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Research Article

Category Markers or Attributes

Why Do Labels Guide Infants' Inductive Inferences?

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ABSTRACT—*To clarify the role of labels in early induction, we compared 16-month-old infants' (*n *= 114) generalization of target properties to test objects when objects were introduced by the experimenter in one of the following ways: (a) with a general attentional phrase, (b) highlighted with a flashlight and a general attentional phrase, (c) via a recorded voice that labeled the objects using a naming phrase, (d) with a label consisting of a count noun embedded within a naming phrase, (e) with a label consisting of a single word that was not marked as belonging to a particular grammatical form class, and (f) with a label consisting of an adjective. Infants relied on object labels to guide their inductive inferences only when the labels were presented referentially, embedded within an intentional naming phrase, and marked as count nouns. These results suggest that infants do not view labels as attributes of objects; rather, infants understand that count-noun labels are intentional markers denoting category membership.*

Inductive inferences involve reasoning that things that are true for one exemplar of a category will hold true for other members of the same category (Moore & Parker, 1989). Numerous studies have demonstrated that labeling objects can play a potent role in guiding infants' and preschoolers' inductive inferences about nonobvious object properties (e.g., Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Graham & Kilbreath, 2007). That is, preschoolers and infants will assume that two objects with the same label share a nonobvious property, even if these objects are perceptually dissimilar. Although there is consensus that labels can guide children's inductions, there is considerable debate about *why* infants attend to shared labels when making inductive inferences (e.g., Gelman & Waxman, 2007; Sloutsky, Kloos, & Fisher, 2007). In the present study, we addressed this debate by examining the conditions under which 16-month-olds rely on shared labels to guide their inferences.

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Inductive reasoning during infancy is generally examined using imitation paradigms in which an experimenter models an action on a target object and then observes whether the infant imitates the action on test objects (e.g., Baldwin, Markman, & Melartin, 1993). If infants view the test objects to be members of the same category as the target object, they will imitate the target actions on the test objects. Studies using this paradigm demonstrated that when target and test objects were labeled with the same novel count noun, infants as young as 13 months generalized nonobvious properties from the target object to the test object, even when the objects were dissimilar (Graham & Kilbreath, 2007; Graham, Kilbreath, & Welder, 2004; Welder & Graham, 2001). In contrast, when objects were not labeled, infants relied on the perceptual similarity of the objects to guide their inductions, generalizing only to objects that were highly similar in appearance.

There are a number of potential explanations for the effect of labels on infants' inductions. First, it is possible that labels act as an attentional spotlight, leading infants to examine objects more closely, and thereby allowing them to detect minimal perceptual similarities between objects. Studies supporting this notion have demonstrated that labeling objects increases infants' attention to these objects, relative to conditions in which the objects are not labeled (e.g., Baldwin & Markman, 1989; Xu, 2002). Another potential explanation is that rather than drawing infants' attention to objects, shared labels drive young children's induction because they increase the perceptual similarity of compared objects (e.g., Fisher & Sloutsky, 2005; Sloutsky & Fisher, 2004a, 2004b). In this view, the more features two entities have in common, the greater their shared similarity, and the more likely that children will infer that they share nonobvious properties. One specific similarity-based account is the label-as-attribute model (Sloutsky & Lo, 1999; Sloutsky, Lo, & Fisher, 2001), which assumes that (a) labels are attributes of entities that contribute to the similarity of compared entities and (b) labels contribute to younger children's similarity judgments more than other attributes do. Studies supporting this account have demonstrated that young children view identically labeled entities as more similar than differently labeled entities (Sloutsky & Fisher, 2004a; Sloutsky & Lo, 1999).

Finally, children may rely on labels to guide their inductive inferences because they expect labels to denote categories (e.g., Gelman, 2003; Gelman & Coley, 1990). According to this account, children's categories are based on meaningful, underlying commonalities (e.g., being a mammal), rather than on perceptual similarities alone (Gelman, 2003). Thus, children rely on labels to guide their inductions because they recognize that labels provide direct access to an object's kind, and that objects from the same kind likely also share nonobvious properties (Gelman, 2003). Studies supporting the label-as-category-marker account have shown that preschoolers will use category labels to draw inferences about shared properties even when category membership competes with perceptual similarity (e.g., Gelman & Markman, 1986, 1987; Jaswal, 2004; Jaswal & Markman, 2007) and will not draw inferences about shared properties when two objects are labeled with a transient state term (e.g., "sleepy") rather than a category label (e.g., "bird"; Gelman & Coley, 1990).

It is difficult to adjudicate among the possible explanations for the labeling effect as the extant research has not provided unequivocal support for one account over another. In the present study, we directly contrasted these three potential explanations for the labeling effect by varying the conditions under which objects were labeled. In particular, we contrasted the following possibilities: that labeling objects acts as an attentional spotlight, that labels are viewed as attributes of the objects, and that labels act as category markers. We presented 16-month-olds with novel target objects that possessed nonobvious properties and then with test objects that varied in how similar their shapes were to the target objects (i.e., high and low similarity). The infants were divided into six different groups, and a different procedure was used to introduce the objects to each group. In the case of the *no-label* and *light* groups, the experimenter introduced the target and test objects with a general attentional phrase (e.g., "Look at this one"); for infants in the light group, the experimenter also highlighted the objects with a flashlight to direct the infants' attention to the objects. For infants in the *count-noun* group, the experimenter introduced the target and test objects using a count noun embedded within a naming phrase (e.g., "This is a *blick*"). Objects were introduced to the *recorded-label* group by an audiotaped voice that labeled the objects using the same phrases the experimenter used with the count-noun group. In the case of the *word-alone* group, the experimenter introduced the objects with a word without a naming phrase (e.g., "Look. *Blick.*"). Finally, the experimenter introduced the objects to infants in the *adjective* group by using a novel adjective (e.g., "Look. This is *blickish.*").[1]

[1]We used the suffix *-ish* to mark the label as an adjective. However, infants may not interpret this suffix in this way and could interpret such labels as adjectives, proper names, or mass nouns, but not as count nouns.

We made separate predictions for the high-similarity and low-similarity test objects. On the basis of research demonstrating the importance of shape similarity in categorization tasks (e.g., Landau, Smith, & Jones, 1988, 1992), we predicted that when the target and test objects were highly similar in shape, infants would rely on that similarity to guide their inductive inferences, regardless of whether or how the objects were labeled. In contrast, our predictions for the low-similarity test object varied according to the theoretical explanation for infants' reliance on shared labels. According to the attentional-spotlight account, if labels simply increase infants' attention to the objects, so that the infants can detect minimal perceptual similarities between the objects, then any other salient means by which infants' attention is drawn to objects should produce similar effects. Thus, in our study, all groups except the no-label group would be expected to generalize the nonobvious property to the low-similarity object. According to the label-as-attribute account, the presence or absence of shared labels, rather than the type of labeling, should influence infants' inductions. Thus, in our study, infants would be expected to generalize target properties to the low-similarity object when objects were described with any type of shared label, as shared labels, regardless of how they are presented, contribute to the shared similarity of objects. Finally, according to the label-as-category-marker account, infants would expect the low-similarity test object to have the same nonobvious property as the target object only when the objects were labeled intentionally with a count noun embedded within a naming phrase. When objects were labeled in any other way, infants would not expect the low-similarity test object to share the nonobvious property with the target.

METHOD

Participants

Data from 114 infants (mean age = 16.70 months, SD = 0.39 months, range: 16.00–17.50 months) were included in the final sample. The mean size of their productive vocabulary, as assessed by the MacArthur-Bates Communicative Development Inventory: Words and Sentences (MCDI Advisory Board, 1992), was 40.91 words (SD = 35.80 words, range: 0–160 words). An additional 23 infants were tested but excluded for excessive fussiness (n = 9), failure to complete the task (n = 3), parental interference (n = 3), or experimenter error (n = 2), or because their data were statistical outliers (n = 6; see Coding and Data Screening).

Materials

Three object sets were created: a ringing set, a rattling set, and a squeaking set (see Fig. 1). Each set consisted of a target object and two test objects: a high-similarity and a low-similarity test object. The high-similarity object was similar in shape and texture to the target object, but differed in color and size. The

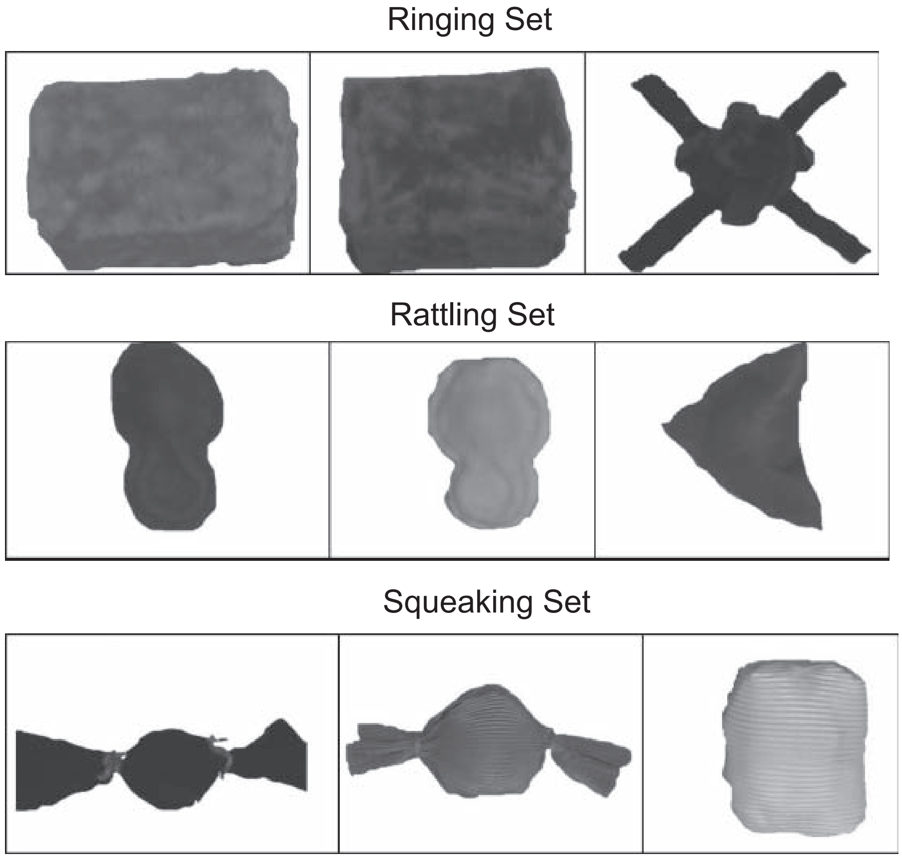

Fig. 1. The three object sets used in the experiment. Within each set, objects made the same sound in the predicted condition (ringing, rattling, or squeaking). The first object in each set is the target; the second and third objects are the high- and low-similarity test objects, respectively.

low-similarity object was similar in texture to the target object, but differed in shape, color, and size. Each set possessed a distinctive, visually nonobvious sound property that could be evoked with a specific action—the ringing set rang when tapped, the rattling set rattled when shaken, and the squeaking set squeaked when squeezed. There were two versions of each object set: a version in which the objects possessed the nonobvious property and a version in which the objects were disabled such that the nonobvious property could not be elicited.

Design

Objects were presented in three within-subjects expectation conditions (see Table 1 for an overview of the conditions). In the condition of interest, the *unpredicted* condition, the target object possessed a nonobvious property, but the test objects were disabled. Infants' performance in this condition provided a measure of whether they expected the test objects to possess the same nonobvious property as the target object. If infants expected the test objects to share that property, they would persist in performing the target actions in order to try to elicit the property. In the *baseline* condition, neither the target nor the test objects possessed the nonobvious property. This condition provided a baseline measure of infants' exploratory actions on the objects. In the *predicted* condition, both the target and the test objects possessed the nonobvious property. This condition was included so that the infants would not become quickly bored or frustrated with the objects. For each infant, one of the three object sets was always presented in the unpredicted condition, one set was always presented in the predicted condition, and one set was always presented in the baseline condition. We counterbalanced which of the three object sets was assigned to each condition across infants.

The test phase consisted of two blocks of three trials: one trial in the unpredicted condition, one in the predicted condi-

TABLE 1
Overview of the Three Within-Subjects Conditions

	Presence or absence of the nonobvious property		
Condition	Target object	Test objects	Infants' expectation
Baseline	Absent	Absent	None
Predicted	Present	Present	Fulfilled
Unpredicted	Present	Absent	Violated

Note. ''Infants' expectation'' refers to whether the infants would have expected the test objects to have the nonobvious property and whether or not this expectation was met. The specific object set assigned to each condition was counterbalanced across infants.

tion, and one in the baseline condition. Each trial consisted of presenting a target object and then a test object from the same set. Each object set was presented once within each block. That is, one test object (e.g., a high-similarity object) from a set (e.g., the ringing set) was presented in the first block, and the other test object (e.g., a low-similarity object) from that same set was presented in the second block. The order of presentation of test objects within each block was counterbalanced across infants. The order of presentation of the conditions was counterbalanced for each infant. Testing protocols were yoked across groups.

Procedure

Infants were seated in a booster chair or on their parent's lap, across a table from the experimenter. The experimenter began each test trial by presenting the infant with a target object, using a general attentional phrase (e.g., "Look. Look at this."). In the unpredicted and predicted conditions, she then demonstrated the nonobvious property of the target object five times while drawing the infant's attention to the object (e.g., "Look. See what this can do."); in the baseline condition, the target objects did not possess a nonobvious property that could be demonstrated. Following this introduction, the experimenter placed the target object on the table directly in front of the infant (but out of reach).

The procedure then diverged according to the group to which the infant had been assigned. If the infant was in the count-noun group, the experimenter labeled the object with a count noun using a naming phrase (e.g., "This is a *blick*."). If the infant was in the recorded-label group, a recorded version of the experimenter's voice (emitted from a transcribing machine activated by a foot pedal) labeled the target object with a count noun in a naming phrase. This recorded script had the same pace, tone, and volume as the script verbalized by the experimenter for infants in the count-noun group. If the infant was in the word-alone group, the experimenter labeled the object with a word without using a naming phrase (e.g., "Look. *Blick*."). If the infant was in the adjective group, the experimenter labeled the object with an adjective (e.g., "This is *blickish*."). If the infant was in the no-label group, she described the object with a general attentional phrase (e.g., "Look at this one."). Finally, if the infant was in the light group, the experimenter highlighted the object using a flashlight while describing the object with a general attentional phrase. For all groups, the label or general phrase was repeated six times. Once the target object had been introduced, the infant was given the object to explore for 10 s. The experimenter then retrieved the target object and placed it out of the infant's reach but still within view.

The experimenter then introduced one of the test objects in the same way that she had introduced the target object—that is, using the same count noun in a naming phrase (count-noun group), playing the same recorded voice that named the object with the same count noun in a naming phrase (recorded-label group), using the same count noun without a naming phrase (word-alone group), using the same adjective (adjective group), using a general attentional phrase (no-label group), or using a general attentional phrase plus a flashlight (light group). The label or general phrase was repeated six times. The experimenter did not perform any actions on the test object. The infant was given 20 s to explore the test object. If the object was dropped off the table or moved out of the infant's reach, the experimenter (or parent) placed the object back in front of the infant within his or her reach.

The same procedure of introducing the target object, allowing the infant to explore the target object, introducing the test object, and allowing the infant to explore the test object was repeated for all trials.

Coding and Data Screening

The number of target actions infants performed on the target and test objects was recorded by coders using a scheme that outlined criteria for the target action for each object set. The target action for the ringing set involved patting or tapping the object with the hand. The target action for the squeaking set involved squeezing the fingers together on the object. The target action for the rattling set involved moving the object in a back-and-forth or up-and-down motion. (For more details, see Graham et al., 2004, or Welder & Graham, 2001). Coders were unaware of hypotheses and group assignment and were unable to distinguish the expectation conditions from each other on the basis of the videotapes. Twenty-one percent of the data was recoded by a second person. The intraclass coefficients for the ratings for both target and test objects were .99 ($ps < .001$). Infants whose standard scores for frequency of the target action were more than 3.0 standard deviations above or below the mean in the unpredicted or baseline condition were considered statistical outliers and were removed from the data analyses ($n = 6$).

RESULTS

Table 2 presents the mean frequencies of target actions performed on test objects at each level of shape similarity within each label group, for both the predicted and the unpredicted conditions. Data from the predicted condition were not analyzed because it is impossible to distinguish actions performed as a result of an expectation about a shared property from those performed as a result of the reinforcing nature of the sound properties of the test objects themselves (see Baldwin et al., 1993). Thus, our analyses focus on infants' performance of actions on the test objects in the unpredicted and baseline conditions. We first examined the data from the baseline condition to assess whether target properties of the objects were nonobvious to infants. This examination revealed that the mean number of target actions performed in the baseline condition (in which objects made no sound) was never greater than 0.45, and

TABLE 2

Mean Frequency of Target Actions Performed on Test Objects in the Predicted and Unpredicted Conditions

Label group	Predicted condition		Unpredicted condition	
	High-similarity object	Low-similarity object	High-similarity object	Low-similarity object
Count-noun (n = 18)	7.61 (8.87)	6.50 (5.54)	4.28 (6.55)	6.67 (6.71)
Recorded-label (n = 18)	5.50 (6.85)	2.39 (4.00)	5.44 (6.45)	1.78 (2.13)
No-label (n = 20)	5.55 (5.34)	2.30 (4.69)	4.20 (5.49)	1.00 (1.56)
Word-alone (n = 19)	7.95 (11.70)	2.84 (4.34)	3.53 (4.94)	0.95 (1.03)
Light (n = 21)	4.89 (6.75)	1.56 (4.29)	4.44 (5.28)	0.89 (1.60)
Adjective (n = 18)	4.71 (7.23)	1.76 (2.70)	2.95 (3.51)	1.29 (2.19)

Note. Standard deviations are given in parentheses. Means within the baseline condition ranged from 0 to 0.45. In all groups except the count-noun group, infants performed significantly more target actions on high-similarity objects than on low-similarity objects, $ps < .05$.

the modal number of target actions performed in the baseline condition was 0. This finding demonstrates that the test objects did not suggest the nonobvious properties through their appearances.

Next, to test our key question whether infants' inductions in the unpredicted condition would vary as a function of shape similarity and label group, we conducted a 2 (shape similarity) × 6 (label group) mixed-factor analysis of variance (ANOVA). This analysis yielded a significant main effect of shape similarity, $F(1, 108) = 18.45$, $\eta_p^2 = .15$, $p < .001$, and a significant interaction of shape similarity and label group, $F(5, 108) = 3.70$, $\eta_p^2 = .15$, $p < .01$. To understand the source of this interaction, we examined the effects of label group separately at each level of shape similarity. Follow-up analyses indicated a significant main effect of label group on the frequency of target actions performed on low-similarity objects, $F(5, 108) = 9.62$, $\eta_p^2 = .31$, $p < .001$, but not on high-similarity objects, $p > .78$. Pair-wise comparisons using least-significant-difference (LSD) tests with a Bonferroni correction revealed that infants in the count-noun group performed more target actions on the low-similarity objects than did infants in the recorded-label, word-alone, adjective, no-label, and light groups (all $ps < .001$). These latter five groups did not differ significantly in the number of target actions performed on low-similarity objects (all $ps > .99$). Thus, when the test object was highly similar in shape to the target object, infants' generalization of target properties did not vary according to label group. In contrast, when the test object and the target object had nonsimilar shapes, infants in the count-noun group were more likely to generalize nonobvious properties to the test object than were infants in the other groups; this finding suggests that infants in the count-noun group expected the low-similarity object to have the target property, whereas infants in the other groups did not share this expectation.

Finally, we compared the frequency of target actions performed on high- versus low-similarity objects within each label group using planned paired t tests. Infants in the recorded-label, word-alone, adjective, no-label, and light groups performed significantly more target actions on high-similarity objects than on low-similarity objects, $ps < .05$. In contrast, infants in the count-noun group did not differ in their frequency of performing target actions on the high- versus low-similarity objects ($p > .05$).

DISCUSSION

The results of our study offer two key insights into the conditions under which infants rely on shared labels to guide their inductive inferences. First, infants rely on shared labels to guide their inductions only when those labels are presented within a naming context that clearly marks them as count nouns. When objects were labeled by the experimenter with a shared count noun, infants deemphasized shape information and relied on shared object labels to generalize nonobvious properties. In contrast, when objects were described with labels that were presented referentially but in isolation or marked as adjectives, infants relied on shared shape similarity to guide their inferences. The finding that count nouns are privileged in guiding infants' inductions suggests that it is not simply a shared label that guides infants' inductive inferences. Rather, it is the presence of a grammatical marker for a count noun paired with a shared label that signals inductive potential.

Second, infants view count-noun labels as having inductive potential when those labels are presented with clear indications of referential intent. When count-noun labels were presented by a recorded voice, infants relied on shared shape similarity, rather than shared object labels, as the basis for inferences. These findings are consistent with a large body of work that has demonstrated infants' sensitivity to cues about a speaker's referential intent when mapping words to objects (e.g., Baldwin et al., 1996; Campbell & Namy, 2003).

Our study offers critical insight into the debate surrounding the mechanisms underlying the labeling effect in induction. First, our findings indicate that infants do not rely on shared labels to guide their inferences solely because labels increase attention to objects. If this were the case, any type of cue that increased attention to the objects in our study should have influenced infants' inductions. Moreover, if infants simply increased their attention to the objects upon hearing shared intentional labels, we would have found the same pattern of inference across the three conditions that involved such labels (i.e., count-noun, word-alone, and adjective).[2]

Instead, our study provides clear support for the label-as-category-marker account. That is, our finding that infants used shared labels to guide their inferences when labels were conveyed intentionally and clearly marked as count nouns indicates that by 16 months of age, infants appreciate that count nouns license inductive inferences. When considered along with critical research demonstrating that naming objects enables infants to form categories of objects that may share more than just obvious perceptual features (e.g., Booth & Waxman, 2002; Fulkerson & Waxman, 2007; Waxman & Markow, 1995), our findings demonstrate that infants recognize that words index categories and categories promote inductive inferences.

Finally, our results challenge the label-as-attribute account on at least two fronts. First, according to this model, infants should have been more likely to generalize properties to the high-similarity test object when objects were labeled than when they were not labeled, as this model would predict an additive effect of labels plus shape. That is, the test object would share more critical features with the target object when the two objects shared both similarity and a label than when they shared only similarity. Our results reveal no such additive effect: Infants did not generalize the nonobvious property to the high-similarity object more often when it was labeled than when it was not. Second, if labels were simply features of objects, then the provision of any type of shared label, be it a count noun or an adjective, should have increased the shared similarity of the objects and thus guided infants' inductive inferences. Again, our results indicate that infants used the label to guide their inferences to the low-similarity object only when the label was presented referentially and marked as a count noun.

In summary, our findings have advanced understanding of the role of labels in guiding infants' inductive inferences, demonstrating that infants treat shared count nouns as markers of shared category membership. Future research examining how and when infants acquire this appreciation that labels act as markers of category membership will further understanding of the emergence of this critical ability.

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[2]To further rule out the attentional explanation, we coded looking time across the introduction phase for target and test objects for the count-noun, recorded-label, no-label, and light groups. The groups differed only minimally in looking times, and analyses indicated that any differences in looking times did not account for differences in performance of target actions across groups.

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