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The Role of Comparison in the Extension of Novel Adjectives

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Previous research has documented that basic-level object categories provide an initial foundation for mapping adjectives to object properties. Children ranging from 21 months to 3 years can successfully extend a novel adjective (e.g., *transparent*) to other objects sharing a salient property if the objects are all members of the same basic-level category; if the objects are members of different basic-level categories, they fail to extend adjectives systematically (R. S. Klibanoff & S. R. Waxman, 2000a; S. R. Waxman & D. B. Markow, 1998). The present study proposed that the process of comparison is instrumental in children's ability to move beyond this foundation. To promote comparison, 2 target objects were introduced to 3-year-olds. In Experiment 1, the targets had contrastive properties (e.g., 1 transparent and 1 opaque object); in Experiment 2, the targets had consistent properties (e.g., 2 transparent objects). The results of both experiments illustrate that comparison—a general psychological process—operates in conjunction with naming to support the extension of novel adjectives to properties of objects from diverse basic-level categories.

John Locke (1690/1975) posited that mapping words to properties of objects (e.g., color, texture, temperature) is a straightforward matter. Particularly for properties of objects that are available directly to the senses (or "simple ideas," in Locke's terminology), all that is required is an association between these simple ideas and their names. On the basis of this logic, Locke made two assertions: first, that these simple ideas would be among the earliest acquired and, second, that once an association between a sense experience and its name was established, that name would be readily and widely extended to describe other portions of the same sensory experience.

> Thus the same colour being observed to-day in chalk or snow, which the mind yesterday received from milk, it considers that appearance alone, makes it a representative of all of that kind; and having given it the name *whiteness*, it by that sound signifies the same quality wheresoever to be imagined or met with. (Locke, 1690, Book II, chaps. xi, 9)

According to Locke's view, names for properties (such as *white* or *rough*) should be extended readily across a diverse range of objects (e.g., such as cups or cats).

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However, despite its logic and intuitive appeal, Locke's seemingly straightforward account fails to capture the process by which young learners map words to objects and their properties. For although many object properties are indeed directly available to our senses, the words describing these "simple ideas" (in Locke's terminology) are not well represented in infants' earliest lexicons. Instead, property terms tend to emerge late, especially as compared with words describing other, perhaps more complex, concepts ("complex ideas" in Locke's terminology) such as object categories (e.g., dog or table; Fenson et al., 1994). In addition, contrary to Locke's assertion, children do not extend newly acquired property terms widely to a diverse range of objects. Instead, these terms are initially applied to fairly restricted sets of objects (Klibanoff & Waxman, 2000a; Waxman & Markow, 1998).

These observations suggest that mapping words to object properties requires more than simply associating a sensory experience with a name. In fact, recent experimental and theoretical work reveals that for children ranging between 21 months and 3 years of age, the mappings between novel adjectives and object properties (such as color or texture) initially unfold within the context of basic-level object categories (such as cup or cat). The earliest evidence for this position comes from 21-month-old infants who are just beginning to produce adjectives spontaneously on their own (Fenson et al., 1994). Waxman and Markow (1998) presented 21-month-olds with a single target (e.g., a red object) and two test objects (e.g., a red vs. a blue object). Infants successfully extended a novel adjective, applied to the target (e.g., a red car), to a test object sharing that property (e.g., another red car). However, they did so if, and only if, the target and test objects were all members of the same basic-level object category (e.g., all cars). In sharp contrast, if the target (e.g., a red car) and test objects (e.g., a red vs. a blue horse) were members of different basic-level categories, 21-month-olds failed to extend the adjective systematically. This outcome is startling, especially because in these experiments, the target and matching test objects were identical with respect to the property in question: On trials examining color, the objects were painted from precisely the same can of paint (e.g., red #14, blue

#27); on trials examining texture, they were covered with exactly the same fabric (e.g., sandpaper, corduroy).

Additional research has confirmed that this pattern is not restricted to infants in their earliest efforts to build a repertoire of property terms. Like infants, 3-year-old children successfully extend novel adjectives to object properties when all the objects are members of the same basic-level category (e.g., all plates), but they fail to extend adjectives systematically if the target (e.g., a transparent plate) and test object (e.g., a transparent cup) are members of different basic-level categories. This is intriguing, because by 3 years of age, most children have acquired a fairly extensive set of adjectives to describe object properties, and they extend these familiar adjectives to properties of objects from diverse basic-level categories (e.g., *wet* applied to diapers, grass, finger paintings; *red* applied to balloons, apples, shoes). Nonetheless, when initially mapping a novel adjective to an object property, 3-year-olds exhibit a clear reliance on basic-level categories to guide their extensions (Klibanoff & Waxman, 2000a; see also Gelman & Markman, 1985; Hall, Waxman, & Hurwitz, 1993; Waxman, 1990). This developmental evidence, bolstered by evidence from adults' on-line processing (Allopenna, Magnuson, & Tanenhaus, 1998; Deutsch & Pechmann, 1982; Halff, Ortony, & Anderson, 1976; Levelt, 1993; Medin & Shoben, 1988) and from connectionist models (Gasser & Smith, 1998), suggests that a reliance on basic-level object categories is not a fleeting phenomenon associated with only very young word learners or with only a small set of adjectives. On the contrary, basic-level categories appear to play a foundational role in the extension of novel adjectives.

This robust phenomenon presents a clear challenge to Locke's (1690/1975) view, but it also raises several questions of its own. One set of questions concerns the source(s) underlying this foundational role for basic-level categories. For example, it is possible that the initial tendency to extend adjectives within, but not across, basic-level categories derives from the linguistic fact that across languages, adjectives are morphologically, syntactically, and semantically dependent on the (basic level) count nouns that they modify (Bolinger, 1967; Dixon, 1982; Wierzbicka, 1986). It is also possible that this phenomenon rests upon aspects of the objects themselves, and in particular on the degree of similarity—perceptual and/or conceptual—among members of basic-level categories.

Another set of questions centers more directly on the developmental implications of this phenomenon. Although a novel adjective may initially be restricted to objects from the same basic-level category, it is eventually extended appropriately to properties of objects from diverse basic-level categories. In the experiments reported here, we examined the circumstances that motivate this advance. We focused on the processes of naming and comparison because, by its very nature, extending a novel word from one object to another involves a comparison between objects.

A long and productive research tradition has revealed several important insights into the process of comparison (see Gentner & Medina, 1998, or Medin, Goldstone, & Gentner, 1993, for reviews). First, we know that for both adults and children, the comparison process highlights similarities, as well as differences, among objects (Gentner & Markman, 1994; Goldstone & Medin, 1994; Kemler, 1983; Smith, 1989). Second, it is apparent that the process of comparison is itself strongly influenced by the similarity—both perceptual and conceptual—among the entities being compared. When entities are similar (e.g., red car, blue car) and, in particular, when they vary primarily along a single dimension, the comparison process is relatively straightforward. The entities are readily compared, and the relevant similarities (both are cars) and differences (red vs. blue) are readily abstracted. However, when entities are dissimilar (e.g., red car, blue dolphin) and, in particular, when they vary along several dimensions, it is more difficult to determine the relevant basis for comparison and to identify the relevant dimension(s). Comparisons involving objects that vary along several dimensions are difficult for adults (Gentner & Markman, 1994; Goldstone & Medin, 1994), and they appear to be especially challenging for young children (Kemler, 1983; Smith, 1984; Tighe & Tighe, 1969).

We suggest that these insights are directly relevant to the task of mapping novel adjectives to object properties. The disparity between children's success when mapping adjectives within a given basic-level category and their failure to do so across different basic-level categories may be a consequence of the particular comparisons involved. When the target (e.g., transparent plate) and test objects (e.g., transparent vs. opaque plate) are drawn from the same basic-level category, the comparison is relatively straightforward. The objects can be readily aligned on the basis of their common category membership (plates: transparent, opaque) and compared. In this case, the relevant property (transparency) can be readily identified, mapped to the adjective, and then extended to the appropriate test object. In contrast, when the target (e.g., transparent plate) and test objects (e.g., transparent vs. opaque toothbrush) are drawn from different basic-level categories, the comparison is ambiguous: The objects can be aligned on the basis of common category membership[1] (plate [transparent] vs. toothbrush [transparent, opaque]) or on the basis of transparency (transparent [plate, toothbrush] vs. opaque [toothbrush]). In such cases, then, the comparison itself provides insufficient support for identifying the relevant dimension(s). This observation suggests that the process of comparison underlies the foundational role of basic-level categories.

In the experiments reported here, we go one step further to propose that this same process is instrumental in children's ability to move beyond this foundation, to extend adjectives appropriately beyond the limits of basic-level categories. A review of the comparison literature reveals a potential mechanism for this advance. Performing a relatively simple comparison—one that supports the identification of a relevant dimension—can itself facilitate subsequent performance on more abstract and difficult comparisons (Gentner & Medina, 1998; Gentner & Namy, 1999; Gentner & Rattermann, 1991; Kotovsky & Gentner, 1996). This is intriguing because it suggests that learners take advantage of relatively simple comparisons in the service of mastering increasingly abstract comparisons (Gentner & Medina, 1998; Kotovsky & Gentner, 1996). If this process is beneficial in advancing children beyond an initial reliance on basic-level object categories in the extension of novel adjectives, then children who first perform a simple comparison—one that permits them to identify the target property and

[1] Note that the objects can also be aligned on the basis of a host of other properties that are common to members of a basic-level category (e.g., shape, part structure).

map it to a novel adjective—should subsequently succeed when it comes to extending that adjective in more complex comparisons.

Preliminary support for this hypothesis comes from another of our studies (Klibanoff & Waxman, 2000a). Providing 3-year-olds with an initial opportunity to map a novel adjective within the context of a basic-level category (e.g., from one transparent plate to another) facilitated their subsequent ability to extend that adjective to members of different basic-level categories (e.g., to transparent plates, bottles), even in the absence of any corrective feedback. In contrast, providing children with an initial opportunity to map a novel adjective across different basic-level categories (e.g., from a transparent plate to a transparent toothbrush) conferred no such advantage. Thus, when the initial process of comparison was relatively simple (in this case, when the initial mapping involved novel adjectives and objects from the same basic-level category), children readily identified the target property, mapped it to the novel adjective, and went on to succeed in the more difficult task of extending the adjective beyond the limits of a basic-level category.

In the current series of experiments, we sought a broader base of support for the hypothesis that providing children with an initial opportunity to perform a relatively simple comparison supports their extension of novel adjectives beyond the basic level. We also asked whether the comparison process alone is sufficient to motivate an advance beyond the basic level or whether children depend upon the presence of a name for the property. We included 3-year-old children as research participants for two reasons. First, because in previous work 3-year-olds have exhibited a strong dependence on basic-level categories when initially extending novel adjectives (Klibanoff & Waxman, 2000a, 2000b), they provide us with an opportunity to identify the factors that permit them to move beyond this basic-level foundation. Second, because 3-year-olds reveal a clear expectation that novel adjectives refer to properties of objects (Hall et al., 1993; Heibeck & Markman, 1987; Waxman, 1990),[2] they provide us with an opportunity to examine the contribution of naming in this process.

To provide a natural opportunity for comparison, we introduced children to two (rather than one) target objects. The first target object always exemplified the novel object property under consideration (e.g., a transparent object). In Experiment 1, we examined one type of comparison—explicit contrast—by introducing a second target object (e.g., an opaque object) that contrasted with the first. In Experiment 2, we considered another type of comparison—multiple positive exemplars—by introducing a second target (e.g., another transparent object) that exemplified the same novel property as the first. In both experiments we asked whether children could identify the target property when faced with objects that were drawn from different basic-level categories than any of the targets.

In each experiment, we systematically varied the similarity between the first and second target object. Half of the children were randomly assigned to a *within-basic*-level comparison, in which the first and second targets were both drawn from the same basic-level category; the remaining children were assigned to an *across-basic*-level condition, in which the targets were drawn from different basic-level categories. We expected that providing children with an opportunity to perform a simple comparison—one that permitted the identification of the relevant property—would support its subsequent identification in objects from diverse basic-level categories.

To examine the contribution of naming, we had half of the children in each condition hear a novel adjective[3] in conjunction with the targets (*novel adjective* condition) and half participate in a control task (*no-word* condition). If comparison alone is sufficient to support the identification of the relevant target property, then performance in the no-word condition should mirror that in the adjective condition. However, if adjectives focus children's attention on the target property, over and above the comparison itself, then performance in the adjective condition should surpass that in the no-word control.

In sum, we predicted that in both experiments, the benefits of an initial comparison would be mediated by (a) the similarity of the objects in the initial comparison and (b) the provision of a name for the target property.

Experiment 1

The goal of Experiment 1 was to examine the role of explicit contrast in 3-year-olds' ability to extend a novel adjective to a novel object property in objects from diverse basic-level categories. Children were shown a first target object that instantiated the novel property under consideration (e.g., transparency) and a second target object with a contrastive property (e.g., opacity). In the within-basic condition, the two targets were members of the same basic-level object category (e.g., transparent plate, opaque plate); in the across-basic condition, the targets were members of different basic-level categories (e.g., transparent plate, opaque toothbrush). Children were then presented with a forced-choice task involving objects from yet another basic-level category (e.g., bottles) and were instructed to choose between (a) a matching test object (e.g., a transparent bottle) and (b) a foil (e.g., an opaque bottle).

We reasoned as follows: In the within-basic condition, in which the two target objects (e.g., a transparent plate and an opaque plate) vary primarily along a single novel dimension (transparency), the initial process of comparison should support the identification of the relevant property and should facilitate the identification of that property at test. However, in the across-basic condition, in which

[2] We characterized this expectation as an emerging one, because 3-year-olds, unlike 4-year-olds, have difficulty recruiting this expectation in demanding circumstances (e.g., when the objects are unfamiliar or when the objects are drawn from diverse basic-level categories).

[3] As in previous work, we took several steps to support children's efforts to map the adjectives to object properties. We introduced the novel adjectives in contexts that were unambiguously adjectival: All novel adjectives incorporated the suffix *-ish,* were modified by the adverb *very,* were presented in both prenominal and predicative frames (e.g., "... a very *blick-ish* one ... another one that is *blick-ish*?"). In addition, because preschoolers more successfully map novel adjectives to object properties when these are applied to familiar, as opposed to unfamiliar, objects (Hall et al., 1993; Markman & Wachtel, 1988), we presented objects from familiar basic-level categories. We selected objects on the basis of a previous investigation (Klibanoff & Waxman, 2000a), in which we analyzed data from an independent sample of 3-year-olds. Children in this sample successfully produced or comprehended the basic-level names for the stimulus objects at a mean rate of 98% (see Hall et al., 1993, for a complete description of the procedure).

the two targets (e.g., a transparent plate and an opaque toothbrush) vary in several ways, including transparency, category membership, and myriad other perceptible properties common to members of the same basic-level category (e.g., flatness or circularity), the process of comparison alone cannot support the identification of a unique property and therefore should not facilitate its subsequent identification in test trials. We therefore predicted that the initial comparison between the two target objects would be more effective in the within-basic than in the across-basic condition.

We also examined the contribution of naming. Because 3-year-old children interpret novel adjectives as referring to property-based (rather than category-based) commonalities among objects, we predicted that children in the novel adjective condition would be more likely to identify the target property than those in the no-word condition.

Finally, we were interested in potential interactions between these factors. In particular, we wondered if novel adjectives would highlight the relevant property-based differences between the targets, as opposed to the category-based differences, in the across-basic sets.

Method

Participants

Thirty-two 3-year-olds (ranging in age from 3 years to 3 years 11 months, with a mean of 3 years 5 months) participated. All were enrolled in preschool programs serving primarily Caucasian, middle- to upper-middle-class families in Evanston, IL. There were approximately equal numbers of boys and girls in each condition.

Stimuli

Stimuli were 84 small, lightweight objects that could be easily handled by the participants (see Table 1). The objects were organized to form 12 different sets, with two sets representing each target property (transparent, bumpy, curly, shiny, spotted, holey). Each set included six discriminably different objects: a first target object (e.g., a transparent object), a second target object (e.g., an opaque object), and two different pairs of test objects (clear vs. opaque objects).

Relations among target objects. As can be seen in Table 1, each set included two target objects. All children saw the same first target (e.g., transparent plate). For children in the within-basic condition, the second target (e.g., opaque plate) was a member of the same basic-level category as the first target; these objects varied slightly in size, orientation, and shape. For children in the across-basic condition, the second target (e.g., opaque toothbrush) was a member of a different basic-level category than the first target.

Relations among test objects. Within each set, we developed two different test trials. On each, the two test objects differed only with respect to the property under consideration (e.g., transparent vs. opaque). Test objects were always drawn from different basic-level categories than either of the targets.

Procedure

Children were tested individually in a quiet room in their preschool. To begin, the experimenter introduced a hand puppet ("Gogi") and explained that Gogi did not speak English. For each set, the experimenter introduced the first target, followed by the second (contrastive) target. She then presented the first pair of test objects, along with a prompt for the child to select one of them. Once the child made a selection, the experimenter removed the first test pair and presented the second. Target objects remained in view at all times.

Children were assigned randomly to either the within-basic condition or the across-basic condition. In each condition, children were assigned randomly to either the adjective or no-word conditions. In the adjective condition, the experimenter pointed to the first target, saying, for example, "Gogi says this is a very *blick-ish* one." She then pointed to the second (contrastive) target, saying, for example, "He says this one is not *blick-ish*." She then presented the two test objects, saying, for example, "Can you give Gogi another one that is *blick-ish*?" After the child made a selection, the experimenter removed the first test pair and presented the second, explaining, "Now Gogi wants another *blick-ish* one. Can you give him another one that is *blick-ish*?" (The novel adjectives were *dak-ish, zav-ish, wugg-ish, fepp-ish, tal-ish,* and *blick-ish.*) The procedure in the no-word condition was identical except that no novel words were introduced. For example, the experimenter pointed to the first target, saying, "Gogi likes this one," and to the second (contrastive) target, saying, "He doesn't like this one." Presenting the test trials, she said, "Now Gogi wants another one. Can you give him another one that he'd like?"

Each child completed this procedure for all sets, yielding a total of 24 trials per child. These trials were presented in two blocks; each block included one set representing each of the six properties. Within each block, the order of presentation was counterbalanced.[4] Children received no corrective feedback.

We calculated two dependent measures. The first measured the proportion of trials on which children selected the matching test object. For this measure, chance responding was .50. We also developed a more stringent measure, calculating the proportion of sets on which children consistently selected the matching test objects on both the first and the second test trials for a given target. The probability of making selections that were consistently property-based on a given set was .25 (.50 on Trial 1 × .50 on Trial 2). Analyses based on these dependent measures revealed precisely the same effects. We report the results based on the latter, more stringent measure.

Results

The results are depicted in Figure 1. As predicted, comparing two contrastive members of the same basic-level category facilitated children's ability to identify the relevant property, map it to a novel adjective, and subsequently extend that adjective broadly to objects from different basic-level categories. However, comparing the very same objects, in the absence of a novel adjective, or comparing two members of different basic-level categories—with or without a novel adjective—conferred no such advantage. These results point to an important role for both naming and comparison.

The data were submitted to an analysis of variance (ANOVA) with word (adjective vs. no-word) and level (within-basic vs. across-basic) as between-subjects factors; children's consistently property-based selections were used as a dependent measure. The analysis revealed a main effect for word, $F(1, 28) = 20.43$, $p < .001$, and for level, $F(1, 28) = 16.48$, $p < .001$. These effects were qualified by a Word × Level interaction, $F(1, 28) = 20.43$, $p < .001$. As predicted, children in the adjective condition made more consistently property-based selections when the first and second (contrastive) targets were both members of the same basic-level category ($M = 0.89$) than when they were members of different

[4] In the adjective condition, novel adjectives were randomly assigned to properties; for a given child, the same pairing between novel adjective and property was preserved over the first and the second block.

Table 1
Complete List of Stimuli for Experiment 1

First target	Second target: Within-basic level	Second target: Across-basic level	Test objects: Trial 1		Test objects: Trial 2	
transparent	opaque	opaque	transparent	opaque	transparent	opaque
uncolored	white	white	red vs.	red	blue vs.	blue
plate	plate	toothbrush	bottle	bottle	bottle	bottle
transparent	opaque	opaque	transparent	opaque	transparent	opaque
uncolored	white	white	red vs.	red	green vs.	green
cup	cup	fork	soap dish	soap dish	soap dish	soap dish
bumpy	smooth	smooth	bumpy	smooth	bumpy	smooth
green	green	green	blue vs.	blue	yellow vs.	yellow
rhinoceros	rhinoceros	bear	horse	horse	horse	horse
bumpy	smooth	smooth	bumpy	smooth	bumpy	smooth
green	green	green	blue vs.	blue	yellow vs.	yellow
pig	pig	seal	lizard	lizard	lizard	lizard
curly	straight	straight	curly	straight	curly	straight
white	white	white	green vs.	green	purple vs.	purple
noodle	noodle	pipe cleaner	straw	straw	straw	straw
curly	straight	straight	curly	straight	curly	straight
white	white	white	green vs.	green	purple vs.	purple
ribbon	ribbon	shoelace	cord	cord	cord	cord
shiny	dull	dull	shiny	dull	shiny	dull
red	red	red	blue vs.	blue	green vs.	green
bug	bug	cat	hippo	hippo	hippo	hippo
shiny	dull	dull	shiny	dull	shiny	dull
red	red	red	blue vs.	blue	green vs.	green
turtle	turtle	crab	duck	duck	duck	duck
spotted	solid	solid	spotted	solid	spotted	solid
green	green	green	black vs.	black	white vs.	white
dog	dog	fish	snake	snake	snake	snake
spotted	solid	solid	spotted	solid	spotted	solid
green	green	green	black vs.	black	white vs.	white
elephant	elephant	rabbit	frog	frog	frog	frog
holey	solid	solid	holey	solid	holey	solid
white	white	white	black vs.	black	metal vs.	metal
basket	basket	paper	spoon	spoon	spoon	spoon
holey	solid	solid	holey	solid	holey	solid
white	white	white	white vs.	white	metal vs.	metal
spatula	spatula	sock	bowl	bowl	bowl	bowl

Note. *Within-basic level* refers to a comparison in which the first and second targets were both drawn from the same basic-level category; *across-basic level* refers to a comparison in which the targets were drawn from different basic-level categories.

basic-level categories ($M = 0.30$; Tukey's honestly significant difference [HSD], $p < .001$). Performance in the no-word control did not differ as a function of level.

We also compared performance in each condition with the level expected by chance (.25). In the adjective condition, when the contrastive targets were drawn from the same basic-level category, children made more consistently property-based selections than would be expected by chance, $t(7) = 14.32$, $p < .001$; when the contrastive targets were drawn from different basic-level categories, performance in the adjective condition did not differ from chance. In the no-word control, performance did not differ from chance at either level. Therefore, in the absence of a novel word, the comparison itself was not sufficient to induce children to identify the novel target property and use it to guide choice behavior.

In a supplementary analysis, we considered the possibility that performance on this task was related to children's familiarity with the English words for the target properties. We therefore tested an independent sample of 3-year-olds ($N = 45$) for their comprehension of the English adjectives for the properties included in the current experiment (see Klibanoff & Waxman, 2000b, for a complete description of the comprehension task). A rank-order correlation revealed no relation between children's familiarity with a given adjective (as measured in the independent sample) and their tendency to identify that property (as measured in the current experiment).

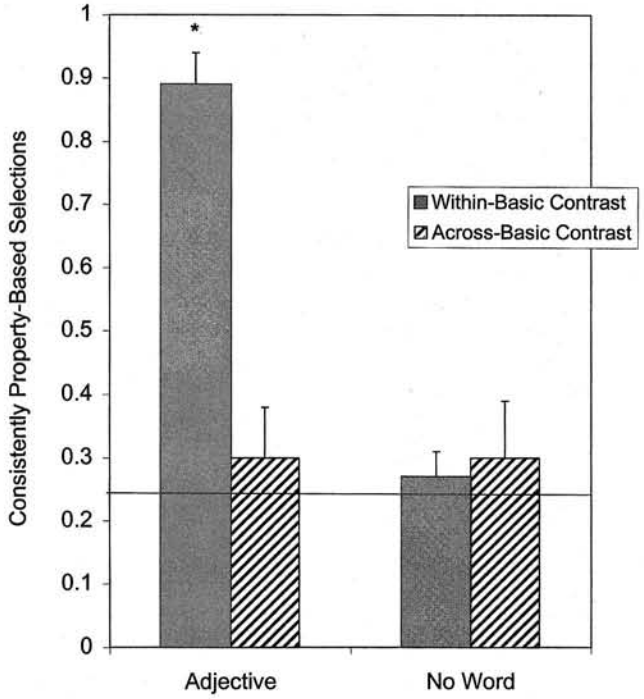

Figure 1. Experiment 1: Mean proportion of consistently property-based selections (+*SE*) as a function of word and level. * $p < .001$ (differs from chance .25).

Finally, we examined each individual child's pattern of response. Following the binomial formula and setting $p \leq .05$, we characterized children who consistently selected the matching test object on both test trials, for at least 7 of the 12 sets, as displaying consistently property-based performance. As can be seen in Table 2, children's tendency to extend a novel adjective across different basic-level categories varied systematically as a function of the level of contrast provided. In the adjective conditions, when children were provided with within-basic contrast, 8 (out of 8) children displayed consistently property-based performance; when they were provided with across-basic contrast, only 1 child did so. In the no-word conditions, children were unlikely to display consistently property-based performance at either level of contrast.

These strong individual patterns amplify the results of the main parametric analyses to reveal an important role for the process of comparison and for naming. When provided with an initial comparison between two contrastive members of a basic-level category, and when the target property was named in this comparison, 3-year-olds abstracted the target property, mapped it to the novel adjective, and subsequently extended that adjective to objects from different basic-level categories. It is important to note, however, that this comparison itself was not sufficient, for in the absence of a novel adjective, children in the no-word condition failed to identify the target property in test trials. Moreover, when the initial comparison involved contrastive members of different basic-level categories, children failed to identify the target property whether the target property was named or not.

Providing children with names for object properties, coupled with explicit contrast between members of the same category, supports the identification of the target property. This initial opportunity for comparison and mapping sets the stage for children's subsequently broader extension of the novel adjective to members of different basic-level categories. In the natural course of events, children are certainly provided with circumstances satisfying these criteria. Recall, for example, that in Carey and Bartlett's (1978) classic study, as in Au's more recent work (1990; Au & La Framboise, 1990), adults have asked preschool-aged children to find " . . . the chromium tray, not the red one." This appears to be precisely the kind of input that supports children's extension of adjectives beyond the limits of a basic-level category. However, this is unlikely to be the only circumstance that motivates children to broaden their extensions of novel adjectives. Indeed, we suggest that any initial comparison that supports the identification of the relevant property should serve them in good stead. Therefore, in the next experiment, we looked beyond explicit contrast to consider the role of comparison from a different, but complementary, perspective.

Experiment 2

Experiment 2 was designed to examine the influence of initially comparing two consistent exemplars of an object property on children's subsequent ability to extend novel adjectives to objects from different basic-level categories. In this experiment, the first and second target objects both instantiated the same target property (e.g., transparency). In the within-basic condition, the targets were also members of the same basic-level object category (e.g., two transparent plates). In the across-basic condition, the targets were members of different basic-level object categories (e.g., a transparent plate and a transparent toothbrush). As in Experiment 1, the test objects were drawn from different basic-level categories than either of the targets.

As in Experiment 1, we predicted that the initial comparison would be most effective if it provided children with an opportunity to identify the relevant dimension. Notice, however, that in this experiment, it is the across-basic condition that provides this opportunity. In the within-basic condition, in which the two targets are members of the same basic-level category and share the same target property, there is nothing in the process of comparison itself to support the identification of a unique property (e.g., transparency) over a host of other, potentially relevant similarities shared by most members of the category "plate" (e.g., flatness, circularity). However, in the across-basic condition, in which the two targets are members of different basic-level categories (e.g., trans-

Table 2
Individual Patterns: Number of Children (Out of a Possible 8) Displaying Consistently Property-Based Performance

	Relation between the two targets	
Experiment/condition	Within-basic level	Across-basic level
Experiment 1		
Adjective	8	1
No word	0	1
Experiment 2		
Adjective	1	6
No word	0	0

parent plate, transparent toothbrush), the comparison is considerably more instructive: Comparing these two objects should support the identification of the target property (e.g., transparency), because this comparison rules out the other potential properties of the first target (e.g., flatness or circularity). Note that the across-basic condition also provides another potentially important source of information: It offers explicit evidence regarding the instantiation of this property in objects from different basic-level categories.

We therefore predicted that when presented with two consistent exemplars of the target property, the process of comparison would be more effective if the first and second target objects were members of different basic-level categories than if they were drawn from the same basic-level category. If this comparison alone is sufficient to focus children's attention on the relevant target property, then performance in the no-word condition should mirror that in the adjective condition. However, if novel adjectives direct children's attention to the target property, over and above the comparison itself, then performance in the adjective condition should surpass that in the no-word control.

Method

Participants

Thirty-two 3-year-olds (ranging in age from 3 years 1 month to 3 years 11 months, with a mean age of 3 years 6 months) were drawn from the same population as in Experiment 1. In each condition (see below), the mean ages were approximately equal, and there were approximately equal numbers of girls and boys.

Stimuli

Stimuli were 84 small, lightweight objects (see Table 3). Following the logic of Experiment 1, we organized these into within-basic sets and across-basic sets.

Procedure

The procedure was identical to that of Experiment 1 except that both targets instantiated the target property. In the adjective conditions, the experimenter introduced the two targets, saying, for example, "Gogi says this is a very *blick-ish* one. He says this one is also very *blick-ish*." Presenting the test objects, she said, for example, "Now Gogi wants another *blick-ish* one. Can you give him another one that is *blick-ish*?" In the no-word condition, the experimenter introduced the two targets, saying, "Gogi likes this one. He also likes this one." She then presented the test objects, saying, "Now Gogi wants another one. Can you give him another one that he'd like?"

Results

The results, depicted in Figure 2, provide additional evidence for the importance of naming and comparison in children's extensions of novel adjectives. As predicted, when children were provided with two positive exemplars of a target property, the process of comparison was more effective if these objects were members of different basic-level categories than if they were drawn from the same basic-level category. It is noteworthy, however, that this comparison alone was insufficient to support the identification of the target property if the target property was not named. Moreover, if the initial comparison involved members of the same basic-level categories, children failed to identify the target property, with or without a novel adjective.

An ANOVA, based on children's consistently property-based selections, revealed a main effect for word, $F(1, 28) = 12.30$, $p < .01$, as well as for level, $F(1, 28) = 5.35$, $p < .05$. These were qualified by a Word × Level interaction, $F(1, 28) = 11.28$, $p < .01$. As predicted, children in the adjective condition made more consistently property-based selections when the targets were drawn from different basic-level categories ($M = .72$) than when they were drawn from the same basic-level categories ($M = .32$; Tukey's HSD, $p < .001$). Performance in the no-word control did not differ as a function of level. Moreover, performance in these latter three conditions did not differ from chance level (.25). Only in the adjective/across-basic condition did children make consistently property-based selections more often than would be expected by chance, $t(7) = 4.90$, $p < .001$. A subsequent analysis, conducted as in Experiment 1, indicated that performance on this task was not correlated with children's comprehension of the English adjectives of the properties under investigation.

Finally, an analysis of each individual child's responses (computed as in Experiment 1) was entirely consistent with the results of the main parametric analyses. In the adjective/across-basic condition, 6 (out of 8) children displayed consistently property-based performance; in the adjective/within-basic condition, only 1 did so. Children in the no-word condition were unlikely to display consistently property-based performance at either level.

These results provide additional support for the hypothesis that children's capacity to extend novel adjectives appropriately to properties of objects from diverse basic-level categories is facilitated by a process of comparison and by naming. When comparing two objects from different basic-level categories that both instantiated the relevant property, and when the target property was named in this comparison, 3-year-olds abstracted the relevant property, mapped it to an adjective, and then extended it to members of different basic-level categories. However, this comparison alone was not sufficient in the absence of a novel word. Moreover, when the initial comparison involved objects from the same basic-level category, children failed to identify the target property at test, whether or not it was named.

We therefore conclude that providing multiple exemplars of a given property, in conjunction with a novel adjective, supports children's ability to map adjectives appropriately beyond the limits of a given basic-level category. This outcome has also been observed in younger children, ranging from 24 to 36 months (Mintz & Gleitman, 1998). The same appears to be true of infants: When they are provided with a novel adjective in conjunction with several different exemplars of a target property (e.g., purple horse, purple car, purple bear, purple cup), infants as young as 13 months successfully abstract the consistent property (here, color), map it to an adjective, and go on to extend that adjective appropriately (Waxman, 1999; Waxman & Booth, 2000).

General Discussion

Previous work has documented that basic-level object categories provide an initial foundation for mapping novel adjectives to object properties (Gasser & Smith, 1998; Klibanoff & Waxman, 2000a; Waxman & Markow, 1998). Our goal here was to identify processes that motivate young word learners to advance beyond

Table 3
Complete List of Stimuli for Experiment 2

First target	Second target: Within basic level	Second target: Across basic level	Test objects: Trial 1			Test objects: Trial 2		
transparent	transparent	transparent	transparent		opaque	transparent		opaque
uncolored	green	green	red	vs.	red	blue	vs.	blue
plate	plate	toothbrush	bottle		bottle	bottle		bottle
transparent	transparent	transparent	transparent		opaque	transparent		opaque
uncolored	blue	blue	red	vs.	red	green	vs.	green
cup	cup	fork	soap dish		soap dish	soap dish		soap dish
bumpy	bumpy	bumpy	bumpy		smooth	bumpy		smooth
green	purple	purple	blue	vs.	blue	yellow	vs.	yellow
rhinoceros	rhinoceros	bear	horse		horse	horse		horse
bumpy	bumpy	bumpy	bumpy		smooth	bumpy		smooth
green	purple	purple	blue	vs.	blue	yellow	vs.	yellow
pig	pig	seal	lizard		lizard	lizard		lizard
curly	curly	curly	curly		straight	curly		straight
white	red	red	green	vs.	green	purple	vs.	purple
noodle	noodle	pipe cleaner	straw		straw	straw		straw
curly	curly	curly	curly		straight	curly		straight
white	red	red	green	vs.	green	purple	vs.	purple
ribbon	ribbon	shoelace	cord		cord	cord		cord
shiny	shiny	shiny	shiny		dull	shiny		dull
red	purple	purple	blue	vs.	blue	green	vs.	green
bug	bug	cat	hippo		hippo	hippo		hippo
shiny	shiny	shiny	shiny		dull	shiny		dull
red	purple	purple	blue	vs.	blue	green	vs.	green
turtle	turtle	crab	duck		duck	duck		duck
spotted	spotted	spotted	spotted		solid	spotted		solid
green	red	red	black	vs.	black	white	vs.	white
dog	dog	fish	snake		snake	snake		snake
spotted	spotted	spotted	spotted		solid	spotted		solid
green	red	red	black	vs.	black	white	vs.	white
elephant	elephant	rabbit	frog		frog	frog		frog
holey	holey	holey	holey		solid	holey		solid
white	purple	purple	black	vs.	black	metal	vs.	metal
basket	basket	paper	spoon		spoon	spoon		spoon
holey	holey	holey	holey		solid	holey		solid
white	purple	purple	white	vs.	white	metal	vs.	metal
spatula	spatula	sock	bowl		bowl	bowl		bowl

Note. *Within-basic level* refers to a comparison in which the first and second targets were both drawn from the same basic-level category; *across-basic level* refers to a comparison in which the targets were drawn from different basic-level categories.

this foundation and to extend novel adjectives more broadly to a diverse range of objects. We focused specifically on the role(s) of naming and comparison. Our interest in naming derived directly from the evidence that by 3 years of age, children expect that a novel adjective, applied ostensively to an object, will refer to a property of that object. We therefore predicted that children would be more likely to identify an object property when presented with a novel adjective than in the context of a no-word control. Our interest in the process of comparison stemmed from two observations: (a) the act of extending a word from one object to another inherently involves a process of comparison, and (b) the act of performing a simple comparison can itself facilitate subsequent performance on more difficult or abstract comparisons (Gentner & Medina, 1998).

How might this general cognitive process be applied to the particulars of mapping adjectives to object properties? We proposed that providing an initial opportunity to perform a relatively simple comparison would highlight the relevant object property and that this, in turn, would support the subsequent identification of that property in objects from different basic-level categories. We further sharpened this prediction, arguing that the benefits of an initial comparison would be mediated by the similarity of the objects in the initial comparison and the provision of a name for the target property.

Support for these predictions came from experiments involving two different kinds of comparison. In Experiment 1, when children were provided with explicit contrast (e.g., a transparent object and an opaque object), the initial comparison was effective if it in-

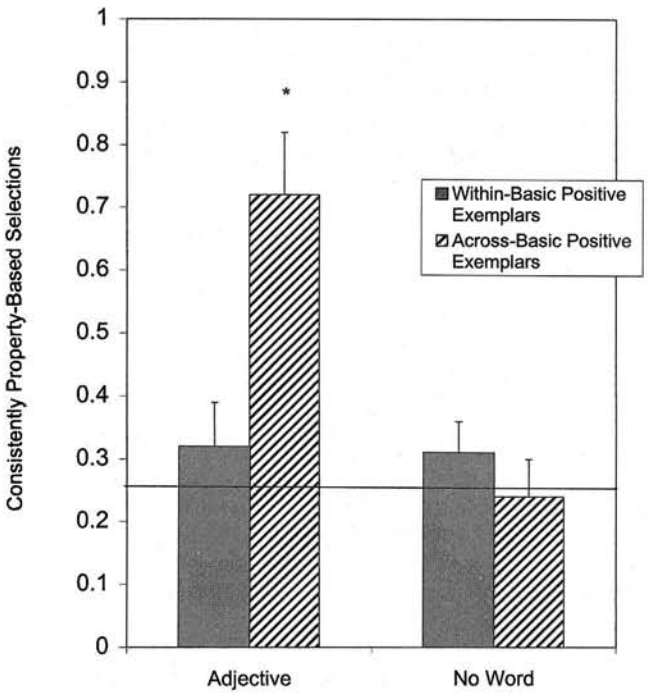

Figure 2. Experiment 2: Mean proportion of consistently property-based selections (+*SE*) as a function of word and level. * $p < .001$ (differs from chance .25).

volved two objects from the same basic-level category (e.g., a transparent plate vs. an opaque plate), presented in conjunction with a novel adjective. In this experiment, children in the within-basic/adjective condition identified the target property, mapped it to the novel adjective, and subsequently extended that adjective to properties of objects from different basic-level categories. If the initial comparison involved members of different basic-level categories, or if the target property was not named, children failed to identify the target property. In Experiment 2, when children were provided with consistent exemplars of the target property (e.g., two transparent objects), the initial comparison was effective if it involved two objects from different basic-level categories (e.g., a transparent plate and a transparent toothbrush), presented in conjunction with a novel adjective. In this experiment, children in the across-basic/adjective condition abstracted the target property, mapped it to the novel adjective, and subsequently extended that adjective to objects from different basic-level categories. If the initial comparison involved members of the same basic-level category, or if the target property was not named, children failed to identify the target property at test.

This outcome is consistent with the observation that although novel adjectives may initially depend on the support of basic-level object categories, this dependence is not frozen or immutable, even in early development. These results support the hypothesis that the process of comparison, mediated by the similarity of the objects being compared and the provision of a novel adjective, promotes children's advance beyond the basic level foundation.

Moreover, these results offer some precision in identifying the elements of an optimal initial comparison. Across both experiments, initial comparisons in which the objects varied primarily along a single dimension—either the object property (in Experiment 1, the within-basic comparison) or the object category (in Experiment 2, the across-basic comparison)—were optimal. Initial comparisons involving variation along both dimensions (in Experiment 1, the across-basic comparison) or involving variation along neither dimension (in Experiment 2, the within-basic comparison) did nothing to support the identification of the target property, even when these were presented in conjunction with a novel adjective. However, even these "optimal" initial comparisons were not, in and of themselves, sufficient. Unless these optimal comparisons were presented within the context of a novel adjective, children failed to identify the appropriate object on the subsequent and more difficult test trial.

These experiments represent a first step toward identifying the circumstances that support 3-year-old children's extension of adjectives to properties of objects from diverse categories. They also point to several avenues for future work. For instance, because the current experiments included only 3-year-olds as participants, it will be important to ascertain whether the same mechanisms support the extension of novel adjectives across development. Consider first the evidence regarding contrast. A review of this literature suggests that throughout the preschool years, children succeed in mapping novel adjectives to object properties when they are provided with contrast between members of the same basic-level category in conjunction with an adjective (Au, 1990; Au & LaFramboise, 1990; Carey & Bartlett, 1978; Heibeck & Markman, 1987). More recent work suggests that the same is true for infants at 13 months (Waxman & Booth, 2000). A review of the evidence regarding multiple exemplars and naming yields a similar conclusion. Exposure to multiple exemplars promotes property induction and generalization in infants, preschool-aged children, and adults (Gentner & Namy, 1999; Osherson, Smith, Wilkie, Lopez, & Shafir, 1990; Rips, 1975; Ross, Nelson, Wetstone, & Tanouye, 1986; Wilcox, 1999). More recent work suggests that this genre of comparison is also instrumental in the process of mapping adjectives to properties of objects for infants at 13 months (Waxman, 1999; Waxman & Booth, 2000) and at 24 and 36 months (Mintz & Gleitman, 1998). We therefore believe that the current experiments point to precisely the kinds of information that support the broad extension of adjectives appropriately beyond the limits of a given basic-level object category; we suspect that these results are neither exclusive to children at 3 years of age nor to performance within a particular experimental paradigm.

Another important issue concerns the relative contributions of perceptual and conceptual similarity in the foundational role of basic-level categories. In the natural course of events, as in the experiments conducted to date (Klibanoff & Waxman, 2000a, 2000b; Waxman & Markow, 1998), these factors are confounded: Objects from the same basic-level category enjoy stronger perceptual and conceptual similarities than objects drawn from different basic-level categories. On the basis of the current evidence, it is impossible to ascertain whether children's reliance on basic-level categories derives from perceptual similarity, conceptual similarity, or a combination of these factors (Gelman, 1996; Gentner & Markman, 1994; Kemler, 1983; Macnamara, 1986; Shepp & Swartz, 1976; Smith, 1984; Waxman, 1999). To more carefully identify the relative contributions of perceptual and conceptual factors, in an ongoing series of experiments (Klibanoff, 2000), we

independently manipulate conceptual and perceptual similarity. For example, we identify members of the same basic-level category that are perceptually close (e.g., birthday hat, witch's hat) and others that are perceptually distant (e.g., birthday hat, ski cap). We also identify members of different basic-level categories that are perceptually close (e.g., birthday hat, funnel) and others that are perceptually distant (e.g., birthday hat, sock). Preliminary results indicate that perceptual and conceptual similarity each contribute to children's successful extension of novel adjectives.

Finally, it will be important to examine this phenomenon from a cross-linguistic perspective, because there is substantial linguistic variation in the manner in which object properties are encoded across languages. In languages such as English, with rich, open-class adjectival systems, most object properties are lexicalized as adjectives. Yet in other languages, particularly those with much sparser adjectival systems (e.g., the Bantu languages),[5] the object properties that we used in the current experiments tend to be lexicalized either as nouns or verbs. This cross-linguistic variation permits one to ask whether the process of comparison is instrumental in the extension of adjectives in particular or in the extension of property terms more generally. It will also permit one to consider the extent to which these phenomena are related to aspects of objects and their properties or to the manner in which these properties are encoded within the language.

Contrary to Locke's (1690/1975) assertions, mapping words to object properties requires more than a straightforward association between a name and a sensory experience. Instead, the mappings between adjectives and object properties initially unfold within the support of basic-level object categories. The experiments reported here demonstrate how comparison—a general cognitive process—operates in concert with word-learning to support the appropriate extension of novel adjectives to object properties in a diverse range of objects.

[5] In Bantu, the number of words that can be classified as adjectives ranges from approximately 10 to 50 (Dixon, 1982).

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