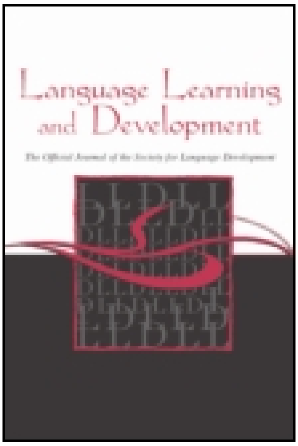

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Words Are Not Merely Features: Only Consistently Applied Nouns Guide 4-year-olds' Inferences About Object Categories

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Although there is considerable evidence that nouns highlight category-based commonalities, including both those that are perceptually available and those that reflect underlying conceptual similarity, some have claimed that words function merely as features of objects. Here, we directly test these alternative accounts. Four-year-olds ($n = 140$) were introduced to two different novel animals that were highlighted with nouns, adjectives, or stickers. Children heard a nonobvious novel property applied to the first animal and were asked whether this property applied to other animals that filled the similarity space between the original two animals. When the two animals were named with the same noun, children extended the property broadly throughout the similarity space. When the animals were marked with adjectives or stickers, children adopted a similarity-based pattern. These findings demonstrate clearly that nouns exert a unique effect on categorization—they promote category formation and engage conceptual reasoning beyond perceptual similarity alone.

There is now a clear consensus that from infancy through adulthood, naming plays a powerful role, supporting object categorization and inductive reasoning. However, there is considerable controversy concerning the mechanism that underlies this facilitative effect (e.g., Gelman & Waxman, 2007; Sloutsky, Kloos, & Fisher, 2007). On one account, nouns highlight category-based commonalities, including both those that are perceptually available and those that reflect underlying conceptual similarity (Waxman & Gelman, 2009). In contrast, others argue that words

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are merely features of the objects with which they have become associated (Sloutsky, 2010). The current experiment was designed to distinguish between these two distinctly different accounts for the naming effect.

To begin, we review the evidence for the facilitative role of naming on categorization and induction in infants and preschoolers. Within their first year of life, infants show a remarkable sensitivity to words, particularly nouns, when forming object categories (e.g., Dewar & Xu, 2007; Waxman & Booth, 2001). In the first set of experiments to address this question, Waxman and Markow (1995) demonstrated that providing 13-month-old infants with the same name for a set of distinct objects (e.g., four different animals) supported the formation of a unified category (e.g., animal). In contrast, when the objects were not labeled, infants failed to form the category. This effect has gained converging support from a range of methods (Plunkett, Hu, & Cohen, 2008). Subsequent research has identified the specificity of this phenomenon: naming each distinct object with a unique noun fails to promote object categorization (Waxman & Braun, 2005). Moreover, other kinds of auditory stimuli, including tones and melodic sequences, fail to facilitate categorization even when these stimuli are paired consistently with objects (Fulkerson & Waxman, 2007; Waxman & Braun). Tracing the developmental origins of this phenomenon, Ferry, Hespos, and Waxman (2010) document that nouns (but not tones) promote object categorization in infants as young as three months of age. Within the second year, infants begin to differentiate among different kinds of novel words (e.g., nouns, adjectives, verbs) when forming novel categories (Booth & Waxman, 2009; Waxman & Booth, 2001).

Thus, naming a set of distinct objects with a consistently applied noun highlights commonalities among them that might otherwise have gone undetected. In addition, there is strong evidence that by 13 months, naming engages abstract conceptual information (e.g., "cause," "animacy"), in addition to sensory and perceptual features of objects. By 13 months, naming guides infants' and preschoolers' inductive inferences about hidden properties (properties that cannot be discovered from perceptual inspection alone; e.g., Booth & Waxman, 2002; Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Jaswal & Markman, 2007). For example, Graham and colleagues demonstrated that when novel objects are introduced with the same count noun, 13- to 22-month-old infants assume that objects, even those that share only minimal perceptual similarity, also share a deeper, hidden property (Graham, Kilbreath, & Welder, 2004; Graham & Kilbreath, 2007; Welder & Graham, 2001). However, when the same objects are not named, infants assume that only objects that are perceptually very similar share hidden properties (Graham & Diesendruck, 2010). By 16 months, infants' expectations about naming and inductive inferences are finely tuned: Only novel words that are presented referentially, embedded within an intentional naming phrase, and marked as count nouns serve to promote infants' inferences about hidden properties (Keates & Graham, 2008).

Two alternative accounts have been advanced to account for these striking effects of nouns on categorization and induction. The predominant view is that nouns serve as beacons for conceptual categories. That is, noun meanings incorporate abstract conceptual knowledge as well as sensory and perceptual features of objects (Waxman & Gelman, 2009). Thus, naming objects highlights category-based commonalities, including both those that are perceptually available and those that reflect underlying conceptual similarity (Gelman, 2003; Waxman, 2004; Waxman & Gelman, 2009, 2010). But this account has not gone unchallenged. Most recently, Sloutsky and colleagues have asserted that the facilitative effect of nouns on young children's categorization is driven by general attentional factors rather than by the relation between the noun and the conceptual content of the category (Napolitano & Sloutsky, 2004; Sloutsky & Fisher, 2004; Sloutsky & Lo, 1999). On this view, labels are themselves perceptual features that are integrated into similarity computations (Sloutsky & Fisher, 2004; Sloutsky & Lo, 1999). On this account, then, young children's categorization and induction are based only on the perceptual similarity among entities; labels contribute to this similarity computation (e.g., Sloutsky, 2010; Sloutsky, Kloos, & Fisher, 2007). Proponents of this perspective acknowledge that, for adults, nouns may link to conceptual content, but this is not the case during the preschool years (Sloutsky, 2010; Sloutsky & Fisher, 2011).

In the current experiment, we evaluate these alternative accounts directly. We focus on 4-year-olds to address the now-persistent claim that words are merely features of objects for children of this age (Deng & Sloutsky, 2010; Sloutsky, 2010). To do so, we draw upon an elegant design pioneered by Landau and Shipley (2001). We present 4-year-olds with sets of novel animals. Each set includes two standard objects (Standard A and B) and three intermediate objects that we created by successively morphing together the two standards. Within this continuous similarity space, we selected i) a high similarity object, ii) a medium similarity object, and iii) a low similarity object (relative to Standard A). See Table 1. The task was straightforward: During the induction phase, the experimenter presented the first standard (Standard A) from a given set and ascribed to it a hidden novel property (e.g., "has sacra inside"). She then introduced Standard B, but ascribed to it no property. During the test phase, the experimenter presented the three intermediate test objects, asking children to judge whether the novel property, ascribed to Standard A, also applied to that test object. This aspect of the design permitted us to examine children's tendency to infer that the hidden property was shared by other objects, which have not themselves been explicitly named.

To adjudicate between the two alternative accounts, we manipulated the type of marker (novel noun, novel adjective, colorful sticker) applied to the standards and the consistency with which these were applied. Our reasoning was as follows: On the words-as-features account, any consistently applied marker, be it a noun, adjective, or sticker, should (1) highlight an inclusive category that encompasses the full similarity space between the two standards and (2) support the inference that the novel property can be ascribed to each. That is, children should treat all three of the test objects identically and infer they all share the nonobvious property. However, on the nouns-link-to-conceptual-content account, only consistently applied nouns should highlight an inclusive category that encompasses the similarity space between the two standards. In all other conditions, children's generalization of the novel nonobvious properties should vary linearly as a function of the perceptual similarity of the test object to the standard to which it was initially ascribed.

METHOD

Participants

The final sample consisted of 140 preschool-aged children ($M = 4.70$ years, SD = 0.29, range = 4.02–5.31 years) from primarily Caucasian families of middle-socioeconomic class in which English was the primary language. Children were randomly assigned to conditions, including a No Marker condition and six other conditions in which we varied the type of marker provided

TABLE 1
Standards and Test Objects Used

Set	**Standards**	**Similarity** High	Medium	Low
Standard A1				
Standard B1				
Standard A2				
Standard B2				
Standard A3				
Standard B3				
Standard A4				
Standard B4				

(noun, adjective, sticker) and the consistency (consistent vs. contrastive) with which it was applied. See Table 2 for participant details for each condition.

Materials

The visual materials consisted of four sets of digitally-rendered novel creatures. Each set included two standards (Standard A and B) and three test objects: a high similarity object, a medium similarity object, and a low similarity object (relative to Standard A; see Table 1). The test objects were created using a commercial morphing program that successively morphed together the two standards. The result was three pictured objects that filled the similarity space

TABLE 2
Participant demographics by condition

	Mean Age	*SD*	*Range*	*Gender*
No label	4.78	.25	4.43–5.28	10 males; 10 females
Noun				
Consistent	4.68	.39	4.02–5.31	8 males; 12 females
Contrastive	4.79	.33	4.15–5.23	8 males; 12 females
Sticker				
Consistent	4.83	.25	4.37–5.26	10 males; 10 females
Contrastive	4.57	.31	4.08–5.10	9 males; 11 females
Adjective				
Consistent	4.61	.18	4.33–4.97	11 males; 9 females
Contrastive	4.68	.23	4.15–5.00	11 males; 9 females

between the two standards. For each set, the experimenter introduced a nonobvious property (*has a sacra inside, eats modis, lives in a plinker, needs zavit to live).*

Procedure

Children were tested individually either in the lab or in a quiet area of their preschool. Each child first participated in three warm-up trials, designed to familiarize them with the task and to assure them that both "yes" and "no" were appropriate responses. During the warm-up, the experimenter introduced two familiar objects (e.g., a ball and a dog). She labeled one (e.g., "this is a dog") and simply drew the child's attention to the other object (e.g., "look at this one!"). She then presented two additional objects, and asked the child whether each was the same kind of thing as the first object. After this warm-up, the experimental task began. The novel property assigned within each set was counterbalanced across children. The order of presentation of the three sets, and of the test pictures within each set, was randomized across children.

The experimental task, repeated for each set of objects, comprised two phases: an introduction phase followed by a test phase. The introduction phase followed the same structure across the conditions; what varied was the type of marker provided and the consistency with which it was applied. The experimenter first revealed Standard A from a given object set, along with a novel property (e.g., "This (one/X) has a sacra inside"). She then introduced Standard B (e.g., "Look at this one/X"), with no mention of the property.

In the *No Marker* condition, the experimenter introduced the standards with a general attentional phrase (e.g., "Look at this one"). This condition allowed us to capture children's baseline patterns of inductive inference in this task. We predicted that children's extension of the novel property would be based on perceptual similarity between each test object and the standard. More specifically, we predicted a linear pattern: the more similar each test object was to Standard A, the more likely children would be to extend the novel property to it.

In the *Consistent Noun* condition, the two standards were labeled with the same novel count noun (e.g., Look at this *dax*). In the *Inconsistent Noun* condition, the standards were labeled with two different novel count nouns (e.g., *dax, cheb*). We predicted that in the Consistent Noun condition, children would establish a broad inclusive category and would extend the novel property broadly and equivalently across all three test objects, but that in the Inconsistent Noun condition, their extension of the novel property would vary as a function of the perceptual similarity between the test object and the standard.

In the *Consistent Adjective* condition, the two category standards were labeled with the same novel adjective (e.g., Look at this *daxish one*). In the *Inconsistent Adjective* condition, the standards were labeled with two different novel adjectives (e.g., *daxish one, chebish one*). Here, the different accounts of the naming effect yield divergent predictions. If the link to object kinds is specific to nouns, then adjectives should fail to support broad and inclusive generalization of nonobvious properties. Instead, preschoolers' inferences in the Adjective conditions, like those in the No Marker condition, should be guided by perceptual similarity. However, if a word acts merely as an additional feature of the named object, then any consistently applied name, be it a noun or an adjective, should have the same effect on categorization and reasoning. Thus, if the two standards are labeled with the same adjective, children's performance should mirror that of children in the Consistent Noun condition.

Finally, in the Sticker conditions, we introduced a different kind of marker, one that permits us to rule out the influence of children's prior experience with different kinds of words. By four years of age, children link novel adjectives specifically to object properties (e.g., color, texture) and not object categories (Waxman & Markow, 1998; Hall & Moore, 1997); this could influence their performance in the current category-based induction task. However, children have no prior expectations about stickers and their links to meaning. In the *Consistent Sticker* condition, the experimenter placed a small, colorful sticker on each standard, drawing children's attention to it without a novel label (e.g. "Look at this!"). She then removed the sticker and placed it on the second standard. In this way, the sticker was applied at a moment in time, as was the case for the nouns and adjectives, providing a stringent assessment of the nouns as features account. That is, this procedure allows us to assess whether stickers, when introduced in a manner similar to nouns (i.e., in a brief pairing), function similarly to nouns in guiding generalization. In the *Inconsistent Sticker* condition, each standard was marked briefly with a different sticker. Here again, the distinct theoretical accounts of the naming effect yield different predictions. If the facilitative effects of naming are based on the conceptual status of count nouns, then marking objects with stickers, however colorful or attention-grabbing they may be, should not influence generalization. Instead, children should display the baseline similarity-based pattern. However, if nouns exert their effects by simply serving as additional features of objects that figure into similarity computations, then the *Consistent Sticker* condition should mirror the *Consistent Noun* condition.

Immediately after the introduction phase, the test phase began. Here, the procedure was identical for children in all conditions. With both standards on the table, the experimenter brought out each test picture, one at a time and in random order, placing each between the two standards, asking, e.g., "Does this one have a sacra inside?" Note that the test pictures were not named or marked in any way. After presenting all three test pictures, the experimenter repeated this procedure for the remaining object sets.

Coding and preliminary analyses

For each child, we computed the percentage of yes responses to the high, medium, and low similarity test object, averaging across the four object sets. Preliminary analyses revealed no main effects or interactions for the child's gender; therefore, this factor was not included in the main analyses.

RESULTS

The results are consistent with the view that the facilitative effect of naming on categorization and induction in preschool-aged children is based on the conceptual status of count nouns, and cannot be explained by appealing to a feature-based account (see Figure 1).

To begin, we characterized children's patterns of inductive inference in the No Marker condition. We submitted children's extensions of the hidden property in the No Marker condition to an analysis of variance (ANOVA), using their responses to the high, medium, and low similarity test objects as a repeated measure. As predicted, there was a main effect of similarity, $F(2, 38) = 6.93$, $\eta_p^2 = .27$, $p < .01$, and this was characterized by a significant linear trend (high similarity > medium similarity > low similarity), $F(1, 19) = 7.91$, $\eta_p^2 = .29$, $p < .05$ (see Figure 1). Thus, in this baseline condition, 4-year-olds' tendency to generalize a nonobvious novel property to a test object varied linearly as a function of its similarity to the standard to which the property had been initially ascribed. This provides a foundation for considering the influence of different kinds of markers.

In the next analysis, we considered the effect of the different kinds of markers. We submitted children's property extensions to a 2 (Marker type: Noun, Adjective, Sticker) × 2 (Consistency: Consistent vs. Contrastive) × 3 (Similarity: High, Medium, Low) mixed factor ANOVA. This analysis yielded significant main effects of consistency and similarity, and a significant interaction between these two factors. These were qualified by a significant three-way interaction between marker type, consistency, and similarity, F (4, 228) = 2.56, $\eta_p^2 = .04$, $p < .05$ (see Figure 1). Children's treatment of the test objects varied reliably as a function of the kind of marker they heard applied to the standard, and the consistency with which it was applied.

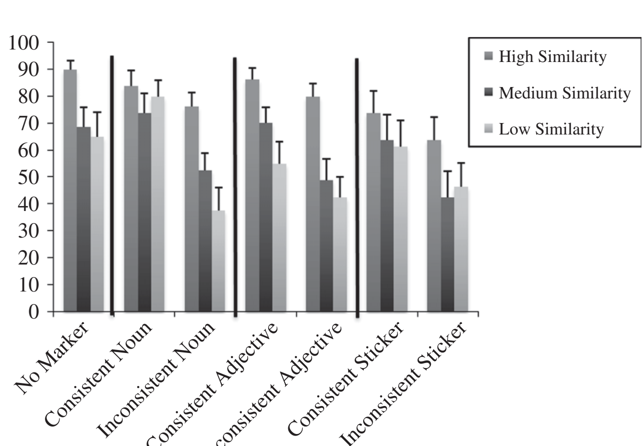

FIGURE 1 Generalizations to the test objects as a function of condition.

As predicted, only in the Consistent Noun condition did children extend the hidden property equally to all test objects, independent of their perceptual similarity to the standards. This is consistent with the nouns-link-to-conceptual-content account. We pursued this interaction more closely by examining performance in each condition.

Nouns as Markers. A 2 (Consistency: Consistent Noun vs. Inconsistent Noun) × 3 (Similarity: High, Medium, Low) ANOVA revealed a significant interaction between consistency and similarity, $F(2, 76) = 6.17$, $\eta_p{}^2 = .14$, $p < .01$. In the Consistent Noun condition, children formed an inclusive category and extended the property broadly across all members. Children's extensions to the three test objects were uniformly high; there was neither a main effect for similarity ($p > .14$) nor a linear trend (high>medium>low; $p > .42$). This suggests that the consistently-applied noun prompted children to treat the test objects as members of an equivalence class, and to use this as a basis for making inferences about properties that they could not observe directly.[1] However, in the Inconsistent Noun condition, performance echoed the similarity-based pattern observed in the No Marker condition: The pattern of linear change across the test objects was significant: $F(1, 19) = 14.50$, $\eta_p{}^2 = .43$, $p < .01$.

Adjectives as markers. A 2 (Consistency: Consistent Adjective vs. Inconsistent Adjective) × 3 (Similarity) ANOVA yielded only a main effect of similarity, $F\ (2, 76) = 35.42$, $\eta_p{}^2 = .48$, $p < .001$. Neither the consistency main effect ($F\ (1, 38) = 2.78$, $\eta_p{}^2 = .07$; $p = .10$) nor the consistency by similarity interaction was significant ($F\ (2, 76) = 1.62$, $\eta_p{}^2 = .04$, $p = .20$). In both Adjective conditions, children displayed a similarity-based extension pattern, mirroring that in the No Marker condition. That is, their tendency to extend the property to a test object varied linearly as a function of its similarity to the standard initially assigned the property, $F\ (1, 38) = 52.49$, $\eta_p{}^2 = .58$, $p < .001$.

Stickers as markers. When the standards were marked with stickers, the results mirrored those in the No Label and Adjective conditions. The 2 (Consistency: Consistent Sticker vs. Inconsistent Sticker) × 3 (Similarity) ANOVA yielded only a main effect of similarity, $F\ (2, 76) = 12.29$, $\eta_p{}^2 = .24$, $p < .001$. Neither the main effect of consistency ($F\ (1, 38) = 1.59$, $\eta_p{}^2 = .04$, $p = .22$) nor the interaction between consistency and similarity, ($F\ (2, 76) = 1.25$, $\eta_p{}^2 = .03$, $p = .29$) were significant. As in the No Marker and Adjective conditions, the pattern of linear change across the test objects was significant: $F(1, 38) = 18.74$, $\eta_p{}^2 = .33$, $p < .001$, indicating that children in both Sticker conditions generalized on basis of perceptual similarity.

DISCUSSION

The goal of this experiment was to adjudicate between two distinctly different accounts of the role of naming in categorization and induction, namely, the proposal that the link between naming and categorization is based on the conceptual status of count nouns versus the proposal that words are merely features of the objects to which they are applied. To differentiate between these accounts, we systematically varied: a) the types of markers applied to two category standards; and b) the consistency with which they were applied. We then examined children's inferences about

[1]Analyses comparing children's generalizations to the Low Similarity objects to chance-levels indicate that only generalizations in the Consistent Noun condition were above chance-levels ($p < .0001$).

test objects that filled the similarity space between these two standards. Our findings demonstrate that nouns (but not adjectives or stickers) facilitated categorization and guided children's inductive inferences, but only if the same noun was applied consistently to both standards. In the Consistent Noun condition, and in this condition only, children formed an inclusive category, one that encompassed all the test objects between the two perceptually dissimilar standards, despite the fact that none of these test objects had themselves been explicitly named. This effect was specific to consistently applied novel nouns. When the two standards were marked with novel adjectives or with stickers, children displayed a similarity-based extension pattern, regardless of whether the standards were marked with the same or different labels.

This outcome challenges the claim that nouns act as additional features of the objects to which they are applied. If this were the case, then any shared feature — be it a noun, an adjective, or even a sticker — should increase the perceived similarity of the two standards. Instead, the current findings underscore that nouns play a special role in promoting object categorization and supporting category-based inductive inferences.

When considered in conjunction with other recent evidence from infants and preschoolers (e.g., Ferry et al., 2010; Gelman & Markman, 1987; Gelman & Coley, 1990; Keates & Graham, 2008; Jaswal, 2004; Jaswal & Markman, 2007; Waxman & Markow, 1995; Waxman & Booth, 2001), our findings reveal that nouns influence conceptual organization in a way that is not evident for other kinds of markers. Naming diverse objects with the same noun promotes categorization and supports inductive inferences, even for properties that are nonobvious and even when the test objects themselves have not been named. Although the effect of nouns is clear, it is important to note that there are other routes to establishing membership in an object kind (e.g., shared functions for artifacts, essential properties for natural kinds, or causal properties more generally speaking) (Booth, 2008; Booth & Waxman, 2002).

In closing, our findings provide clear support for the proposal that nouns are an index of shared membership in a category of like kinds (Gelman, 2003; Waxman, 2004; Waxman & Gelman, 2009, 2010). This work also highlights that there is considerable continuity across development in the link between count nouns, object categories, and category-based inductive inferences.

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