Learning Count Nouns and Adjectives: Understanding the Contributions of Lexical Form Class and Social-Pragmatic Cues

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In two experiments, one hundred ninety-two 3-year-olds, 4-year-olds, and adults heard a novel word for a target object and then were asked to extend the label to one of two test objects, one matching in shape-based object category (the shape match) and the other matching in a property other than shape (the property match). We independently manipulated the lexical form class cues (count noun, adjective) and social-pragmatic cues (point actions, property-highlighting actions) accompanying the label. The impact of these two types of cue on extension differed markedly across age groups. Adults and 4-year-olds extended the word to the property match significantly more often when the term was modeled as an adjective and when it was presented with property-highlighting actions; but adults extended both adjectives and count nouns systematically to the property match when the speaker highlighted the non-shape property, whereas 4-year-olds systematically extended only adjectives to the property match under these conditions. Three-year-olds extended the word to the property match significantly more often when the label was modeled as an adjective but were not significantly affected by the social-pragmatic cues; and they failed to extend either adjectives or count nouns systematically to the property match when the speaker highlighted the non-shape property. We discuss the results in terms of the proposal that word learning draws on cues from multiple sources and the nature of the “shape bias” in lexical development.
Extensive research has established that young learners make use of several distinct sources of information during lexical acquisition. For example, when preschoolers face the task of assigning an interpretation to a novel word for an object, there is evidence that they take account of the object’s perceptual and conceptual properties, as well as lexical form class information accompanying the label and social-pragmatic information provided by the labeler (e.g., Baldwin & Tomasello, 1998; Bloom, 2000; Hall & Waxman, 2004; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Woodward & Markman, 1998). The current investigation focuses on these last two sources of information, exploring the interaction between lexical form class cues and social-pragmatic cues in word learning.

**Lexical Form Class Cues**

An important type of information available to guide word learning resides in the sentence context surrounding a novel term. By helping to identify the word’s lexical category, sentential cues provide learners with information about the label’s general meaning (e.g., Bloom, 1994; Macnamara, 1986). Previous research has established that young children are sensitive to sentential cues marking words from several different categories, including proper names (e.g., Gelman & Taylor, 1984; Hall, Lee, & Bélanger, 2001), mass nouns (Soja, 1992; Soja, Carey, & Spelke, 1991), prepositions (e.g., Fisher, Klingler, & Song, 2006), and verbs (e.g., Imai, Haryu, & Okada, 2005). Two lexical categories have been the focus of especially detailed investigation: count nouns (referring to object categories) and adjectives (referring to object properties). Hearing a novel word for an object modeled in a sentence appropriate for a count noun (e.g., “This is a ___”) commonly leads young children to extend the term to other objects from the same shape-based object category. Hearing the same word for the same object modeled in a sentence appropriate for an adjective (e.g., “This is a ___ one”) typically leads them to extend it to other objects that share a salient property other than shape, often color or texture (e.g., Hall, Waxman, & Hurwitz, 1993; Taylor & Gelman, 1988; Waxman & Markow, 1998). Recent results have revealed that children acquire sensitivity to form class cues indexing count nouns as distinct from adjectives before their second birthdays (e.g., Booth & Waxman, 2003, in press; Waxman, 1999; Waxman & Booth, 2001, 2003; Waxman & Markow, 1995, 1998).

**Social-Pragmatic Cues**

An independent body of research has documented that young children can make sophisticated use of social-pragmatic cues to guide their interpretation
of novel words. Some of these cues help learners to specify a novel word’s referent, and they include a speaker’s eye-gaze direction and pointing actions (e.g., Baldwin, 1991, 1995; Booth, McGregor, & Rohlfing, 2008; Moore, Angelopoulos, & Bennett, 1999; Tomasello, 2001; Woodward, 2004), a speaker’s expressions of emotion (e.g., Tomasello & Barton, 1994), as well as a speaker’s familiarity with an object in a particular discourse context (e.g., Akhtar, Carpenter, & Tomasello, 1996; Birch & Bloom, 2002; see also Diesendruck & Markson, 2001; Samuelson & Smith, 1998). Several studies have also recently demonstrated the importance of another type of social-pragmatic cue in children’s lexical acquisition: a speaker’s object-directed actions. There is naturalistic evidence indicating that caregivers touch and/or manipulate an object when they teach a new word for it (e.g., Gogate, Bahrick, & Watson, 2000; Zukow-Goldring, 2006), and recent experimental work confirms the value of these actions to children in object-word learning (Booth et al., 2008). These action cues are of interest in the current discussion because they also provide learners with another way—aside from lexical form class cues—to specify the interpretation of a novel noun as distinct from that of an adjective.

First, several studies have reported evidence suggesting young children are sensitive to a speaker’s object-directed actions in noun interpretation. Kobayashi (1997) offered 2-year-olds a novel word (in Japanese) for an object while demonstrating one of two types of action on the object, either shape highlighting or material highlighting. The word was modeled as a neutral noun, meaning that the form class cues indicated that the word was a category term but left unspecified whether it was a (possibly shape-based) object category or a material category. Children then had to choose another referent of the word, either a shape-matching object or a material-matching object. Children who saw the shape-highlighting action tended to choose the shape-matching object; those who saw a material-highlighting action tended to choose the material-matching object. In another study, Kobayashi (1998) presented 2-year-olds with a novel neutral noun for an unfamiliar object that had a salient part, while either pointing to the part (point action) or pointing to and acting upon the part (part-highlighting action). Children then were asked to extend the word to either the whole object or just the part. Children who saw the part-highlighting action tended to choose the part; those who merely saw the point tended to choose the whole object. Recently, Kobayashi (2002) found similar results with 2-year-olds even when the part-highlighting action did not involve moving the part. Together, these findings show that a speaker’s property- or part-highlighting actions can help to specify the interpretation of a novel noun.

Second, research by O’Neill, Topolovec, and Stern-Cavalcante (2002) has demonstrated the role of object-directed actions in 2- and 3-year-olds’
acquisition of adjectives. Children heard an unfamiliar adjective given to a target object with a target property, accompanied by either a point or a property-highlighting action. Children then had to choose between an object that matched the target object in terms of the target property and one that did not. Children were more likely to pick the property-matching object after seeing a property-highlighting action than after seeing a point action. These findings indicate that a speaker’s property-highlighting actions can aid in specifying the interpretation of unfamiliar adjectives.

Integrating the Cues

Prior explorations of learners’ use of speakers’ actions upon objects to guide word interpretation indicate that these gestures can enhance the ability to learn both nouns (e.g., Kobayashi, 1997, 1998, 2002) and adjectives (e.g., O’Neill et al., 2002). In this previous research, the form class cues and the social-pragmatic information have notably been consistent with each other: The intended meanings suggested by the actions were compatible with the general meanings expressed by the form class cues. By presenting actions and form class cues that were congruent, however, the previous studies leave open the important question of how the social-pragmatic information and the lexical category cues interacted to guide learning. Specifically, did the actions guide interpretation only because they were consistent with the meanings suggested by the form class cues, or would they also exert their effects if they conflicted with the meanings indicated by the lexical category cues (noun or adjective)? One way to answer this question is to manipulate object-directed actions and form class cues independently, an approach that would advance our understanding of two current issues in the study of word learning.

The first issue surrounds the relative contributions of different sources of information to the interpretation of novel words. One recurrent theme in research addressing this issue pertains to whether the presence of one type of cue obviates the need for another, in contexts where both cues are available to guide learning. A number of recent results clearly implicate the use of multiple cues in such situations. For example, Jaswal and Hansen (2006) asked participants to choose the referent of a novel word in the presence of two objects, one familiar and one unfamiliar. The authors gave preschoolers social-pragmatic information that suggested the familiar object was the appropriate referent by pointing or gazing toward it. At the same time, children received conflicting information via the cue provided by the differential familiarity of the two objects, which should have led them to choose the unfamiliar object, according to word-meaning constraints like mutual exclusivity (i.e., the assumption that an object has only one object-category label;
e.g., Markman, 1989; Markman, Wasow, & Hansen, 2003). Findings from a baseline condition revealed that preschoolers understood that the social-pragmatic cues implied reference to the familiar object, but children nonetheless tended to select the unfamiliar object as the word’s referent. This result indicates that the social-pragmatic information did not eliminate preschoolers’ reliance on the differential object familiarity (and by hypothesis, word-meaning constraints) to direct their interpretation. Other recent findings also suggest that social-pragmatic knowledge works in conjunction with word-meaning constraints to guide the learning of count nouns for whole-object categories (e.g., Hollich et al., 2000), count nouns for object-part categories (e.g., Saylor, Baldwin, & Sabbagh, 2004; Saylor & Sabbagh, 2004), and proper names for individual objects (e.g., Markman & Jaswal, 2004). An examination of the interaction between object-directed actions and form class cues would clarify whether social-pragmatic information also works together with lexical category information to guide the learning of adjectives and count nouns.

A second issue that would be advanced by investigating the interaction between form class cues and object-directed actions surrounds the “shape bias,” the well-documented tendency for learners to extend a novel count noun from a labeled object to other objects from the same shape-based object category (e.g., Graham, Williams, & Huber, 1999; Landau, Smith, & Jones, 1988). The interpretation of this phenomenon has been the subject of considerable debate. On the one hand, the shape-as-cue account views it as reflecting children’s knowledge that the novel word is a count noun, which refers to an object category, and that shape is a reliable cue to object-category membership (e.g., Diesendruck & Bloom, 2003; Markson, Diesendruck, & Bloom, 2008). On the other hand, the attentional-learning account posits that novel word extension on the basis of shape arises from learned associations between words appearing in certain linguistic contexts (e.g., “This is a ___”) and particular shapes and the subsequent increased attention to shape upon encountering novel words appearing in those contexts (e.g., Samuelson & Smith, 1999; Smith & Samuelson, 2006).

On either of the preceding accounts, it is important to specify the types of cues that drive learners to go beyond shape as a basis for extending count nouns, because many count nouns must not be generalized (solely) by shape (e.g., superordinate-level category terms, like “animal” or “vehicle;” or certain artifact category terms, like “rattle,” “sponge,” or “magnet”). These sorts of cues must factor into any ultimately successful account of the phenomenon, whether they are interpreted as signals of reference to an object category with members that do not share a common shape (shape-as-cue account) or as members of the set of learned associations that produce a higher-order tendency to attend to object features other than shape.
Recent research has begun to catalogue these types of cues. First, it is clear that perceptual cues can promote count noun extension in terms of properties other than shape. For example, adding eyes or shoes to a novel artifact-like object (suggesting an animate object) promotes extension of a novel count noun for the object in terms of the combination of shape and texture rather than shape alone (e.g., Jones & Smith, 1998; Jones, Smith, & Landau, 1991). Second, linguistic cues can foster the extension of novel nouns along dimensions other than shape. For example, giving children linguistic information indicating that a novel object is an animal rather than an artifact leads to extension by the combination of shape and texture rather than by shape alone (e.g., Booth, Waxman, & Huang, 2005; Yoshida & Smith, 2003). Similarly, telling children that a novel object is a food rather than an artifact results in extension by the combination of color, texture, and smell rather than by shape (e.g., Lavin & Hall, 2001). Furthermore, providing children with information about a novel artifact’s intended function can promote extension by properties other than shape (e.g., Diesendruck, Bloom, & Markson, 2003; Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Kemler Nelson & 11 Swarthmore College undergraduates, 1995). A test crossing object-directed actions with count noun and adjective form class cues would enable an assessment of whether nonlinguistic social-pragmatic cues also have the potency to drive learners to move beyond the tendency to extend count nouns by shape.

Current Experiments

We manipulated both form class cues and social-pragmatic cues (in the form of object-directed actions) accompanying a novel object word and examined the impact on extension. In our task, learners saw an object (e.g., a cup) with a property (e.g., it was spotted) and heard a novel count noun (e.g., “This is a flazzy”) or adjective (e.g., “This is a flazzy one”). To accompany the word, participants saw either a point action (e.g., a point toward the cup) or an object-directed action highlighting the non-shape property (e.g., a touch to the cup’s spots). We then asked participants to choose another referent of the word, either an object that matched in terms of the shape-based object category (the shape match, e.g., a striped cup) or one that matched in terms of the non-shape property (the property match, e.g., a spotted plate). Given prior results, we expected that both form class cues and object-directed actions would influence extension. Specifically, we predicted more property-match choices if the word was modeled as an adjective than if it was modeled as a count noun, and more property match choices if the word was presented with a property-highlighting action than if it was presented with a point action. We were especially interested in the interaction between
these two types of cues and, in particular, in whether property-highlighting actions would reduce the effect of form class cues, leading learners to extend both adjectives and count nouns systematically in terms of a non-shape property.

To provide a more nuanced assessment of the impact of the two cue types on word extension, we incorporated three additional factors into the design of the experiments.

Age

Our sample included adults, 4-year-olds, and 3-year-olds. The rationale for testing adults as well as preschoolers was to examine how both mature speakers and young word learners integrate form class and social-pragmatic cues when extending labels. We also had a particular interest in testing both 4-year-olds and 3-year-olds. As noted earlier, a number of studies have established that sensitivity to the semantic distinction between count nouns and adjectives first appears during the 2nd year (e.g., Booth & Waxman, 2003, in press; Waxman, 1999; Waxman & Booth, 2001, 2003; Waxman & Markow, 1995, 1998). There is, however, clear evidence that children as old as 3 years have difficulty in extending an ostensively defined novel adjective systematically from one object bearing a target property to other objects bearing the property when the objects belong to different familiar shape-based (basic-level) categories (e.g., in extending a novel adjective from a spotted cup to a spotted bowl rather than to a striped bowl). Several studies have reported that 3-year-olds remarkably fail to make such systematic extensions (e.g., Mintz, 2005; Mintz & Gleitman, 2002; Waxman & Klibanoff, 2000), even in cases where 4-year-olds succeed in doing so in the same task (e.g., Klibanoff & Waxman, 2000). Our inclusion of both 4- and 3-year-olds enabled us to examine whether the use of a property-highlighting action that provides a clear clue to the target property would eliminate this previously observed age-related difference in the ability to extend a novel adjective across familiar object categories. To date, this question has not been addressed in the literature.

Property Type

Choosing the non-shape properties for the object triads in this research was complicated by the fact that objects manifest properties of different types, some visible and some not. To acquire a word meaning involving a visible property (e.g., furry), a point action may be sufficient to signal that the property is relevant to the interpretation. On the other hand, to learn a word meaning involving a non-visible property (e.g., squishy), a point could not
be enough, and the property-highlighting action should be crucial. As a consequence, we expected that property-highlighting actions would have a more powerful impact on word extension when the object triads involved non-visible properties. We were also interested in whether learners would be generally more successful in extending words according to the properties when the properties were visible than when they were non-visible. With the notable exception of O’Neill et al.’s (2002) research on adjectives, few studies have compared the two property types, with the bulk of the experimental literature focusing on visible properties (in particular, color or texture). In the interest of further broadening our understanding of how learners extend labels (count nouns and adjectives) associated with different sorts of properties, we thus manipulated property type (visible and non-visible) within participants.

Object Familiarity

A final factor that we manipulated in this research was object familiarity. In Experiment 1, we used objects that were familiar, in the sense that participants likely knew shape-based count nouns for them (e.g., “cup,” “plate”). Previous research suggests that knowing a count noun for an object enhances the likelihood that preschoolers will interpret a novel word for it as labeling an object property, an effect that has been attributed to word-meaning constraints like mutual exclusivity (e.g., Hall et al., 1993; Markman & Wachtel, 1988). In Experiment 2, we replicated a portion of Experiment 1, using objects that were unfamiliar, in the sense that participants likely did not know a shape-based (basic-level) count noun for them. Several results suggest that children are more likely to extend a novel object word to other members of the same shape-based object category if the object is unfamiliar than if it is familiar (e.g., Hall, 1991; Hall et al., 1993; Markman & Wachtel, 1988). This phenomenon has also been interpreted as reflecting word-meaning constraints, leading children to take words for unfamiliar objects as labeling whole-object categories (e.g., Woodward & Markman, 1998). We therefore predicted that the use of unfamiliar rather than familiar objects would weaken learners’ tendency to extend a novel word to the property match. Our particular interest was in understanding whether any effects involving lexical form class and social-pragmatic cues observed in Experiment 1 would persist through this manipulation of familiarity.

In summary, two experiments explored the interaction between form class cues (count noun, adjective) and social-pragmatic information (point actions, property-highlighting actions) in the extension of novel object words. The primary goal was not only to elucidate the nature of the
interplay between two sources of information previously documented to
guide word learning but also to assess the potency of social-pragmatic
information as a way to move beyond the “shape bias” observed in the
interpretation of novel count nouns. To provide more fine-grained insight
into these issues, we manipulated three further factors in the design of the
experiments: the age of the participants (adults, 4-year-olds, 3-year-olds),
the visibility of the non-shape property under examination (non-visible,
visible), and the familiarity of the objects (familiar in Experiment 1,
unfamiliar in Experiment 2).

EXPERIMENT 1

Method

Participants

There were 144 participants: forty-eight 3-year-olds ($M = 42.8$ months;
$SD = 3.2$ months), forty-eight 4-year-olds ($M = 53.5$ months; $SD = 3.4$
months), and forty-eight adults. Within each age group, 24 participants
were assigned randomly to the point action and property-highlighting action
conditions. Within each age by action-type condition, 12 participants were
assigned randomly to the count noun and adjective conditions. Within each
action type by form class condition, the 3- and 4-year-olds’ conditions had
roughly equal numbers of boys and girls and a roughly equivalent mean age.
Children were from middle- and upper-middle-class backgrounds. They
were tested individually either in day care centers or in the laboratory.
Adults were tested individually or in small groups in a quiet room on a
university campus.

Materials

There were six object triads. Each triad consisted of a target object (e.g., a
spotted cup), a shape-based category match (the shape match, e.g., a
striped cup), and a non-shape property match (the property match, e.g.,
a spotted bowl). For three of the triads, the non-shape property was visible
(e.g., spotted for a cup). For the three others, it was non-visible (e.g.,
squishy for a duck) and could not be ascertained through visual inspection
alone (e.g., for the triad in which the target object was a squishy duck, it
was impossible to tell from looking whether any of the objects were
squishy, because they all were covered with the same yellow felt). Table 1
lists all six triads.

We also used a bird-like hand-puppet, named “Sam.”
Participants sat at a table across from the experimenter. The experimenter introduced Sam and asked participants to help him. The procedure varied according to whether participants were in the point action condition or the property-highlighting action condition.

**Point action conditions.** On the first of six trials, the experimenter brought out the target object from the first triad. In the count-noun condition, the experimenter said, “It’s an X.” In the adjective condition, the experimenter said, “It’s an X one.” In both conditions, the label coincided with a point toward the object with the index finger from a distance of about 10 cm.

In the count-noun condition, the experimenter repeated the label (simultaneously with the point) three more times as follows: “See, this one is an X. Do you like Xs? Well, I really like this X.” In the adjective condition, the experimenter repeated the label (simultaneously with the point) three more times as follows: “See, this one is very X. Do you like X things? Well, I really like this X one.”

The target remained in view on the experimenter’s side of the table, in front of the child but out of the child’s reach. The experimenter then
said, “You know what? Sam is looking for another X” (count-noun condition) or “...another X one” (adjective condition). The experimenter then brought out the first test object (the shape match or the property match) and said, “First, he finds this.” The experimenter pointed to the object. The experimenter placed this object in front of the child, several inches to the child’s left or right. The experimenter then brought out the second test object and said, “Then he finds this.” Again, the experimenter pointed to the object. The experimenter also placed this object in front of the child, on the side opposite the first test object.

The experimenter then reminded the child about the target by again pointing to it. At the same time, the experimenter said, “Remember, this one is an X” (count-noun condition) or “...very X” (adjective condition).

In the count-noun condition, the experimenter said, “Sam is looking for another X. Can you show Sam another X?” In the adjective condition, the experimenter said, “Sam is looking for another X one. Can you show Sam another one that is X?” The experimenter wrote down children’s choices. Adults indicated their choices by marking left or right on an answer sheet.

After participants made a choice, the experimenter said, “Thank you,” and removed the triad from the table. The same procedure was followed for the remaining five trials.

**Property-highlighting action conditions.** The procedure was the same as in the point action conditions, except that the experimenter produced an action highlighting the target object’s non-shape property (e.g., she touched three spots on the spotted cup) at the same times she had produced a point action in the point action conditions. The experimenter also produced an action highlighting the non-shape properties of the test objects exactly when she had pointed to them in the point action conditions. Table 1 contains a description of all property-highlighting actions.

In all conditions, each triad was paired consistently with a given novel word. From the first to the last triad shown in Table 1, these words were “moopy,” “zirky,” “glorgy,” “flummy,” “rifty,” and “flazzy.” Across the six triads, the shape match and property match were presented first half the time, in one of two alternating orders: property-shape-shape-property-property-shape or shape-property-property-shape-shape-property. The side of placement of the first test object was fixed within a participant but alternated across participants within each condition. The order of presentation of the six triads was counterbalanced across participants, subject to the constraint that visible and non-visible property triads were given in alternation.
Results

To reiterate, we predicted that lexical form class and social-pragmatic cues would both affect extension, with more property-match choices in the adjective conditions and more property-match choices in the property-highlighting action conditions. Our central interest was in the interaction between these cues and specifically in whether the property-highlighting actions would be potent enough to diminish the effect of form class cues, leading learners to extend both adjectives and count nouns systematically to the property match.

To test our predictions, we began with an overall mixed analysis of variance (ANOVA) using the proportion of property-match choices as the dependent measure, with action type (point, property highlighting), form class (adjective, count noun), and age (3-year-olds, 4-year-olds, adults) as between-subjects factors, and property type (non-visible, visible) as a within-subjects factor. These proportions appear in Figure 1. Consistent with our predictions, there were significant main effects of action type, $F(1, 132) = 54.08, p < .0001, \eta^2_p = .29$, and form class, $F(1, 132) = 41.45, p < .0001, \eta^2_p = .24$. There was also a significant main effect of age, $F(2, 132) = 8.51, p < .0005, \eta^2_p = .11$, reflecting an increase in selections of the property match from 3-year-olds to 4-year-olds to adults; and there was a significant main effect of property type, $F(1, 132) = 49.44, p < .0001, \eta^2_p = .27$, indicating more selections of the property match when the property was visible.

The ANOVA also revealed four significant or near-significant interaction effects. One was the interaction between action type and property type, $F(1, 132) = 10.70, p < .005, \eta^2_p = .08$, indicating that the increase in the tendency to pick the property match when given a property-highlighting action was greater when the property was non-visible. The three others involved action type and age: a two-way interaction between action type and age, $F(2, 132) = 7.57, p < .001, \eta^2_p = .10$; a three-way interaction among action type, age, and property type, $F(2, 132) = 4.24, p < .05, \eta^2_p = .06$; and a near-significant four-way interaction among these three factors and form class, $F(2, 132) = 2.76, p < .10, \eta^2_p = .04$.

To shed light on the last three interactions, we followed up the overall ANOVA with separate planned analyses of each age group separately. Within each age group, we carried out three analyses. First, we conducted a mixed ANOVA using the proportion of property-match choices as our dependent measure, with action type and form class as between-subjects factors and property type as a within-subjects factor. Second, to assess participants’ performance in absolute terms in both the point action and the property-highlighting conditions, we compared the mean proportion of
property-match choices within each form class by property-type condition to chance (\(=0.50\)). We used a Bonferroni-corrected alpha level of .0125 (.05/4) because we conducted four comparisons within each action-type condition per age group. The results appear in Figure 1. Finally, to evaluate the consistency of participants’ choices across trials in both the point action and the property-highlighting action conditions, we classified any

FIGURE 1 Results of Experiment 1. Error bars represent 1 standard error. *Significantly different from chance (\(=0.50\)). \(N=12\) per condition.
participant within each form class by property-type condition as a “property-match chooser” if he or she picked the property match on three out of three trials, and as a “shape-match chooser” if he or she picked the shape match on three out of three trials. Table 2 gives the numbers of property- and shape-match choosers. We used the binomial distribution to determine whether the number of property- or shape-match choosers in any condition exceeded chance. The probability that any participant would be classified as a property- or shape-match chooser by chance was $0.50 \times 0.50 \times 0.50$ or $0.125$. Because we conducted eight comparisons within each action-type condition per age group, our Bonferroni-corrected alpha level was $0.00625$ ($0.05/8$). As a result, 6 or more participants out of 12 were required in any condition to exceed chance. See Table 2 for the results.¹

We now report the results of these analyses from each age group.

**Adults**

In the ANOVA, there were significant main effects of action type, $F(1, 44) = 67.37, p < .0001, \eta^2_p = .61$; form class, $F(1, 44) = 20.33, p < .0001, \eta^2_p = .32$; and property type, $F(1, 44) = 45.48, p < .0001, \eta^2_p = .51$. There was also a significant action-type by property-type interaction, $F(1, 44) = 14.66, p < .0001, \eta^2_p = .25$, indicating that the increase in the tendency to pick the property match when given a property-highlighting action was greater for non-visible properties. These effects were also observed in the overall ANOVA. In addition, there was a near-significant action-type by form class interaction, $F(1, 44) = 3.01, p < .10, \eta^2_p = .07$, and a significant three-way interaction among action type, form class, and property type, $F(1, 44) = 7.48, p < .01, \eta^2_p = .15$. These last two results reflect the fact that for adults, the form class effect was significantly diminished when they saw a property-highlighting action, and this diminishment was particularly evident when the property was visible.

We next compared the proportion of property-match choices within each action-type condition to chance. When the novel word was presented with a point action, the proportion was significantly above chance in the adjective/visible-property condition, significantly below chance in the count-noun/non-visible-property condition, and at chance in the two other conditions.

¹All adults and all 4-year-olds made a selection on all trials. However, six 3-year-olds failed to choose on one trial for either visible or non-visible properties. The missing data were handled as follows: For the proportion of property-match choice analyses, the proportions were calculated as numbers out of two, not three. For the pattern analyses, the missing data points were counted as being neither property-match nor shape-match choices when we determined property-match choosers and shape-match choosers.
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<td>2</td>
<td></td>
</tr>
<tr>
<td>4-year-olds</td>
<td>Count Noun</td>
<td>0</td>
<td>10*</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
<td>1</td>
<td>4</td>
<td>6*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>Count Noun</td>
<td>0</td>
<td>10*</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
<td>0</td>
<td>4</td>
<td>7*</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Property-</td>
<td>3-year-olds</td>
<td>Count Noun</td>
<td>1</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Highlighting</td>
<td>Adjective</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4-year-olds</td>
<td>Count Noun</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
<td>7*</td>
<td>0</td>
<td>8*</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Adults</td>
<td>Count Noun</td>
<td>6*</td>
<td>2</td>
<td>10*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjective</td>
<td>11*</td>
<td>0</td>
<td>12*</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

*Significantly different from chance.

$N = 12$ per condition.
When the word was presented with a property-highlighting action, however, the proportion was significantly above chance in all but the count-noun/non-visible-property condition, where it was well above 0.50 but statistically at chance.

We then examined the numbers of property-match and shape-match choosers within each action-type condition. The results were consistent with those from the preceding analyses. In the point action conditions, there were significantly more property-match choosers than expected by chance in the adjective/visible-property condition and significantly more shape-match choosers in the count-noun/non-visible condition. In the property-highlighting conditions, there were significantly more property-match choosers than expected by chance in all conditions.

4-Year-Olds
As was the case with adults, the ANOVA revealed significant main effects of action type, $F(1, 44) = 16.79$, $p < .0001$, $\eta^2_p = .28$; form class, $F(1, 44) = 20.13$, $p < .0001$, $\eta^2_p = .31$; and property type, $F(1, 44) = 15.76$, $p < .0001$, $\eta^2_p = .26$. There was also a significant action-type by property-type interaction, $F(1, 44) = 11.85$, $p < .005$, $\eta^2_p = .21$, again indicating that the increase in the tendency to pick the property match when given a property-highlighting action was greater for non-visible properties. Unlike the case with adults, there were no significant interactions involving form class, indicating the effect of form class was equivalent when the novel words were accompanied by point actions and by property-highlighting actions.

We then compared the proportion of choices of the property match within each action-type condition to chance. When the word was presented with a point action, the proportion was significantly above chance in the adjective/visible-property condition, significantly below chance in the count-noun/non-visible-property condition, and at chance in the two other conditions. These findings echoed those from adults. When, however, the word was presented with a property-highlighting action, the proportion of property-match choices was significantly above chance in the adjective conditions, but it was merely at chance in the count-noun conditions. These results differed from those of adults, who showed a greater tendency to select the property match when the word was presented as a count noun, especially when the property was visible.

Next, we considered the numbers of property- and shape-match choosers in each action-type condition. The results were consistent with those from the preceding analyses. In the point action conditions, we observed significantly more property-match choosers than expected by chance in the adjective/visible-property condition and significantly more shape-match
choosers in the count-noun/non-visible condition. In the property-highlighting conditions, in contrast, we found significantly more property-match choosers than expected by chance in the adjective but not the count-noun conditions.

3-Year-Olds

In the ANOVA, there were significant main effects of form class, \( F(1, 44) = 6.04, p < .05, \eta_p^2 = .12 \), and property type, \( F(1, 44) = 7.83, p < .01, \eta_p^2 = .15 \). Unlike the case with adults or 4-year-olds, there was no significant main effect of action type or indeed any further significant effects.

We next compared the proportion of property-match choices with each action-type condition to chance. In the point action conditions, the proportion was significantly below chance in the count-noun/non-visible-property condition, as it was with adults and 4-year-olds. Unlike the case with adults and 4-year-olds, however, the proportion was merely at chance in the adjective/visible-property condition. In the property-highlighting conditions, the proportion of property-match choices did not differ from chance in any condition, unlike the case with adults and 4-year-olds who extended words to the property match at above-chance levels in the adjective conditions.

We then examined the numbers of property- and shape-match choosers within each action-type condition. When the word was accompanied by a point action, the number of shape-match choosers significantly exceeded chance in the count-noun/non-visible-property condition. When the word was accompanied by a property-highlighting action, however, the number of property- (or shape-) match choosers did not differ from chance in any condition.

Finally, we carried out supplementary analyses to explore age-related differences in learners’ use of the property-highlighting actions in word extension. We split the proportion of property-match choices data by action type instead of by age, and we performed mixed ANOVAs separately within the point action and property-highlighting action conditions. Form class and age were the between-subjects factors; and property type was the within-subjects factor. In both the point and property-highlighting action conditions, there were significant main effects of form class, \( F(1, 66) = 37.77, p < .0001, \eta_p^2 = .36 \), and \( F(1, 66) = 11.52, p < .001, \eta_p^2 = .15 \), respectively, and property type \( F(1, 66) = 39.10, p < .0001, \eta_p^2 = .37 \), and \( F(1, 66) = 11.00, p < .001, \eta_p^2 = .14 \), respectively. The main effect of age was, however, significant in the property-highlighting action conditions, \( F(2, 66) = 12.77, p < .0001, \eta_p^2 = .28 \), but not in the point action conditions. Post-hoc pair-wise tests (Fisher’s least significant difference [LSD]) revealed
that, in the property-highlighting action conditions, adults made significantly more property-match choices than 4-year-olds \((p < .05)\), who in turn made significantly more property-match choices than 3-year-olds \((p < .05)\). There were no other significant effects in either ANOVA.²

Discussion

We examined the use of lexical form class cues (adjective, count noun) and social-pragmatic cues (point actions, non-shape property-highlighting actions) in a task requiring 3-year-olds, 4-year-olds, and adults to extend a novel word from a target object to one of two test objects: a shape-based object-category match (the shape match) or a non-shape property match (the property match). Our primary interest was in the interaction between these two types of cues, particularly in whether the use of property-highlighting actions would weaken the impact of lexical form class cues on extension, leading learners to extend both adjectives and count nouns systematically to the property match.

We observed striking age differences not only in the impact of these two types of cue on extension but also in the interaction between them. Adults’ extensions were powerfully influenced by both the form class cues and the social-pragmatic cues. They were more likely to extend adjectives than count nouns to the property match, and they were more likely to extend words to the property match when they were accompanied by a property-highlighting action than when they were accompanied by a point action. When, however, the speaker highlighted the non-shape property, adults systematically extended both count nouns and adjectives to the property match. For adults, then, the property-highlighting actions strongly mitigated the impact of the lexical form class cues on extension. Four-year-olds’ extensions were also significantly affected by both the form class and the social-pragmatic cues, but when the speaker provided property-highlighting actions, they systematically extended adjectives but not count nouns to the property match. For 4-year-olds, then, the

²We conducted two further analyses. One focused on the familiarity of the 18 stimulus items. We asked all preschoolers, after they completed the task, to name each object they had seen. Three- and 4-year-olds provided an appropriate count noun on 92.8% and 93.7% of trials, respectively. These findings indicate that the stimuli were familiar, in that children knew a count noun for them.

A second analysis focused on the performance of the individual stimulus triads. We calculated the mean proportion of property-match choices for each of the six triads across the 144 participants. Using one-way repeated-measure ANOVAs, we found no significant difference across either the three visible or the three non-visible property triads. In other words, the triads within each property type performed similarly across participants.
count-noun lexical form class cues remained potent in fostering extension to the shape match, even in the face of clear actions highlighting the non-shape properties. Finally, 3-year-olds’ extensions were significantly guided by the form class cues but not by the social-pragmatic cues. Moreover, when the speaker highlighted the non-shape property, 3-year-olds failed to extend either adjectives or count nouns systematically to the property match. For 3-year-olds, the property-highlighting actions were not even sufficiently powerful to lead to the systematic generalization of *adjectives*.

We begin our discussion of the observed age differences by considering the contrast between adults and 4-year-olds. In the point action conditions, the performance of these two groups was strikingly similar (see Figure 1). In the property-highlighting conditions, however, adults systematically extended both adjectives and count nouns to the property match, whereas 4-year-olds did so only for adjectives. There is more than one possible explanation for this age-related difference. One possibility is that it reflects a change in the understanding of the meaning of the count-noun lexical form class cues. For example, it is possible that the association between count nouns and extension by shape (or knowledge of the link between count nouns and reference to shape-based object categories) is weaker in adults’ lexicons than in 4-year-olds’ lexicons, as a result of adults’ knowledge of a larger number of count nouns, many of which (i.e., non-basic level terms) are *not* extendible (solely) in shape terms. A problem with this explanation, however, is that shape is a primary organizing property of the extension of count nouns in both children’s and adults’ vocabularies (Samuelson & Smith, 1999). Alternatively, adults may be more adept than 4-year-olds at overriding a word-meaning constraint like mutual exclusivity to interpret a novel count noun for a familiar object as a second (non-shape-based) object-category term. A concern with this explanation, however, is that even young preschoolers can override mutual exclusivity to acquire hierarchically related count nouns (Taylor & Gelman, 1989; Waxman & Hatch, 1992).

Given the preceding considerations, we suggest another interpretation of the difference between adults and 4-year-olds, namely that it stems from a change in the understanding of the social-pragmatic information provided in the task. In particular, we posit that adults may have a more sophisticated ability than 4-year-olds to infer the relevance of a property-highlighting action to a speaker’s intended interpretation of a novel count noun. This proposal is consistent with other recent results suggesting that there are increases during early childhood in sensitivity to social-pragmatic cues to word meaning (Hollich et al., 2000; Saylor et al., 2004).
We turn now to the difference between 4-year-olds and 3-year-olds. Four-year-olds extended novel adjectives systematically to the property match, both in the point action conditions (when the property was visible) and in the property-highlighting conditions. Three-year-olds did so in none of these conditions, although they did show a non-significant tendency to extend adjectives to the property match in the property-highlighting condition when the property was visible (i.e., the proportion of property match choices was 0.70). Again, there is more than one possible explanation for the observed age-related difference. One possibility is that it stems from a change in the understanding of the semantic implications of adjectival form class cues. For example, the strength of the association between adjectives and extension by non-shape properties (or knowledge of the link between adjectives and reference to non-shape properties) may increase between 3 and 4 years, as children’s repertoire of adjectives grows in size and diversity (see Smith, 2001; see also Samuelson & Smith, 1999). This explanation is, however, difficult to reconcile with prior evidence indicating that 2-year-olds represent an appropriate semantic distinction between novel count nouns and adjectives (e.g., Booth & Waxman, 2003, in press; Waxman, 1999; Waxman & Booth, 2001; Waxman & Markow, 1995, 1998). An alternative possibility is that 4-year-olds are better able than 3-year-olds to invoke a word-meaning constraint, like mutual exclusivity, in order to interpret novel adjectives as referring to object properties by overriding the bias to interpret these words as referring to whole-object categories. Yet children appear to have the ability to use mutual exclusivity before the age of 2 years (e.g., Markman et al., 2003).

Another possibility is that the difference reflects a change in the understanding of the social-pragmatic information provided in the task. In particular, 4-year-olds may be more proficient than 3-year-olds in determining the relevance of a speaker’s property-highlighting actions to the intended interpretation of a novel adjective. As noted, other recent results suggest that there are increases in the strength of social-pragmatic information as a cue to object-word interpretation during the 2nd year (Hollich et al., 2000) and to object-part word interpretation during the preschool years (Saylor et al., 2004). This explanation does not, however, account for the finding that 3-year-olds failed to extend adjectives systematically to the property match even in the point action conditions.

In light of the preceding discussion, we suggest another interpretation of the difference between 4- and 3-year-olds, namely that it follows from a change in the information required to identify a target property shared by two objects that differ with respect to shape-based (basic-level) category. This change may be a reflection of 4-year-olds’ increased information-processing abilities (cf. Klibanoff & Waxman, 2000; see Halford, 1992,
As noted earlier, several previous studies have reported that 3-year-olds fail to generalize novel adjectives appropriately across familiar basic-level categories (e.g., Klibanoff & Waxman; Mintz, 2005; Mintz & Gleitman, 2002; Waxman & Klibanoff, 2000). For example, Klibanoff and Waxman found that 3-year-olds—but not 4-year-olds—failed to extend an ostensibly defined novel adjective systematically from one object (e.g., a spotted elephant) to a different-category property match (e.g., a spotted frog) rather than to a different-category property mismatch (e.g., a solid frog). Yet when 3-year-olds receive additional information to help them isolate the target property, they may succeed in extending the word across familiar categories. For example, 3-year-olds may succeed if they see multiple exemplars of the target property from different basic-level categories, prior to being asked to extend the adjective (e.g., two or three spotted animals from different animal categories, rather than just one spotted cat). This additional information may help children identify the property by highlighting what is common across the perceptually and conceptually different objects (Waxman & Klibanoff; see also Mintz & Gleitman). Furthermore, 3-year-olds may succeed if, in addition to providing multiple exemplars of the target property, the speaker explicitly mentions the basic-level count nouns when introducing the adjective, providing evidence that the word is a label for a property rather than a (second) label for a basic-level category (e.g., “This is a blickish cat,” rather than “This is a blickish one”) (Mintz & Gleitman; but see Waxman & Klibanoff).

According to the preceding account, 3-year-olds failed to extend adjectives systematically in our point action condition because of limitations in their ability to identify a target property when it is instantiated in objects from two different (shape-based) basic-level categories. This failure is consistent with findings from several previous experiments involving tasks similar to ours (e.g., Klibanoff & Waxman, 2000; Mintz, 2005; Mintz & Gleitman, 2002; Waxman & Klibanoff, 2000). Furthermore, 3-year-old failure to extend adjectives systematically in our property-highlighting condition suggests that their difficulty in identifying a target property in cross-category adjective extension cannot be surmounted simply by furnishing social-pragmatic information in the form of object-directed actions. Consistent with this suggestion, one recent study has reported that 3-year-olds showed a significant increase in the tendency to extend adjectives across familiar object categories when they saw property-highlighting actions in a task that also furnished additional cues to help identify the target property (e.g., explicit mention of the basic-level count nouns; O’Neill et al., 2002, Experiment 2). An important challenge for future research will be to specify further the precise constellations of
task features that support appropriate adjective extension in children younger than 4 years.3

In Experiment 1, participants in all age groups were more likely to extend the word to the property match when the property was visible than when it was non-visible. In the point action conditions, the finding that property visibility affected adjective extension is straightforward, given our expectation that these words would be extended to the property match and given that the property embodied by the property match was detectable only when visible.4 The finding that property visibility also affected count-noun extension is more notable, because we expected that count nouns would be extended to the shape match, which was easy to detect regardless of whether the non-shape property was visible or non-visible. In the property-highlighting action conditions, the significant effect of property type is also striking, because the property-highlighting actions should have made visible and non-visible properties equally easy to detect. This effect of property type may reflect the fact that the visible properties were simply more salient than the non-visible properties, perhaps because the visible properties were more static and enduring. As a result, it may have been easier for participants to map a novel word to them.

As noted, the property-type distinction in this experiment corresponded directly to whether the non-shape property in question could be inferred from inspecting the object visually, which was true of the three visible properties (i.e., furry, rough, spotted) but not of the three non-visible properties (i.e., squishy, rattling, magnetic). This distinction was also correlated with the functional significance of the property for the object.

3Samuelson, Horst, Schutte, and Dobbertin (2008; see also Samuelson & Smith, 2000) have recently reported that 3-year-olds but not 4-year-olds extended a novel object word by shape rather than material, even when the speaker highlighted a non-visible deformable property (squishy or bendable) when introducing the label, and regardless of whether the word was presented as a count noun (e.g., “This is a kiv”) or as a mass noun (e.g., “This is some kiv”). The authors suggested that the result reflects an overgeneralization of the shape bias among 3-year-olds, given that 1) most count nouns children know at this age name rigid objects in categories organized by shape and 2) the deformable objects that children know how to label at this age are like rigid things in that they are both solid and named by count nouns (e.g., a napkin, a towel). As a result, the authors argued that 3-year-olds tended to generalize words for demonstrably deformable objects by shape. This result is consistent with our finding on the duck trial that 3-year-olds failed to extend a word on the basis of squishiness, even when they saw an action highlighting the property.

4We note, however, that extension to the shape match does not necessarily indicate a failure to interpret the novel word as a property term. Although it is possible that choosing the shape match reflects a shape-based category interpretation, it is also possible that such a choice reflects a shape-property interpretation.
Specifically, the non-visible properties were more likely than the visible properties to be seen as signaling the objects’ functions. As a result, learners may have viewed the non-visible properties as providing clearer criteria for category membership and, thus, as offering a more potent basis for extending novel count nouns. Consistent with this suggestion, English has simple count nouns corresponding to object categories organized around our three non-visible properties (i.e., “sponge,” “rattle,” and “magnet”), but it has no simple count nouns for object categories organized around the three visible properties. Given these considerations, it is notable that participants did not show a greater tendency to extend count nouns to the non-visible property match than to the visible property match, perhaps because of the greater salience of the visible properties.

EXPERIMENT 2

Experiment 2 was a modified partial replication of Experiment 1, designed to assess the interplay between lexical form class and social-pragmatic cues in a word extension task following one further manipulation. As noted earlier, there is evidence that the familiarity (in the sense of knowing a basic-level count noun) of an object provides preschoolers with another cue to the interpretation of a novel word for it. In Experiment 1, the objects were familiar to children. In Experiment 2, we replicated the 4-year-old conditions from Experiment 1, replacing familiar objects with unfamiliar objects for which children would not know a basic-level count noun. In light of prior results, we expected that this change would weaken the tendency to extend a novel word to the property match (e.g., Hall et al., 1993; Markman & Wachtel, 1988; Woodward & Markman, 1998). Given previous evidence that object familiarity works in conjunction with other sources of information to guide the learning of count nouns for object-part categories (e.g., Saylor & Sabbagh, 2004), however, we postulated that the effects of form class cues and social-pragmatic cues observed in Experiment 1 would persist through this manipulation.

We focused on 4-year-olds in Experiment 2 to study the impact of object familiarity in an age group strongly influenced by both form class and social-pragmatic cues in Experiment 1. Recall that 4-year-olds in Experiment 1 revealed a significant form class effect even in the presence of property-highlighting actions. We did not test adults in Experiment 2, because it is difficult to ensure a successful manipulation of familiarity in this age group. Given their larger vocabularies and greater conceptual and pragmatic knowledge, adults may be less likely than preschoolers to
interpret an intended set of unfamiliar objects as lacking a basic-level count noun; and indeed, previous tests of the impact of familiarity on word interpretation have typically not included adults (e.g., Hall et al., 1993; Markman & Wachtel, 1998; Sandhofer & Smith, 2004; Saylor & Sabbagh, 2004). We also did not test 3-year-olds in Experiment 2, because they failed to extend either count nouns or adjectives systematically to the property match in Experiment 1. As a result, they were less than ideal as a target group for examining the effects of familiarity on extension, given our expectation that this manipulation would lower the tendency to select the property match.

**Method**

**Participants**

Forty-eight 4-year-olds participated \((M = 52.9 \text{ months}; SD = 3.7 \text{ months})\), including 24 assigned randomly to the point action and property-highlighting action conditions. None had participated in Experiment 1. Within each action-type condition, 12 children were assigned randomly to the count-noun and adjective conditions. Each action type by form class condition contained roughly equal numbers of boys and girls and had a roughly equal mean age. Children were tested as in the previous experiment.

**Materials**

There were six object triads, each one modeled on a triad from Experiment 1, except that the objects were novel items for which we expected children would not know the shape-based (basic-level) count noun. All non-shape properties were the same as those in Experiment 1. Table 3 lists all six unfamiliar triads.

We again used Sam, the puppet.

**Procedure**

This was the same as in Experiment 1. Table 3 lists all property-highlighting actions.

**Results**

As in Experiment 1, we predicted significant effects of form class and action type. In addition, given our use of unfamiliar objects, we now expected that the tendency to select the property match would be lower
<table>
<thead>
<tr>
<th>Property type</th>
<th>Target (Action)</th>
<th>Shape match (Action)</th>
<th>Property match (Action)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-visible</td>
<td>Squishy staircase-shaped object (Squeeze twice between fingers and thumb)</td>
<td>Hard staircase-shaped object (Try to squeeze twice between fingers and thumb)</td>
<td>Squishy bridge-shaped object (Squeeze twice between fingers and thumb)</td>
</tr>
<tr>
<td></td>
<td>Noisy tube object (Shake twice)</td>
<td>Silent tube object (Shake twice)</td>
<td>Noisy pyramid object (Shake twice)</td>
</tr>
<tr>
<td></td>
<td>Magnetic s-shaped object (Lift twice with a magnet)</td>
<td>Non-magnetic s-shaped object (Try to lift twice with a magnet)</td>
<td>Magnetic o-shaped object (Lift twice with a magnet)</td>
</tr>
<tr>
<td>Visible</td>
<td>Furry pentagonal object (Stroke twice with palm of hand)</td>
<td>Smooth pentagonal object (Stroke twice with palm of hand)</td>
<td>Furry cylindrical object (Stroke twice with palm of hand)</td>
</tr>
<tr>
<td></td>
<td>Rough trimmed heart-shaped object (Stroke twice with palm of hand)</td>
<td>Smooth trimmed heart-shaped object (Stroke twice with palm of hand)</td>
<td>Rough haystack-shaped object (Stroke twice with palm of hand)</td>
</tr>
<tr>
<td></td>
<td>Spotted garden ornament (Touch three spots with index finger)</td>
<td>Striped garden ornament (Touch three stripes with index finger)</td>
<td>Spotted strawberry pot (Touch three spots with index finger)</td>
</tr>
</tbody>
</table>
than in Experiment 1. To facilitate comparison with Experiment 1, we
analyzed the data in the same way we analyzed the 4-year-olds’ data from
that experiment. See Figure 2 and Table 4. To assess directly the impact of
object familiarity on property-match selections, we then conducted analyses
combining the data from this experiment with the data from the
4-year-olds of Experiment 1.

To begin, we carried out a mixed ANOVA, with action type and form
class as between-subjects factors and property type as a within-subjects fac-
tor. As in Experiment 1, there were significant effects of both action type,
\(F(1, 44) = 19.96, \ p < .0001, \ \eta^2_p = .31,\) and form class, \(F(1, 44) = 30.34,
\ p < .0001, \ \eta^2_p = .41.\) Also as in Experiment 1, there was no interaction
between action type and form class, indicating that the effect of form class
was comparable whether the word was introduced with a point action or a
property-highlighting action. Unlike Experiment 1, however, there were no
effects involving property type.

We then compared the proportions of property-match choices within
each action-type condition to chance. In the point action conditions,
the proportions were at chance in both adjective conditions, whereas the
proportion had been significantly above chance in the adjective/visible
condition in Experiment 1. The proportions were significantly below chance
in both count-noun conditions, whereas the proportion had been at chance
in the count noun/visible condition in Experiment 1. In the property-
highlighting action conditions, the proportions were statistically similar to
those in Experiment 1: They were significantly above chance in both adject-
ive conditions and at chance in both count-noun conditions.

Next, we examined the numbers of property- and shape-match choosers
within each action-type condition. In the point action conditions, the number
of property-match choosers was at chance in both adjective conditions,
whereas it had been significantly above chance in the adjective/visible con-
dition of Experiment 1. The number of shape-match choosers significantly
exceeded chance in both count-noun conditions, whereas it had been at
chance in the count noun/visible condition of Experiment 1. In the property-
highlighting conditions, the results were similar to those from Experiment 1:
The number of property-match choosers significantly
exceeded chance in both adjective conditions, and the number of
shape-match choosers was at chance in both count-noun conditions.

To provide a direct test of object familiarity on property-match choices,
we then combined the data from the 4-year-olds in Experiment 1 with the
data from Experiment 2. We carried out a mixed ANOVA, with familiarity
(familiar in Experiment 1, unfamiliar in Experiment 2), action type, and
form class as between-subjects factors, and property type as a within-
subjects factor. There were significant effects of action type,
FIGURE 2  Results of Experiment 2. Error bars represent 1 standard error. *Significantly different from chance (=0.50). \(N = 12\) per condition.

TABLE 4
Experiment 2: Number of Property- and Shape-Match Choosers

<table>
<thead>
<tr>
<th>Action type</th>
<th>Age</th>
<th>Property type</th>
<th>Form class</th>
<th>Non-visible</th>
<th>Visible</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4-year-olds</td>
<td>Count Noun</td>
<td>1</td>
<td>8*</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjective</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>4-year-olds</td>
<td>Count Noun</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjective</td>
<td>7*</td>
<td>0</td>
<td>7*</td>
</tr>
</tbody>
</table>

*Significantly different from chance.

\(N = 12\) per condition.
$F(1, 88) = 36.55, p < .0001, \eta^2_P = .29$, form class, $F(1, 88) = 49.58, p < .0001, \eta^2_P = .36$, and property type, $F(1, 88) = 5.55, p < .05, \eta^2_P = .06$. There was also a significant action-type by property-type interaction, $F(1, 88) = 12.16, p < .005, \eta^2_P = .12$, revealing that the increase in the tendency to pick the property match when given a property-highlighting action was greater for non-visible properties. Although there was no significant main effect of familiarity, there was a significant interaction between familiarity and property type, $F(1, 88) = 10.88, p < .005, \eta^2_P = .11$. Simple main effects tests revealed that the effect of familiarity (i.e., fewer property match choices for unfamiliar than familiar objects) was significant for visible properties, $F(1, 88) = 4.93, p < .05, \eta^2_P = .05$, but non-significant and in the opposite direction for non-visible properties.5

Discussion

The results of Experiment 2 replicated the effects of form class and action type we observed among 4-year-olds in Experiment 1, despite the fact that we used unfamiliar objects in place of familiar objects. As in Experiment 1, we observed no interaction between form class and action type, suggesting

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5As in Experiment 1, we conducted two further analyses. One focused on the unfamiliarity of the 18 stimulus items. We presented the 18 (unfamiliar) stimulus items from Experiment 2 along with the 18 (familiar) stimulus items from Experiment 1 to a separate group of four 4-year-olds. The unfamiliar and familiar objects were intermixed and presented in one of two random orders. Children were asked to name an object if they knew a name, and to say, “I don’t know,” if they did not. The experimenter first gave them a pair of practice objects. One was familiar (a pencil). All children provided the appropriate count noun and received praised. The other practice object was unfamiliar (a novel elastic object). The experimenter encouraged children to say, “I don’t know,” for this object, telling children that she had never seen anything like it before. If children did not say, “I don’t know,” (e.g., tried to label or describe it), the experimenter asked if they were sure and repeated that she had never seen it before. The experimenter continued in this manner, until she elicited an “I don’t know” response, which she praised. The experimenter then showed the 36 stimulus items, one at a time. Consistent with the results of Experiment 1, children provided an appropriate count noun for 94.5% of the familiar objects. In contrast, children provided a count noun for only 34.8% of the unfamiliar objects. This 34.8% includes any word that could have been a count noun, including those that were ambiguous (e.g., “stone”) or inappropriate (e.g., “carpet” for the furry cylindrical object). Despite using this liberal criterion, we found that the difference between sets of stimuli was highly significant, $F(1, 34) = 59.42, p < .0001$, reassuring us that we had succeeded in manipulating the familiarity of the objects between experiments.

As in Experiment 1, we also calculated the mean proportion of property-match choices for each of the six triads across the 48 participants. Using one-way repeated-measures ANOVAs, we found no significant difference across either the three visible properties or the three non-visible properties triads. Thus, the triads within each property type behaved similarly across participants.
that form class cues remained powerful cues to extension even in the presence of the property-highlighting actions. The primary new discovery was that the unfamiliarity of the objects exerted the predicted effect on interpretation, significantly lowering participants’ tendency to select the property match, although only when the property was visible. This effect was not observed for non-visible properties. The finding for visible properties is consistent with previous demonstrations that object unfamiliarity promotes the tendency to extend words to objects sharing a (shape-based) object category, diverting children from extending them to objects sharing a visible property (e.g., Hall et al., 1993; Markman & Wachtel, 1988). The non-significant effect of familiarity when the property was non-visible likely reflects at least partly the fact that the tendency to choose the property match for non-visible properties was very weak even for familiar objects, especially when words were introduced with point actions.

**GENERAL DISCUSSION**

In two experiments, we manipulated form class cues (count noun, adjective) and social-pragmatic information (point actions, property-highlighting actions) in an examination of 3-year-olds’, 4-year-olds’, and adults’ extension of novel object words. We had two main objectives: to specify the nature of the interaction between two types of information previously shown to influence word learning and to evaluate the strength of social-pragmatic information as a means of driving learners to move beyond the “shape bias” previously observed in the extension of novel count nouns.

**Multiple Cues in Word Learning**

We discovered that form class cues and object-directed actions both affected word extension but that they exerted strikingly different effects in our three age groups. Adults’ extensions were powerfully influenced by both the form class cues and the social-pragmatic cues, but the two factors interacted, such that adults extended both count nouns and adjectives systematically to the property match when the speaker highlighted the non-shape property. The property-highlighting actions thus tended to trump lexical form class cues in guiding adults’ extensions. Four-year-olds were also significantly affected by both form class and social-pragmatic cues, yet they extended adjectives but not count nouns systematically to the property match when the speaker highlighted the non-shape property. The count-noun lexical form class cues thus remained powerful in driving 4-year-olds to extend to the shape match, even in the face of actions
highlighting the non-shape properties. Finally, 3-year-olds were significantly guided by the form class cues but not by the social-pragmatic cues; they failed to extend either adjectives or count nouns systematically to the property match when the speaker highlighted the non-shape property. The property-highlighting actions thus were not sufficiently strong to lead 3-year-olds to extend adjectives to the property match.

We have offered several possible interpretations of the differences between adults and 4-year-olds and between 4-year-olds and 3-year-olds. Here, we simply underscore the point that our findings provide new insight into the claim that word learning is a multiply cued process. Our findings document the contribution of both social-pragmatic cues and form class cues to object-word extension, consistent with other recent demonstrations that social-pragmatic knowledge operates in conjunction with other types of knowledge (e.g., word-meaning constraints) to guide the acquisition of whole-object count nouns (e.g., Hollich et al., 2000), object-part count nouns (e.g., Saylor & Sabbagh, 2004), and proper names (e.g., Markman & Jaswal, 2004). At the same time, our results suggest that the contribution of these sources of information to word-extension changes with time, again consistent with other recent demonstrations of age-related differences in the weighting of particular cues in extending words (e.g., Hollich et al.; Saylor & Sabbagh).6

We also documented the effects of two other cues to word extension. The first was the visibility of the target property. When the label was accompanied by a point action, learners were more likely to extend it to the property match when the property was visible (e.g., spotted) than when it was non-visible (e.g., rattling). This result was straightforward: If learners could not see the property, a point to the object naturally could not have led them to use it as a basis for extension. Notably, however, the effect of property type held up, regardless of whether the novel word was modeled as an adjective (which called for extension to the property match; cf. O’Neill et al., 2002, Experiment 1) or a count noun (which called for extension to the shape match). Moreover, the effect persisted even when the word was accompanied by an action highlighting the property, rendering both visible and non-visible properties readily detectable. We have noted that the visible object properties may have provided a more plausible basis for word

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6We have proposed that the property-highlighting actions used in these experiments affected word extension by providing learners with a marker of the intent of the speaker to refer to some feature of an object, but it is possible that these actions operated simply by making the property more salient. If the latter explanation is correct, then we would expect to find that highlighting the property through non-intentional means (e.g., producing the same action accidentally upon the object) would result in a similar effect on word extension.
extension because they were more salient (more enduring, more stable) than
the non-visible properties. In any case, we stress that these results indicate
that the tendency to extend a novel word on the basis of a shared property
depends to a significant degree on the nature of the property in question.

The second additional cue that influenced word extension was object
familiarity, in the form of knowledge of a shape-based (basic-level) count
noun for an object. This cue exerted an effect on word extension inde-
pendent of the effects of both form class and action type. Regardless of
whether 4-year-olds knew (Experiment 1) or did not know (Experiment 2)
a count noun for the target objects, they more often extended a novel adver-
tive than a novel count noun to the property match, and they more often
extended the word to the property match given a property-highlighting
action than given a point action. At the same time, 4-year-olds were more
likely to extend a novel word given to a target object with a visible property
to the property match if the object was familiar than if it was unfamiliar,
consistent with the predictions of word-meaning constraints (e.g., Hall
et al., 1993; Markman & Wachtel, 1988). This discovery suggests that
form class and social-pragmatic knowledge operated in concert with
word-meaning assumptions to guide interpretation.

The Shape Bias

Our other primary aim was to elucidate the shape bias previously observed
in the extension of novel count nouns. Prior research has demonstrated that
both perceptual cues (e.g., Jones et al., 1991) and linguistic cues (e.g., Booth
et al., 2005) can lead preschool children to extend count nouns in terms of
properties other than shape. The current research enabled an assessment of
whether certain nonlinguistic social-pragmatic information is sufficient to
overturn the tendency to extend count nouns for familiar objects by shape.
We found that the potency of the social-pragmatic information to overturn
the shape bias differed across the age groups. Adults were powerfully
swayed by the property-highlighting actions and were largely able to over-
come the bias to extend count nouns by shape, especially when the target
property was visible. Four-year-olds, in contrast, were strongly influenced
by the property-highlighting actions but nonetheless failed to extend novel
count nouns systematically according to the non-shape properties. These
results suggest that 4-year-olds were not able to override fully the drive to
extend novel count nouns according to shape in the presence of the
property-highlighting actions. For 4-year-olds, the shape bias was thus
impervious to the influence of countervailing social-pragmatic cues. Finally,
3-year-olds were not significantly influenced by the property-highlighting
actions, indicating that these social-pragmatic cues did not clearly guide
extension at this age. In sum, adults but not preschoolers were able to use non-shape property-highlighting actions to overcome the tendency to extend a novel count noun by shape.

The current experiments have focused on the impact of property-highlighting actions on the extension of novel count nouns and adjectives, but they leave open many questions about the role of such social-pragmatic information in guiding the learning of words from different lexical categories. Consider one of the property-highlighting actions used in the current experiments. As we have shown, the action of stroking a furry hat may be taken to highlight the hat’s furriness and foster extension on the basis of that visible property. Suppose, however, that the same action was applied to a different kind of object, such as a furry cat. In that instance, the same action might be taken to be an instance of petting and might serve to highlight the individual identity of the cat rather than the property of furriness. If the form class cues accompanying the novel word were ambiguous between an adjective and a proper name (e.g., “This is ZIRKY”), the same action might enhance the learning of a property term in the case of the hat (like “furry”) or an individual term in the case of the cat (like “Fifi”). This example calls attention to yet another cue—the domain of the object category—that may interact with social-pragmatic information to guide the learning of words from different lexical form classes. Further detailed exploration of the interplay between multiple cues in word learning will be important for specifying the intricacies of children’s mastery of the vocabulary of their native language.

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