helps us take care of sheep."). She then placed each test card beside the target, one at a time, in a random order, and asked the child whether this "target" property would apply to each of the test objects (e.g., "Do you think this one [the test object] helps us take care of sheep like this one [the target]?"). Once the child responded, that test card was removed and another presented. The target card remained on the table throughout the test phase for each set. Each child completed this induction procedure for all three stimulus sets (dogs, butterflies, and fish) and received stickers after completing each set. The order of presentation of the three sets was counterbalanced. The entire session lasted approximately 15 min.

Scoring

Each child's response to each test card was recorded. If the child judged that the target property could be extended to a test card, that trial was scored as 1; if the child judged that the target property could not be extended to a test card, that trial was scored as 0. The proportion of "yes" responses to each card served as the dependent measure.

Results and Discussion

Children participated readily and were attentive to the task. Figure 1 depicts the mean pattern of responses at each hierarchical level. Children extended the target property to the other members of the same subordinate level category at a rate of 94%, indicating that they understood that the target property could be extended to other objects beyond the one on which it had been taught. Nonetheless, they did not extend the target property indiscriminately; they extended it to the inanimate object at a rate of only 3%. (Recall that 2 children who extended the target property to the inanimate objects consistently on all three stimulus sets were replaced.) These indexes suggest that children were generally focused throughout the procedure and comprehended the task.

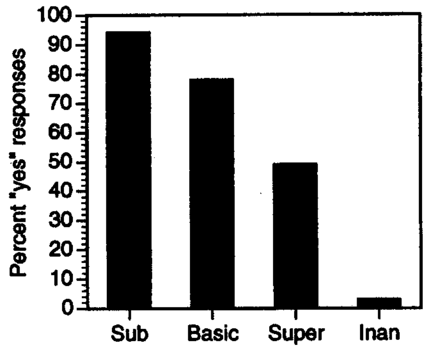

Figure 1. Mean percentage "yes" responses as a function of hierarchical level in Experiment 1. Sub = subordinate; Super = superordinate; Inan = inanimate.

To determine which categories served as preschoolers' basis of inductive inference, we conducted a two-way analysis of variance (ANOVA), with stimulus set (dog, butterfly, fish) and hierarchical level (subordinate, basic, superordinate, inanimate) as within-subjects variables. Children's willingness to extend the target property to the test objects served as the dependent measure. A main effect for hierarchical level, $F(3, 33) = 39.76$, $p < .0001$, is depicted in Figure 1. Children were equally likely to extend the target property to members of the same subordinate ($M = .94$) and basic ($M = .78$) level categories (Tukey's honestly significant difference, HSD, $p > .05$). All other differences among levels were significant (Tukey's HSD, all $ps < .05$). This suggests that for the objects included in this experiment, the basic level serves as the predominant basis for preschool children's inductive inferences. There were no other main effects or interactions.

Children's individual patterns of response on each set were also examined. Three primary response patterns were established, as can be seen in Table 2. In a "subordinate level pattern," the target property would be extended only to the members of the same subordinate level kind (e.g., from the target collie to the two test collies). In a "basic level pattern," the target property would be extended only to the members of the same basic level kind (e.g., from the target collie to the seven test dogs, including the two test collies). In a "superordinate level pattern," the target property would be extended only to the members of the same superordinate level kind (e.g., from the target collie to the nine test animals, including the dogs). In assigning trials to these patterns, we allowed for one error (either an error of commission or omission). For example, a trial would be counted as a "basic level" pattern if the target property was extended (a) to all seven test dogs and to no other (this constitutes the perfect basic level pattern), (b) to only six of the test dogs and to no other (this constitutes a basic level pattern with one error of omission), or (c) to all seven test dogs and to one other test card (this constitutes a basic level pattern with one error of commission).

An examination of Table 2, which shows the proportion of trials falling into each of these response patterns, reveals that 80% of all trials were captured by these three patterns. The predominant pattern of inductive inferences in this task was the basic level pattern; the incidence of the subordinate level response pattern was quite rare.

Thus, the analyses based on group means and individual response patterns converge to reveal that when preschool-age children are presented with a single property about an individual object, their predominant tendency is to extend that property to other objects in the same basic level category. For the preschool-age child, the basic level—and not the subordinate level—most often serves as the basis for inductive inferences for the categories of objects and properties presented here. This result, which provides strong evidence for the import of the basic level in reasoning, is consistent with other evidence demonstrating the inductive power of categories at this mid-level of abstraction in hierarchical systems of organization (Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Shipley, 1992). It is also consistent with the claim that most preschool-age children do

Table 2
Experiments 1 and 2: Individual Analyses

	Experiment 1	Experiment 2			
	Condition	Condition/information type			
Pattern	No training	Contrast/ generaliz.	Contrast/ nongeneraliz.	No contrast/ generaliz.	No contrast/ nongeneraliz.
Subordinate (+ − − −)	.11	.64	.55	.11	.17
Basic (+ + − −)	.39	.03	.11	.19	.39
Superordinate (+ + + −)	.30	.00	.02	.36	.08
Other	.20	.34	.32	.34	.36

Note. Plus and minus denote whether the child extended the target property to the test objects at the subordinate, basic, superordinate, or inanimate level. Generaliz. = generalizability; nongeneraliz. = nongeneralizability.

not yet have clearly established subordinate level categories (e.g., kinds of dogs, kinds of butterflies, or kinds of fish) that can serve as the basis for inductive inferences (Callanan, 1985; Waxman, 1990; Waxman et al., 1991).

In the next experiment, we ask how preschool-age children begin to partition these inductively rich basic level categories to establish subordinate level categories and how these newly established categories gain unique inductive potential.

EXPERIMENT 2

The goal of Experiment 2 was to explore the relative contributions of two factors—the type of information (generalizable, enduring vs. nongeneralizable, transient properties) and the structure of information (contrastive vs. noncontrastive presentation)—on children's establishment of subordinate level categories as an inductive base.

To examine these factors, we added a training phase during which the experimenter provided information regarding two distinct subordinate level categories of a given basic level kind (e.g., setters and samoyeds). In the training phase, we varied both the type of information (providing either generalizable, enduring properties or nongeneralizable, transient properties about each of the subordinate level categories introduced during training) and the structure of the information (presenting either contrastive or noncontrastive information about the two subordinate level categories). A test phase, which was identical to that used in Experiment 1, followed the training phase; the test phase was the same for all children, regardless of condition. As in Experiment 1, the experimenter presented a single instance of a new subordinate level category (e.g., a collie) and an associated target property. Children's extension of the target property to the test objects to ascertain how the pretest training influenced performance on the induction task was then examined.

The predictions were as follows: Regarding the structure of information, it was predicted that children hearing contrastive information at training would be more likely to restrict their extensions of the target property to the subordinate level than would children hearing noncontrastive information at training (Callanan, 1990; Macario et al., 1990; Shipley, 1993; Shipley & Kuhn, 1983). As for the type of information, it was expected that children presented with generalizable, enduring properties about the subordinate level categories during training would be more likely to establish subordinate level categories as an inductive base than would children hearing nongeneralizable, transient properties (Gelman, 1988; Waxman et al., 1991). We therefore predicted that children hearing generalizable, enduring properties at training would be more likely to restrict their extensions of the target property to the subordinate level but that those hearing nongeneralizable, transient properties at training would extend the target property to all members of the basic level (like the children in Experiment 1). We suspected that the generalizable, enduring properties would convey to the children that the perceptual distinctions among the subordinate kinds corresponded to enduring conceptual distinctions but that the nongeneralizable, transient properties would not invoke this expectation of underlying conceptual distinctions to the same extent.

Method

Participants

Forty-eight children (23 boys and 25 girls) from Chicago suburban area preschools participated. The mean age of the children was 3 years 8 months, ranging from 3 years 2 months to 4 years 4 months. The children were randomly assigned to one of four conditions (described below). There were no age differences across conditions. Three children who consistently extended the target property from an animate target object to an inanimate test object in all three sets were replaced (see below).

Stimuli

In addition to the stimuli used in Experiment 1, six additional cards for each set were introduced during the training phase (see Table 1 for a complete list of stimuli). These additional cards depicted three members each of two subordinate level categories (e.g., three setters and three samoyeds, from the dog set). Thus, each set included 17 cards: 1 target card, 6 information and training cards, and 10 testing cards.

Procedure

Children were tested individually in a quiet area of their preschool. The session began with a warm-up exercise, followed by a training phase and an induction test phase. The warm-up exercise and the induction test phase were identical to those in Experiment 1.

Warm-Up Exercise

This was identical to the warm-up phase in Experiment 1.

Training Phase

The training phase consisted of two parts: providing information about two subordinate level kinds from each basic level set and providing two practice trials to permit the children to extend this information to a new exemplar from each of these subordinate kinds (see below).

Information. For each stimulus set (e.g., dog), the experimenter began the training phase by presenting two exemplars of one subordinate level category (e.g., two samoyeds). She labeled these with a novel noun and then presented information about that subordinate level category (see below). Next, she placed two exemplars of a second subordinate level category (e.g., two setters) approximately 18 in. away from the first, labeled them with a different novel noun, and presented information about that subordinate level category. The information presented during training varied as a function of the participants' assignment to condition (see below).

Type of information. Children were randomly assigned to one of two conditions. Children in the Generalizable condition heard generalizable, enduring properties projected onto subordinate level categories during training. For example, the experimenter pointed to the pair of samoyeds, saying, for example, "See these? We call this kind Noocs. They help us pull sleds." Children in the Nongeneralizable condition heard nongeneralizable, transient properties projected onto subordinate level categories during training. For example, the experimenter pointed to the pair of samoyeds, saying, for example, "See these? We call this kind Noocs. They just took a bubble bath." (see Table 3 for a complete description of the properties presented in each condition.) None of the properties was observable from direct inspection of the stimuli themselves.

Structure of information. Within each type of information condition (Generalizable vs. Nongeneralizable), the structure in which the information was presented was varied. Half of the children in each condition were randomly assigned to the Contrast condition; the others were assigned to the No Contrast condition.

For children in the Contrast condition, contrast between the two subordinate level categories was established in two distinct ways. First, the properties themselves (whether they were generalizable or nongeneralizable) incorporated contrastive values along a single dimension. The dimension (e.g., how kinds of dogs help people) was never mentioned explicitly. Second, the experimenter explicitly stated that the properties that had been applied to one subordinate level kind (e.g., samoyeds) could not be extended to the other (e.g., setters). For example, in the Contrast/Generalizable condition, the experimenter said, "See these? We call this kind Tesses. They help us find birds. They don't help us pull sleds like the Noocs. No! They help us find birds." In the Contrast/Nongeneralizable condition, she said, "See these? We call this kind Tesses. They just helped their neighbor cross a busy street. They didn't help their owner by bringing him his slippers like the Noocs. No! They helped their neighbor cross a busy street."

For children in the No Contrast condition, the properties for the two subordinate level categories (whether they were generalizable or nongeneralizable) did not contrast along a single dimension. As a consequence, the properties were not, in principle, specific to the particular subordinate level categories. For example, in the No Contrast/Generalizable condition, the experimenter said, "See these? We call this kind Tesses. They have two kinds of muscle. See these? We call this kind Noocs. They can have five babies at a time." In the No Contrast/Nongeneralizable condition, the experimenter said, for example, "See these? We call this kind Tesses. They have awful colds. See these? We call this kind Noocs. They just took a bubble bath."

Practice. After the children were provided with the properties for the two subordinate level categories for each set, they were given practice extending these properties to another member of each subordinate level category. This part of the training phase was the same for all children, regardless of the condition to which they had been assigned. The goals of the practice trials were (a) to reinforce children's attention to the properties offered and (b) to encourage children to extend the properties to other members of the same subordinate level kind.

In this part of the training phase, children were shown a new, third exemplar from each of the two subordinate level kinds already displayed on the table. These were presented one at a time, in random order. The experimenter held the new card over each existing pair of cards and asked, for example, "See this one [the new samoyed]? Do you think this one goes over here with the Noocs [holding card over the samoyeds] or over here with the Tesses [holding card over the setters]?" The experimenter helped the child to place the practice card correctly and reinforced this placement by remarking, "That's right. It goes here with the Noocs because they're all the same kind." Next, the experimenter asked the child to extend the property previously presented about the original two cards to the new card, saying, for example, "So, do you think this one [the new samoyed] helps us pull sleds like the other Noocs [pointing to the original two samoyeds]?" The experimenter helped guide the children to the correct response by nodding in agreement and then responding, "Sure, because they are all the same kind." The practice trial was then carried out for the remaining subordinate level category (e.g., the setters). Immediately after the practice trials, the testing phase began.

Test Phase

The test phase was identical for all children. With the training sets in full view, the experimenter revealed a new individual from a different subordinate level category (e.g., a collie). This served as the target object. The experimenter applied a new property to the target object, saying, for example, "See this one? Here's a different one. This one helps us take care of sheep." For all children, the target object was described with a generalizable, enduring property. (Note that the contrast between the target property and the training properties varied as a function of experimental condition. For children in the Contrast conditions, the target property represented a new value along the dimension introduced implicitly during training, e.g., how kinds of dogs help people. For children in the No Contrast conditions, the target property was from a different dimension than those introduced during training.) The experimenter then removed all cards used during training, leaving only the target object before the child. As in Experiment 1, the children were then asked whether the target property could be extended to each test card, saying, for example, "Do you think this one [pointing to test object] helps us take care of sheep like that one [pointing to target object]?"

The order of presentation of the three sets (dogs, butterflies, and fish) was counterbalanced within each condition. The presentation of test cards within a set was randomized. The entire session lasted approximately 20 min. Children received stickers after completing the induction task for each set. As in Experiment 1, each child's response to each test card was recorded.

Results

Figure 2 depicts the mean patterns of inference as a function of hierarchical level in each condition. A preliminary examination of children's inductive inferences revealed that they were attentive to the task. They extended the target property to the test cards depicting members of the same subordinate level category at a rate of 85%, indicating that they understood that this property could be extended to other objects. However, their extensions were not indiscriminate; they extended the target property to the inanimate object in only 5% of all cases. (Recall that the three children who extended the property to the inanimate object consistently on all three stimulus sets were replaced.)

To determine which categories served as the basis of the children's inductive inferences, a four-way ANOVA was conducted, with type of information (generalizable vs. nongeneralizable) and structure of information (contrast vs. no contrast) as between-subjects variables and stimulus set (dog, butterfly, and fish) and hierarchical level (subordinate, basic, superordinate, and inanimate) as within-subjects variables.

There was a main effect of hierarchical level, $F(3, 132) = 178.21$, $p < .0001$. Post hoc comparisons revealed that children's tendency to extend the target property differed significantly at all hierarchical levels (Tukey's HSD, all $ps < .01$). There was also a main effect of structure of information, $F(1, 44) = 21.90$, $p < .0001$. As predicted, children in the Contrast conditions ($M = .28$) were more likely to restrict their extensions of the target property than were children in the No Contrast conditions ($M = .50$). There was no main effect of type of information.

Both of the main effects described above were qualified by a series of interactions. The interaction between structure of information and hierarchical level, $F(3, 132) = 8.77, p = .0001$, is depicted in Figure 2. An analysis of simple effects revealed that children in the Contrast condition were less likely than those in the No Contrast condition to extend the target property to test objects at the basic, $F(1, 129) = 40.66$, $p < .0001$, and the superordinate, $F(1, 129) = 17.05$, $p < .0001$, levels. Chil-

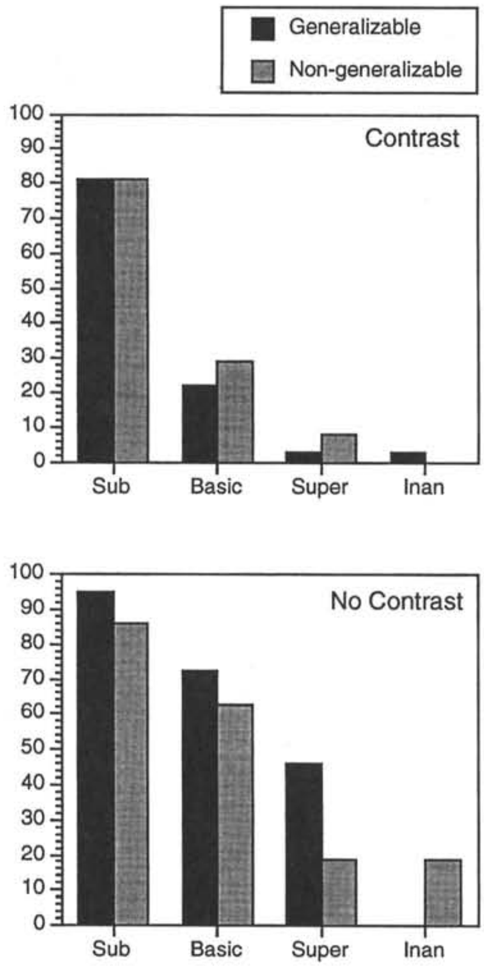

Figure 2. Mean percentage "yes" responses as a function of hierarchical level, type of information, and structure of information in Experiment 2. Sub = subordinate; Super = superordinate; Inan = inanimate.

dren in the No Contrast conditions, like their age-mates in Experiment 1, tended to extend the target property to other members of the basic and superordinate levels. However, in the Contrast condition, this tendency to extend the target property beyond the subordinate level was suppressed. This is consistent with the prediction that contrastive information would facilitate the establishment of the subordinate level as an inductive base.

This interaction was itself qualified by a three-way interaction: Structure of Information × Hierarchical Level × Type of Information, $F(3, 132) = 4.64$, $p < .005$. As is evident in Figure 2, within the Contrast conditions, there were no significant differences between children in the Generalizable and the Nongeneralizable conditions at any hierarchical level. This indicates that when properties (either generalizable or nongeneralizable) are presented in a contrastive fashion during training, the subordinate level can emerge as an inductive base. However, in the No Contrast condition, the subordinate level did not emerge as an inductive base for children in either the Generalizable or Nongeneralizable conditions. The interaction appears to derive from a crossover effect involving the superordinate and inanimate trials in the No Contrast condition: Children in the Generalizable condition were more likely than those in the Nongeneralizable condition to extend the target property to the superordinate level, $t(1, 35) = 2.73$, $p < .01$; conversely, children in the Nongeneralizable condition were more likely than those in the Generalizable condition to extend the target property to inanimate objects, $t(35) = 2.91$, $p < .01$. These differences are quite small in magnitude. There were no significant differences in extension of the target property on either subordinate or basic level trials.

There was also a main effect of stimulus set, $F(2, 88) = 4.90$, $p < .01$. Children were less likely to extend the target property in the fish set ($M = .35$) than in the dog set ($M = .41$) or in the butterfly set ($M = .42$) (Tukey's HSD, $p < .05$). There was no difference in performance on the latter two sets (Tukey's HSD, $p > .05$). The main effect of set was qualified by a series of interactions: Stimulus Set × Hierarchical Level, $F(6, 264) = 10.70$, $p < .00001$; Stimulus Set × Type of Information × Structure of Information, $F(2, 88) = 4.02$, $p < .05$; Stimulus Set × Hierarchical Level × Structure of Information, $F(6, 264) = 3.38$, $p < .005$; Stimulus Set × Hierarchical Level × Structure of Information × Type of Information, $F(6, 264) = 2.68$, $p < .02$.

We suspect that these effects involving stimulus set reflect an unintentional oversight in our selection of training information for the fish set in particular. For this set, the information offered involved the type of teeth characteristic of each subordinate level category of fish (see Table 3). Care was taken to select photographs in which evidence of this property (like the dogs' ways of helping people and the butterflies' diet) was not visible on inspection of the stimuli. This precaution was taken to ensure that children would base their responses in the test phase on inductive inferences rather than on physical evidence. However, children's spontaneous comments suggested that this goal was not accomplished in the fish set. For example, many children searched the fish cards for evidence of the teeth; others asked the experimenter to show them the teeth; still others attempted to correct the experimenter when she presented the target property, commenting that the fish had no teeth. Because children were searching for (nonexistent) physical evidence on this set, they made fewer inductive inferences for this set than for the others, and this set effect interacted with every one of our other variables.[1] Although the target property (has teeth that are all stuck together) was identical to the one used in Experiment 1, this effect for stimulus set did not emerge until Experiment 2. This suggests that the properties presented during the training phase, rather than the target property itself, motivated children to search for teeth during induction.

In a supplementary analysis, we focused specifically on children's tendency to use the subordinate level as an inductive base. For each child, the number of extensions to the subordinate

[1] To confirm that these set effects were carried by the fish set, an additional four-way ANOVA, excluding data from the fish set, was conducted. This analysis revealed the same main effects and interactions as reported in the complete ANOVA, with the exception of the interactions involving set.

Table 3
Experiment 2: Structure of Information (Contrast vs. No Contrast) and Type of Information (Generalizable vs. Nongeneralizable)

Condition and information type	Training phase: Object and property	Training phase: Object and property	Test phase: Object and property
	Stimulus set: dog		
Contrast	Setters	Samoyeds	A collie
Generalizable	—help us find birds.	—help us pull sleds.	—helps us take care of sheep.
Nongeneralizable	—helped their neighbor cross a busy street.	—helped their owner by bringing him his slippers.	—helps us take care of sheep.
No Contrast			
Generalizable	—have two kinds of muscles	—can have five babies at one time.	—helps us take care of sheep.
Nongeneralizable	—have awful colds.	—just took a bubble bath.	—helps us take care of sheep.
	Stimulus set: butterfly		
Contrast	Whites	Blues	A fritillary
Generalizable	—eat mustard plants.	—eat fruits.	—eats violet flowers.
Nongeneralizable	—had strawberries for a snack.	—had corn for dinner last night.	—eats violet flowers.
No Contrast			
Generalizable	—lay eggs shaped like pears.	—sleep standing up.	—eats violet flowers.
Nongeneralizable	—had many friends.	—flew over a rainbow today.	—eats violet flowers.
	Stimulus set: fish		
Contrast	Triggerfish	Goatfish	A parrotfish
Generalizable	—have strong, sharp teeth.	—have small teeth on the tops of their mouths.	—has teeth that are all stuck together.
Nongeneralizable	—lost a tooth yesterday.	—got new grown up teeth.	—has teeth that are all stuck together.
No Contrast			
Generalizable	—like to dig holes in the sand.	—have clear eyelids.	—has teeth that are all stuck together.
Nongeneralizable	—swam for many, many miles this morning.	—are thinking about their lunch.	—has teeth that are all stuck together.

level test objects was computed, and this was divided by the total number of extensions to all test objects. A two-way ANOVA, with structure of information (contrast vs. no contrast) and type of information (generalizable vs. nongeneralizable) as between-subjects variables, revealed a main effect for structure of information, $F(1, 44) = 20.532$, $p < .0001$. Children in the Contrast conditions showed a higher proportion of subordinate level responses ($M = .75$) than did children in the No Contrast conditions ($M = .51$). There were no other main effects or interactions.

Individual children's patterns of inference were also examined with the same criteria as established in Experiment 1. As can be seen in Table 2, in the Contrast conditions, the predominant pattern of response was the subordinate level pattern. In the No Contrast condition, the subordinate level pattern was rare. Instead, basic or superordinate level patterns were predominant.

Together, the analyses based on group means as well as those based on individual patterns indicate (a) that preschool-age children can successfully partition familiar basic level categories into distinct, subordinate level categories and (b) that these may have considerable inductive potential. Moreover, the structure in which the information was presented (contrast vs. no contrast) had greater impact than did the type of information provided (generalizable vs. nongeneralizable) on children's tendency to use the subordinate—as opposed to the basic—level as the basis for inductive inference.

Characterizing Further the Contribution of Contrastive Information

Our design permitted us to characterize further what children in the Contrast conditions had learned about the subordinate level categories during training. In each stimulus set, the cards presented during the test phase included members of each of the subordinate level categories previously introduced during the training phase (e.g., one setter, one samoyed) as well as three additional members of the familiar basic level category to which they had not been introduced during training (e.g., coonhound, pug, Welsh terrier). One possibility is that children in the Contrast conditions learned to single out the two subordinate level kinds under consideration (e.g., samoyeds and setters) from the existing basic level category (e.g., *dog*) but did not make any further subordinate level distinctions or modifications in their representation of the basic level category *dog*. This possibility is illustrated in Figure 3a. If this were the case, then children should be unwilling to extend the target property to members of the "old" subordinate level categories (those on which they had been trained, e.g., setters and samoyeds), but they should be willing to

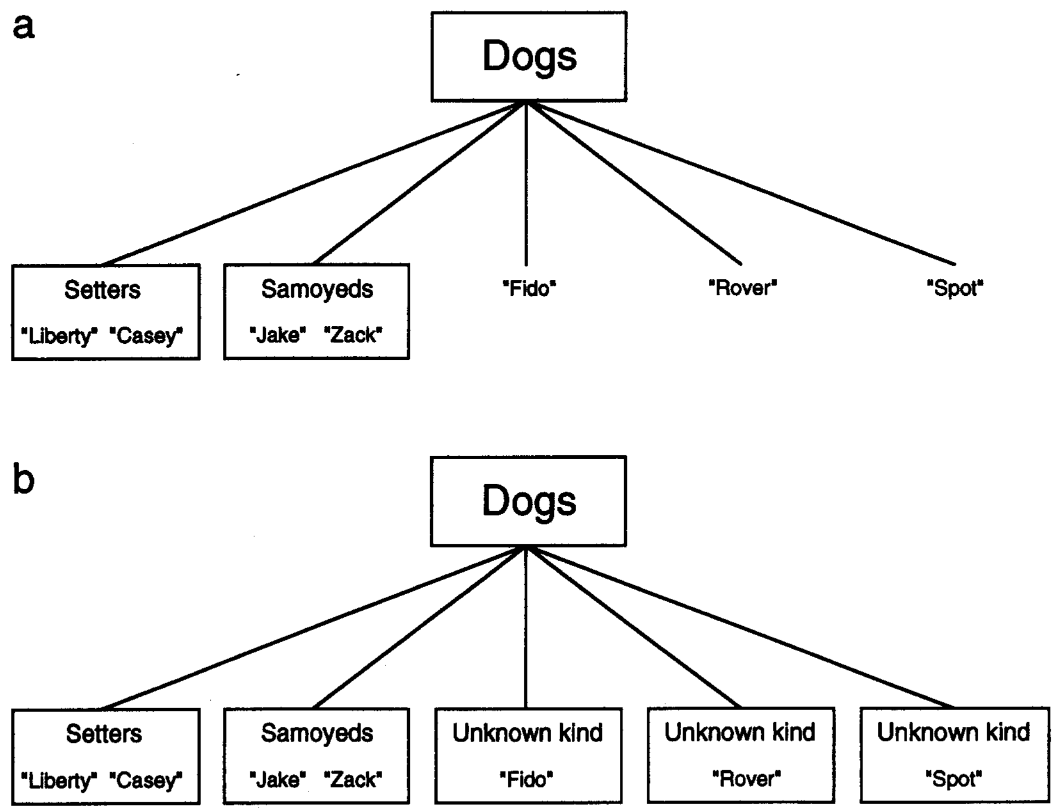

Figure 3. Two possible representations of the category *dog.*

extend the target property to each of the "new" members of the category *dog* (those on which they had not been trained, e.g., coonhound, pug, Welsh terrier).

Another possibility is that the contrastive information presented about the two distinct subordinate level kinds (e.g., samoyed and setter) was sufficient to lead children in the Contrast conditions to expect that the entire basic level category is itself partitioned into distinct subordinate level kinds (see Figure 3b). If this were the case, then children should be unwilling to extend the target property to any test cards other than those representing the same subordinate level category as the target. That is, their tendency to extend the target property to members of either "old" or "new" subordinate level categories should be low.

To explore these possibilities, we examined children's tendency to extend the target property to "old" subordinates (e.g., setters and samoyeds) and to "new" subordinates (e.g., pugs, Welsh terriers, and coonhounds). Children in the Contrast conditions were significantly less likely than their age-mates in the No Contrast conditions to extend the target property to members of either the "old" (Contrast, M = .31; No Contrast, M = .67) or the "new" (Contrast, M = .21; No Contrast, M = .68) subordinates (both $ps < .05$).[2] Performance in the Contrast conditions resembled the alternative depicted in Figure 3b. Children hearing contrastive information during training seemed to expect that the familiar and inductively rich basic level category (e.g., *dog*) is itself composed of distinct subordinate level kinds, some known (e.g., samoyeds and setters) and others as yet unknown (e.g., coonhounds). Perhaps the realization that a basic level category contains (at least) two distinct subordinate level kinds can trigger the realization that other members of the basic level category must be members of a subordinate level kind as well.

Issues Concerning the Type of Information

The absence of an effect for type of information was unexpected. Indeed, the design of Experiment 2 was predicated on the assumptions that (a) there is indeed a psychological distinction between generalizable, enduring versus nongeneralizable, transient properties and (b) this distinction would have observable consequences on the acquisition of new subordinate level categories. The properties for the Generalizable and Nongeneralizable conditions were selected on the basis of our intuitions and were drawn from a pool of properties used in previous induction

[2] The difference between extension to the "old" versus "new" subordinates in the Contrast conditions was not in the direction that was expected. However, the most relevant point for the present is that children in the Contrast conditions were unlikely to extend the target fact to either the old or the new subordinates. The rate of extension to both old and new subordinates was significantly lower than the rate expected by chance (both $ps < .005$).

research (see Table 4). But the surprising null effect for type of information motivated us to assess carefully the psychological distinction between the generalizable and nongeneralizable properties that we presented in Experiment 2.

We therefore conducted two independent control studies, each including 12 undergraduate students enrolled at Northwestern University. Participants were unaware of the purpose of the study. They were presented with written instructions and judgment ratings (described below).

The first control study focused specifically on the dimension of property generalizability. We explained that we were interested in learning what kinds of information can be generalized from an individual to an entire group. Participants were told that some pieces of information were very likely to be generalized but that others were very unlikely to be generalized. As an example, it was noted that if a particular *bear has an aorta,* then it would be safe to assume that this property is likely true of all (or most) members of its kind. We further explained that if a particular *bear just stubbed its toe,* then it would be safe to assume that this property is likely to be true only of that individual, but not true of all (or most) members of its kind. Participants were then presented with 46 different properties (including those listed in Tables 3 and 5), in random order. We embedded them in the following types of construction: "Suppose you are shown a particular dog and are told that it helps us find birds. Is this likely to be true of all (or most) members of its kind or true only of that individual?" Participants indicated their judgment on a scale of 1 (*not likely to be generalized beyond the individual*) to 6 (*likely to be generalized to other members of its kind*).

The second control study focused specifically on the dimension of property endurance. Participants were told that we were interested in learning what kinds of information can be assumed to be stable and enduring properties of an individual. We explained that some pieces of information are very likely to be enduring but that others are very unlikely to be so. As an example, it was noted that if a particular *bear has an aorta,* then it would be safe to assume that this is probably a stable, enduring property of that animal (that is, true of that animal over time). We further explained that if a particular *bear just stubbed its toe,* then it would be safe to assume that this is probably a transient property of that animal. Each participant was then presented with the same 46 properties described above, in random order and embedded in the following types of construction: "Suppose you are shown a particular *dog* and are told that it *helps us find birds.* Is this likely to be a stable, enduring characteristic of the individual, or a fleeting, transient characteristic?" Participants in this experiment indicated their judgment on a scale of 1 (*not likely to be enduring*) to 6 (*likely to be enduring*).

The results provided strong empirical validation of the psychological distinction between the generalizable, enduring versus nongeneralizable, transient properties. In the first control study, participants' judgments revealed that the properties presented in the Generalizable conditions were indeed more generalizable (M = 4.61) than those presented in the Nongeneralizable conditions (M = 1.46), paired $t(22) = 13.23$, $p < .0001$. In the second control study, participants' judgments revealed that the properties presented in the Generalizable condition were also more enduring (M = 4.07) than those presented in the Nongeneralizable condition (M = 2.96), paired $t(22) = 6.54$, $p < .001$. In addition, participants' judgments regarding property generalizability and property endurance were highly correlated (r = .46, p = .001). Although this outcome was based on adults' judgments, the results are consistent with previous research suggesting that preschool-age children also appreciate a distinction between generalizable, enduring and nongeneralizable, transient properties (cf. Gelman, 1988). These studies suggest that the null effect for type of information in Experiment 2 is unlikely to be due to the absence of a psychological distinction between the two types of properties presented.

This leaves open the question of why this psychological distinction had no demonstrable effect on the establishment of new subordinate level categories in Experiment 2. One potential explanation for the null effect of type of information is related to our procedure. During training, both types of information (generalizable and nongeneralizable) were predicated of distinct kinds. This in itself may have led children hearing nongeneralizable properties to infer that the properties were, in some sense, generalizable to the subordinate level kind.

Issues Concerning the Structure of Information

The results of Experiment 2 highlight the importance of contrastive information in the establishment of subordinate level categories as an inductive base. Notice, however, that the pres-

Table 4
Experiment 3: Complete List of Stimuli

	Training phase		Test phase				
Stimulus set	Information	Practice	Target	Subordinate	Basic	Superordinate	Inanimate
Dog	2 setters vs. 2 samoyeds	1 setter vs. 1 samoyed	1 collie	1 collie	Setter, samoyed, coonhound	Caribou, condor	Sneaker
Butterfly	2 whites vs. 2 blues	1 white vs. 1 blue	1 fritillary	1 fritillary	White, blue, swallowtail	Beetle, ferret	Teacup
Fish	2 triggerfish vs. 2 goatfish	1 triggerfish vs. 1 goatfish	1 parrotfish	1 parrotfish	Triggerfish, goatfish, shinerfish	Lobster, armadillo	Sunglasses

Table 5
Experiment 3: Information (Contrast/Generalizable)

	Training phase		Test phase		
			Object and property		
Condition	Object and property	Object and property	Test 1	Test 2	Test 3
	Stimulus set: dog				
	Setters	Samoyeds	A collie		
Contrast	—help hunters find birds.	—help us pull sleds in snow.	1. helps us take care of sheep.	2. can have five babies at a time.	3. has two kinds of muscle.
No Contrast	—are scared of strangers, so they hide from them.	—are nice to strangers, so they lick them.			
	Stimulus set: butterfly				
	Whites	Blues	A frittilary		
Contrast	—eat mustard plants.	—eat fruit.	1. eats violet flowers.	2. sleeps standing up.	3. likes wet places.
No Contrast	—lay eggs shaped like pears.	—lay eggs shaped like pennies.			
	Stimulus set: fish				
	Triggerfish	Goatfish	A Parrotfish		
Contrast	—have strong, sharp teeth.	—have small teeth in the tops of their mouths.	1. has teeth that are all stuck together.	2. likes to dig holes in the sand.	3. eats little shrimp.
	—hide in cracks in rocks.	—hide inside seaweed plants.			
No Contrast	—are ready for dinner.	—just woke up from a nap.			
	—just saw something scary.	—had fun this morning.			

ence or absence of contrast was not an all-or-none phenomenon but was more a matter of degree. To be sure, the most prominent form of contrast was manifested in the Contrast/Generalizable conditions, in which the contrast between the subordinate level training categories was conveyed both implicitly (the generalizable, enduring properties were drawn from contrastive values along a single dimension) and explicitly (the experimenter taught children that the properties applied to one subordinate level training category did not apply to the other). Although the contrast was considerably less prominent in the No Contrast conditions, there was a degree of implicit contrast here as well. During training in the No Contrast conditions, the two perceptually distinguishable subordinate level categories were introduced in separate spatial locations, with distinct category names. Moreover, the properties (both generalizable and nongeneralizable) applied to these distinct, named subordinate level groupings were embedded in generic statements introduced with the word *kind* (e.g., "We call this kind Noocs . . . . They just took a bubble bath.") This implicit contrast was further reinforced during the practice trials. Seen in this light, the results of these experiments suggest the following interpretation: Although the degree of contrast implicit in the No Contrast conditions was insufficient to lead children to establish distinct subordinate level categories as a basis for inductive inference, the contrast provided in the Contrast conditions was sufficient for children to make this new conceptual distinction. With a sufficient degree of contrastive information, preschool-age children are able to establish subordinate level categories as an inductive base.

In the next experiment, we pursue the implication of this finding for children's subsequent reasoning about objects and categories of objects. At issue here is whether children will use a newly established subordinate level category as an inductive base in subsequent inductive inferences involving new properties. These questions are examined in Experiment 3.

EXPERIMENT 3

In Experiment 3, our goals were (a) to replicate the effect observed in the Contrast/Generalizable condition of Experiment 2, (b) to extend this by examining the status of the newly emerging subordinate level categories in subsequent reasoning about additional properties, and (c) to examine the longevity of children's use of the subordinate level as a basis for inductive inference 1 week later.

To address these issues, the following design was adopted. During training, we followed the format used in the Contrast/Generalizable condition in Experiment 2. However, in Experiment 3, children were presented with three different tests of induction for each stimulus set. On the first test, the experimenter presented a target object (e.g., a collie) and a target property (e.g., "helps us take care of sheep"). As in Experiment 2, this property represented a new, contrastive value along a dimension introduced during training (e.g., "helps hunters find birds" or "helps us pull sleds in snow"). Because this aspect of the design is identical to the procedure used in the Contrast/Generalizable condition in Experiment 2, this first induction test provides an opportunity to replicate the results obtained in that condition.

A second induction test, which immediately followed the first, included the test phase only (as in the procedure used in Experiment 1). The third induction test, which was conducted 1 week later, also included the test phase only. The target properties presented on the second and third induction tests were drawn from dimensions *other* than those introduced during training (e.g., "can have five babies at a time," "has two kinds of muscle"). If children depend on contrast among properties to limit their projection of a property to the subordinate level, then they should revert to using the basic level as an inductive base on Tests 2 and 3. However, if the information provided during training is sufficient to sustain the children's use of the subordinate level as a basis of induction, then they may continue to use the subordinate level as the predominant basis for inductions regarding the new target properties offered in Tests 2 and 3.

There were two additional procedural modifications adopted in Experiment 3. First, because children were required to complete two consecutive rounds of the induction task in a single session, the number of test stimuli was reduced from 10 to 7 per set. Second, although in Experiment 2 we had presented only one property for each subordinate level category, in Experiment 3 two properties for each were introduced. These modifications are described fully below.

Method

Participants

Ten children (6 girls and 4 boys) from the greater Chicago area served as participants. The mean age of the children was 3 years 5 months, ranging from 2 years 9 months to 4 years 0 months.

Materials

Stimuli were 42 color photographs of individual animals selected from nature magazines and books. The photographs comprising these sets are listed in Table 4. Three sets of 14 cards each were created. Each set featured a familiar basic level category: dogs, butterflies, or fish. Each included 1 target card, 6 training cards, and 7 testing cards. The 6 training cards depicted three members each of two subordinate level categories (e.g., 3 setters and 3 samoyeds, from the dog set). The 7 test cards varied in their relation to the target: One depicted a member of the same subordinate level as the target (e.g., another collie), 3 depicted members of the same basic level kind (e.g., a setter, a samoyed, and a coonhound), 2 depicted members of the same superordinate level kind (e.g., a caribou and a condor), and 1 depicted an unrelated, inanimate object (e.g., a sneaker). The photographs in each set varied in image size, orientation, body position, and background. In addition, 2 cards with line drawings were used in the warm-up exercise.

Procedure

Children were tested individually in a quiet area of their preschool. The experiment was conducted over two separate sessions. The first session included two different induction tests on each set of cards. The first test took place immediately after the training phase, as in Experiment 2. For each set, after this first test was completed, children participated in a second induction test, with a new target property but the same target and test cards as in the first test. For the second session, the experimenter returned to the preschools 6 to 10 days later to present the third induction test, again using the same target and test cards but a new target property. Children were tested by the same experimenter throughout. Each session lasted approximately 25 min and was audiotaped.

Each session began with a warm-up exercise. The first induction test, which was patterned after Experiment 2, immediately followed the training phase. The second and third induction tests were patterned after the procedure used in Experiment 1. That is, they included the test phase only.

Warm-Up Exercise

The warm-up exercise was identical to those in Experiments 1 and 2.

Training Phase

As in Experiment 2, the training phase consisted of two parts: the provision of information about two subordinate level kinds from each set and two practice trials in which the children extended these properties to a new exemplar of each subordinate kind (see below). In this experiment, all of the properties presented were generalizable and enduring, and all were presented in a contrastive fashion.

For each set, the experimenter initiated the training phase by presenting two exemplars of one subordinate level kind (e.g., two samoyeds). He placed the cards faceup before participants, labeled them with a novel noun, and then presented two properties about that subordinate level kind. For example, for dogs, children were taught that "Noocs help us pull sleds in the snow. And you know what else? They're nice to strangers, so they lick them."

Next, the experimenter placed two exemplars of a second subordinate level kind (e.g., two setters) approximately 18 in. away from the first, labeled them with a different novel noun, and presented two pieces of information about this subordinate level kind. For example, they were then told that "Tesses help hunters find birds. And you know what else? They're scared of strangers, so they hide from them."

As in Experiment 2, the contrast between the two subordinate level categories presented during the training phase was established in two distinct ways. First, the properties consisted of contrasting values along a single dimension: For instance, properties predicated of the subordinate level kinds of dogs varied in (a) the ways in which they help people and (b) their characteristic temperaments. As in Experiment 2, these dimensions were not mentioned explicitly. Second, the experimenter explicitly stated that the property applied to one subordinate level category (e.g., samoyeds) could not be extended to the other (e.g., setters). For example, the experimenter said, "See these? We call this kind Tesses. They help us find birds. They don't help us pull sleds like the Noocs. No! They help us find birds."

Practice

Immediately following training, children were shown a new, third exemplar from each of the two subordinate level kinds already displayed on the table. These were presented one at a time, in random order. The procedure for the practice trials was identical to that in Experiment 2. Immediately after the practice trials, the testing phase began.

Induction Test 1

Children were then shown a new individual member of a different subordinate level category (e.g., a collie). This served as the target object. The experimenter applied a new property to the target object, saying, for example, "See this one? Here's a different one. This one helps us take care of sheep." As in Experiments 1 and 2, this was an enduring and generalizable, but unobservable, property. Notice that the target property took a contrastive value along a dimension introduced during training (as was the case in the Contrast conditions in Experiment 2). The experimenter then removed the cards used during training, leaving only the target object before the child. The experimenter then asked children whether the target property could be extended to each test card, saying, for example, "Do you think this one [pointing to test object] helps us take care of sheep like that one? [pointing to target object]?" Cards were presented singly, in random order.

Induction Test 2

The second test of induction for each set that took place immediately on completion of the first test, involved the same target and test cards as had been used in Induction Test 1. However, unlike Test 1, there was no training phase in Test 2; only the test phase was presented. For each set, the experimenter presented the target object, along with a new target property. In addition, unlike Induction Test 1, the target property introduced in Test 2 did not take a contrastive value along either of the dimensions introduced during training. For example, on Test 2 for the dog set, children were taught that the target object (a collie) "can have five babies at a time."

The order of presentation of the three sets (dogs, butterflies, fish) was counterbalanced within each condition. Cards were presented singly, in random order. The entire session lasted approximately 25 min. Children received stickers after completing the induction test for each set.

Induction Test 3

The third induction test, which took place 6 to 10 days later, used a procedure that was identical to that of Induction Test 2. There was no training phase. Using the same target and test cards as in the first and second rounds, the experimenter presented the target object, along with yet another new target property. As in Induction Test 2, the target property did not take a contrastive value along the dimension introduced during training (in Session 1). The sets were presented in the same order as in the first round. Within each set, test cards were presented singly, in random order. The session lasted approximately 7 min.

Results

Figure 4 depicts the mean patterns of inductive inference as a function of test and hierarchical level. A preliminary examination of these data revealed that children were generally focused throughout the procedure and comprehended the task. Across all three induction tests, they extended the target property to other members of the same subordinate level category as the target object but very rarely extended the target property to the inanimate objects.

Data were submitted to a three-way within-subjects ANOVA, with test (Test 1 vs. 2 vs. 3), hierarchical level (subordinate, basic, superordinate, inanimate), and stimulus set (dog, butterfly, fish) serving as within-subjects variables. There was a main effect for hierarchical level, $F(3, 27) = 39.63$, $p < .0001$. Children were more likely to extend the target property to members of the same subordinate level category than to members related at the basic level or the superordinate level or to the inanimate objects (Tukey's HSD, all $ps < .05$). The difference between extensions to the basic and inanimate objects was also significant (Tukey's HSD, $p < .05$).

This analysis revealed no main effect of test, indicating that participants' performance was comparable across all three tests

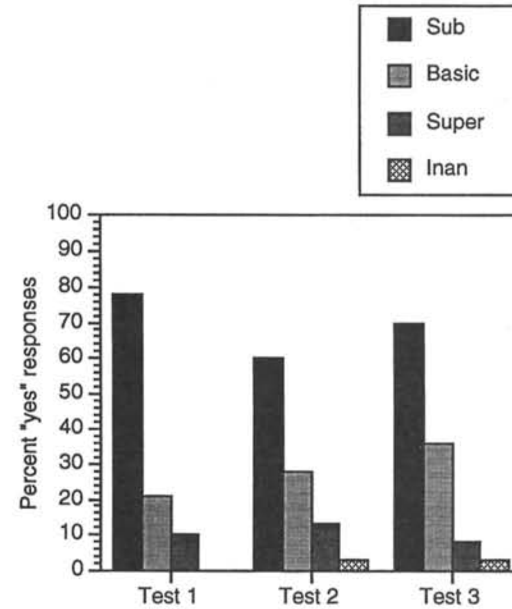

Figure 4. Mean percentage "yes" responses as a function of hierarchical level, type of information, structure of information, and test in Experiment 3. Sub = subordinate; Super = superordinate; Inan = inanimate.

of induction. There was, however, an interaction between hierarchical level and test, $F(6, 54) = 2.32$, $p < .05$. Although children's willingness to extend the target property to the subordinate level, superordinate level, or inanimate objects did not differ across tests, the tendency to extend the target property to other members of the basic level did increase from Test 1 to Test 3.

The interaction between stimulus set and test was marginally significant, $F(4, 36) = 2.56$, $p = .055$. A post hoc analysis of simple effects located this effect at Test 2. On Tests 1 and 3, children's tendency to extend the target property was comparable for each of the three stimulus sets. But on Test 2, children were more likely to extend the target property in the butterfly set than in the dog or fish set ($p < .05$). This difference, which is small in magnitude, may reflect a priori differences in patterns of attribution of the particular properties introduced.

As in Experiment 2, a supplementary analysis was conducted in which we compared the proportions of subordinate level extensions as a function of total extensions. For each test, we computed (for each child) the proportion of subordinate level responses (extensions to the subordinate level objects/extensions to all objects) and entered this as the dependent variable in a one-way ANOVA, with test (Test 1 vs. Test 2 vs. Test 3) as as a within-subjects variable. The proportion of subordinate level responses did not differ across tests ($M = .79, .71$, and $.70$ on Tests 1, 2, and 3, respectively), $F(2, 18) = .92$, $p = .42$. This is consistent with the results of the main ANOVA in suggesting that participants' tendency to use the subordinate level as an inductive base was comparable across tests.

Finally, we examined the patterns of inference displayed by individual participants across all three tests, using the same patterns outlined in previous experiments.[3] Table 6 displays, for each induction test, the percentage of trials that were consistent with each pattern. The strong tendency to display the subordinate level pattern on Test 1 replicates the results of Experiment 2 in the Contrast/Generalizable condition. On subsequent tests, when noncontrastive properties were presented, the individual patterns of performance were less straightforward, as witnessed by the increase in "other" and "basic" level responses on Tests 2 and 3, respectively. Yet even on these latter tests, the subordinate response pattern was more prevalent than either the basic or the superordinate response pattern. This is interesting because it suggests that children did not necessarily revert to using the basic level as the predominant basis for their inductive inferences, even when new, noncontrastive properties were introduced and even after 1 week's delay.

The results of Experiment 3 make two important points. First, these results replicate and extend the findings in the Contrast/Generalizable condition in Experiment 2. The fact that this replication was obtained, despite procedural modifications and despite the relatively small number of participants included in each condition, suggests that these effects are robust. Second, the results of Experiment 3 suggest that these newly established subordinate level object categories can serve as a basis for subsequent inductive inferences. Despite the fact that the target properties presented on Tests 2 and 3 did not contrast directly with any of the training properties and despite the fact that Test 3 occurred 1 week after training, children did not revert to relying primarily on the basic level as a guide for their inductive inferences. This suggests that although a certain degree of contrast may be essential in setting up the subordinate level as a basis for inductive inference, the inductive potential of these new subordinate level categories may then guide the child in making subsequent inferences involving new properties.

This outcome is especially interesting when considering the learning situations typically encountered by the young child. Consider, for example, a scenario in which a child learns contrastive information about two different subordinate level kinds of dogs (e.g., samoyeds and setters) and how they help people. This is plausible because mothers tend to offer contrastive information when they teach their children about nonbasic level categories (Callanan, 1985). The results of Experiment 2 suggest that if that child then hears a new contrastive property applied to an individual from yet another subordinate level category (e.g., a collie), the child will limit the extension of that property to other members of that same subordinate level category (e.g., to other collies). But what happens later, when this child hears an isolated property (e.g., can have five babies at a time) applied to an individual member of the newly established subordinate level category (e.g., a collie)? The data from Experiment 3 suggest that children reveal a tendency to limit their projection of that property to the subordinate level.

Table 6
Experiment 3: Individual Analyses

Responses	Experiment 3: Test 1	Test 2	Test 3
Subordinate (+ − − −)	.57	.37	.37
Basic (+ + − −)	.10	.03	.23
Superordinate (+ + + −)	.03	.03	.03
Other	.30	.57	.37

Note. Plus and minus signs denote whether the child extended the target property to the test objects at the subordinate, basic, superordinate, or inanimate level.

GENERAL DISCUSSION

These three experiments were designed to investigate the emergence of subordinate level categories as a basis for inductive inference in preschool-age children. Previous research had indicated that basic level categories provide a powerful and rich source of inductive inference for children as well as adults (Gelman, 1988; Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Gelman & O'Reilly, 1988; Shipley, 1993). The experiments reported here go beyond this line of research to ascertain how children partition their existing and inductively rich basic level categories to form subordinate level categories with inductive potential and how these newly emerging subordinate categories fare in subsequent reasoning.

To address these issues, we introduced preschool-age children in each experiment to an individual member (e.g., a collie) of a familiar basic level category (e.g., dog). We taught children a novel, generalizable, and enduring property about that individual and then examined their extensions of that particular property to a range of other objects, including some from the same subordinate level category (e.g., other collies), some from the same basic level category (e.g., other dogs), some from the same superordinate level category (e.g., other animals), and some inanimate objects (e.g., a shoe) as well. The results of Experiment 1 confirmed that for the natural kind categories under investigation here, the basic level served as the predominant basis for preschool-age children's inductive inference. This result set the foundation for Experiments 2 and 3.

Experiment 2 was designed to examine the conditions under which children succeed in partitioning these familiar basic level categories into subordinate level categories that can serve as a basis for inductive inference. We identified two variables—type of information (generalizable vs. nongeneralizable) and structure of information (Contrast vs. No Contrast)—that were likely to influence the establishment of subordinate level categories and their inductive capacity. Our data revealed that the structure of the information was of paramount importance: Children in the Contrast conditions (hearing either generalizable or nongeneralizable properties) tended to establish the subordinate level as a basis of inductive inference. Those in the No Contrast

[3] In this experiment, because there were fewer (3) test cards than in Experiments 1 and 2, it was impossible to distinguish a basic level pattern with one error of commission from a superordinate level pattern with one error of omission. There was one such ambiguous pattern on Test 1, three on Test 2, and none on Test 3. These ambiguous responses were included in the "other" category.

conditions relied predominantly on the basic level as an inductive base.

In Experiment 3, the finding that preschool-age children can take advantage of contrastive information to induce a new subordinate level category (e.g., collie) from a single instance (e.g., the target collie) was replicated. We also discovered that these newly established subordinate categories supported inductive inference regarding new properties and continued to serve as an inductive base for as long as 1 week later, even when the subsequent property information was not presented in a contrastive fashion.

These experiments advance in several ways an understanding of conceptual development and inductive reasoning. Most notably, they signal an important role for contrastive information in the establishment of subordinate level categories as an inductive base. This striking result warrants further consideration. We do not mean to imply that in the absence of explicit contrast, children are unable to establish subordinate level categories. Rather, we suspect that in the absence of sufficient contrast, children will require additional support if they are to establish subordinate level categories as an inductive base. Such support may come from several sources, including repeated exposure to and comparison of subordinate level groupings (Gentner & Ratterman, 1991) or the projection of additional properties onto these subordinate level categories (Goodman, 1955/1983; Shipley, 1993; Sloman, 1994).

Our findings regarding the role of contrast in promoting the emergence of distinct subordinate level categories amplify results obtained previously with different behavioral measures. For example, Callanan (1990) has documented that when teaching their preschool-age children about subordinate level categories, parents distinguish among the categories by highlighting a salient dimension along which they contrast. For example, in teaching about kinds of scales, parents tend to make general statements about the basic level category to indicate the salient dimension (e.g., "Scales are for weighing things") and then provide more specific examples of how each subordinate level category varies along that dimension (e.g., "You can weigh a baby on this"; "You can weigh a package on this"). In this way, parents indicate that the familiar basic level category is composed of subordinate level categories, each of which takes a contrastive value along a particular dimension.[4] Similarly, Waxman and her colleagues have demonstrated that providing preschool-age children with contrastive information facilitates the establishment of distinct subordinate level kinds in a classification task (Waxman et al., 1991).

Our results are also consistent with Shipley's claim that children expect that categories at a given hierarchical level will be approximately equal in detail, or variability, and that the types of characteristics that are diagnostic for membership in one category will also be diagnostic for membership in another, contrastive category (Shipley & Kuhn, 1983). Macario et al. (1990) demonstrated that children use information about the degree of variation in one artificial category to make inferences about another novel, contrastive category. The three experiments reported here extend this phenomenon in two ways: from artifacts to natural kinds and from a classification to an induction task.

How can we best account for these robust effects of contrast in the current series of experiments? A theoretical approach outlined by Goodman (1955/1983) and by Shipley (1993) offers one account of this powerful phenomenon. In brief, the idea is that any set of objects (e.g., setters) will gain conceptual coherence and inductive strength when properties (e.g., helps us find birds) are projected onto it. In the Goodman–Shipley account, projections like these strengthen (or provide entrenchment of) both the emerging category (e.g., setters) and the property itself (e.g., helps us find birds). But notice that in Experiment 2, properties were projected onto subordinate level sets for children in both the Contrast and No Contrast conditions. Why, then, was the information provided in the Contrast conditions so much more effective than that in the No Contrast conditions? One possibility is that the contrast permitted the children to infer the ". . . type of property that is invariant within classes at the same level in a class inclusion hierarchy" (Shipley, 1993, p. 275). This is precisely the type of evidence that would be required to establish what Goodman and Shipley have called an "overhypothesis." An overhypothesis takes the form "Kinds of X differ with regard to property Y." For example, *kinds of dog differ in the way in which they help people.*

An interesting feature of the Goodman–Shipley account is that the establishment of an overhypothesis does not necessarily require that children successfully recall, over time, the particular value of a property associated with each emerging category. Nor does the establishment of an overhypothesis require that children have any knowledge of the particular values of the property that will be associated with other, as yet unknown, categories. Rather, the claim is that the overhypothesis specifies a dimension that will partition the more inclusive category (e.g., dog) into subordinate level kinds.

The conceptual advantage of an overhypothesis is clear: It can be established on the basis of experience with only a few categories (e.g., setters and samoyeds), yet it provides structure and expectations for the identification of additional contrastive categories that have yet to be discovered. In principle, it would be to the child's advantage to form categories that support the projection of such overhypotheses. Although our results are consistent with this possibility, they do not provide unambiguous evidence for overhypotheses in children's reasoning. In future work, it will be important to inquire more directly into the existence of overhypotheses in children's inductive inferences.

It will also be important to extend the results of these experiments to incorporate a broader range of properties and categories. For example, we focused exclusively on categories of animals in the current studies, primarily because these natural kinds have rich inductive potential for children (Gelman, 1988; Gelman & Coley, 1990; Gelman & Wellman, 1991; Keil, 1989). It remains to be seen whether the same pattern of findings would

[4] It is interesting that in this series of experiments, children established subordinate level categories that were labeled with novel nouns that were not explicitly "anchored" to a familiar basic level term (Callanan, 1985; Waxman et al., 1991). This is likely because anchoring may have been rendered superfluous by the use of familiar basic level categories and of the term "kind" (e.g., "These are both the same kind. We call this kind Noocs.").

emerge in the establishment of subordinate level categories of other natural kinds or artifacts. Another issue that warrants closer attention is the type of properties that children are willing to project. During training, generalizable, enduring properties were compared with nongeneralizable, transient properties, but, at test, only generalizable, enduring properties were presented. In future work, it will be possible to examine children's patterns of inductive inference when they are presented with transient properties at test (see Gelman, 1988).

A crucial question concerns how children and adults decide which category in a hierarchy serves as the inductive base. Previous research has shown that children and adults assume that members of the same basic level category will share deep, often unknown, properties (Atran, 1990; Gelman et al., 1994; Gelman & Medin, 1993; Gelman & Wellman, 1991; Medin, 1989; Medin & Ortony, 1989; Murphy & Medin, 1985; Shipley, 1993). The data from Experiment 1 are consistent with this work. The results of Experiments 2 and 3 indicate that preschool-age children also expect that members of subordinate level categories share essential, underlying commonalities. This raises interesting questions for future research. If more than one category in a hierarchy can serve as the range of an inductive inference, then how do children and adults determine the range of any particular property? This question has begun to be addressed in recent work with adults (Lassaline, 1994; Sloman, 1994). In future work, it will be important to ask how children determine the range of inductive inference, how they map properties to categories at various hierarchical levels, and how contrastive information exerts an influence in this process.

In closing, we have discovered that a modest amount of contrastive information successfully initiates the emergence of distinct subordinate level categories within familiar basic level categories and licenses their use as an inductive base. To the best of our knowledge, these studies constitute the first demonstration that newly established subordinate level categories function as more than perceptually based groupings; they have considerable inductive potential. These effects are replicable, robust, and may be surprisingly long-lived.

References

Atran, S. (1990). *Cognitive foundations of natural history.* Cambridge, England: Cambridge University Press.

Callanan, M. A. (1985). How parents label objects for young children: The role of input in the acquisition of category hierarchies. *Child Development, 56,* 508–523.

Callanan, M. A. (1990). Parents' descriptions of objects: Potential data for children's inferences about category principles. *Cognitive Development, 5,* 101–122.

Callanan, M. A., & Oakes, L. M. (1992). Preschoolers' questions and parents' explanations: Causal thinking in everyday activity. *Cognitive Development, 7,* 213–233.

Coley, J. D. (1995). Emerging differentiation of folkbiology and folkpsychology: Attributes of biological and psychological properties to living things. *Child Development, 66,* 1856–1874.

Gelman, S. A. (1988). The development of induction within natural kind and artifact categories. *Cognitive Psychology, 20,* 65–95.

Gelman, S. A., & Coley, J. D. (1990). The importance of knowing a dodo is a bird: Categories and inference in 2-year-old children. *Developmental Psychology, 26,* 796–804.

Gelman, S. A., Coley, J. D., & Gottfried, G. M. (1994). Essentialist beliefs in children: The acquisition of concepts and theories. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 341–366). New York: Cambridge University Press.

Gelman, S. A., & Markman, E. M. (1986). Categories and induction in young children. *Cognition, 23,* 183–209.

Gelman, S. A., & Markman, E. M. (1987). Young children's induction 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 conceptual knowledge. *Cognitive Development, 8,* 157–167.

Gelman, S. A., & O'Reilly, A. W. (1988). Children's inductive inferences with superordinate categories: The role of language and category structure. *Child Development, 59,* 876–887.

Gelman, S. A., & Wellman, H. M. (1991). Insides and essences: Early understandings of the non-obvious. *Cognition, 38,* 213–244.

Gentner, D., & Rattermann, M. J. (1991). Language and the career of similarity. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspectives on thought and language: Interrelations in development* (pp. 225–277). Cambridge, England: Cambridge University Press.

Gentner, D., & Waxman, S. R. (1994, June). *Perceptual and conceptual bootstrapping in early word meaning.* Paper presented at the meeting of the International Conference on Infancy Studies, Paris, France.

Goodman, N. (1983). *Fact, fiction, and forecast.* New York: Bobbs-Merrill. (Original work published 1955)

Heit, E., & Rubinstein, J. (1994). Similarity and property effects in inductive reasoning. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20,* 411–422.

Johnson, K. E., & Mervis, C. B. (1994). Microgenetic analysis of first steps in children's acquisition of expertise on shorebirds. *Developmental Psychology, 30,* 418–435.

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

Lassaline, M. E. (1994). *Constraints on similarity as a constraint on induction.* Unpublished doctoral dissertation, University of Michigan.

Macario, J. F., Shipley, E. F., & Billman, D. O. (1990). Induction from a single instance: Formation of a novel category. *Journal of Experimental Child Psychology, 50,* 179–199.

Medin, D. L. (1989). Concepts and conceptual structure. *American Psychologist, 44,* 1469–1481.

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

Mervis, C. B. (1987). Child-basic object categories and early lexical development. In U. Neisser (Eds.), *Concepts and conceptual development: Ecological and intellectual factors in categorization* (pp. 201–233). New York: Cambridge University Press.

Mervis, C. B., Johnson, K. E., & Mervis, C. A. (1994). Acquisition of subordinate categories by 3-year-olds: The roles of attribute salience, linguistic input, and child characteristics. *Cognitive Development, 9,* 211–234.

Murphy, G. L., & Medin, D. L. (1985). The role of theories in conceptual coherence. *Psychological Review, 92,* 289–316.

Osherson, D. N., Lopez, A., Smith, E. E., & Wilkie, O. (1990). Category-based induction. *Psychological Review, 97,* 185–200.

Rips, L. J. (1975). Inductive judgments about natural categories. *Journal of Verbal Learning and Verbal Behavior, 14,* 665–681.

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

Shipley, E. F. (1992). *Inductive inferences by preschoolers and level of category label.* Paper presented at the 33rd annual meeting of the Psychonomic Society, St. Louis, MO.

Shipley, E. F. (1993). Categories, hierarchies, and induction. *Psychology of Learning and Motivation, 30,* 265–301.

Shipley, E. F., & Kuhn, I. (1983). A constraint on comparisons: Equally detailed alternatives. *Journal of Experimental Child Psychology, 35,* 195–222.

Sloman, S. A. (1994). When explanations compete: The role of explanatory coherence on judgments of likelihood. *Cognition, 52,* 1–21.

Smith, E. E., & Medin, D. L. (1981). *Categories and concepts.* Cambridge, MA: Harvard University Press.

Waxman, S. R. (1990). Linguistic biases and the establishment of conceptual hierarchies: Evidence from preschool children. *Cognitive Development, 5,* 123–150.

Waxman, S. R. (in press). The dubbing ceremony revisited: Object naming and categorization in infancy and early childhood. In D. L. Medin & S. Atran (Eds.), *Folkbiology.* Cambridge, MA: MIT Press/Bradford Books.

Waxman, S. R., & Markow, D. B. (1995). Words as invitations to form categories: Evidence from 12- to 13-month-old infants. *Cognitive Psychology, 29,* 257–302.

Waxman, S. R., Shipley, S., & Shepperson, B. (1991). Establishing new subcategories: The role of category labels and existing knowledge. *Child Development, 62,* 127–138.

Received December 8, 1995
Revision received May 26, 1997
Accepted May 26, 1997 ■

Call for Nominations

The Publications and Communications Board has opened nominations for the editorships of **Experimental and Clinical Psychopharmacology, Journal of Experimental Psychology: Human Perception and Performance (JEP:HPP), Journal of Counseling Psychology,** and **Clinician's Research Digest** for the years 2000–2005. Charles R. Schuster, PhD, Thomas H. Carr, PhD, Clara E. Hill, PhD, and Douglas K. Snyder, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 1999 to prepare for issues published in 2000. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations are also encouraged.

To nominate candidates, prepare a statement of one page or less in support of each candidate and send to

Joe L. Martinez, Jr., PhD, for **Experimental and Clinical Psychopharmacology**. Members of the search committee are Conan Kornetsky, PhD; Irwin Lucki, PhD; and Alice M. Young, PhD.

Lyle E. Bourne, Jr., PhD, for **JEP:HPP**. Members of the search committee are Margaret J. Intons-Peterson, PhD; David E. Myer, PhD; and Rose Zacks, PhD.

David L. Rosenhan, PhD, for **Journal of Counseling Psychology.**

Carl E. Thoresen, PhD, for **Clinician's Research Digest**. Members of the search committee are Lizette Peterson-Homer, PhD; Laura S. Brown, PhD; and Maria P. P. Root, PhD.

Send all nominations to the appropriate search committee at the following address:

Karen Sellman, P&C Board Search Liaison
Room 2004
American Psychological Association
750 First Street, NE
Washington, DC 20002-4242

First review of nominations will begin December 8, 1997.