

# Do Perceptual Complexity and Object Familiarity Matter for Novel Word Extension?

**Catherine M. Sandhofer (csandhof@indiana.edu)**

Department of Psychology, 1101 E. 10th Street  
Bloomington, IN 47404 USA

**Linda B. Smith (smith4@indiana.edu)**

Department of Psychology, 1101 E. 10th Street  
Bloomington, IN 47404 USA

## Abstract

This paper examines the relationship between shape complexity and familiarity in extending novel adjectives. Previous research has suggested that familiarity with an object's basic level label determines the likelihood that a novel adjective will be extended to new instances. The present results do not support that conclusion. Instead the results suggest that given an adjectival syntactic frame children are likely to extend novel words to other objects of the same material when the objects are simple in shape. This result suggests that the perceptual properties of objects and the lexical form class cues are integral to understanding how children come to learn new words.

## Introduction

How do children come to extend words to new instances? This question is at the heart of research understanding language development partially because much of language learning presumably takes place using ostensive definition: children learn a label for one object, event, or property and are able to extend that label to new instances. The task used to study this is the novel word extension task. In this task a child is shown an exemplar and the exemplar is labeled. The child is then given other objects that match the exemplar on different dimensions and the child is asked to select the one that also has the same label. Although much of the research in this area tends to focus on how children extend novel count nouns, other grammatical classes have been studied as well.

For example, previous work has suggested that when encountering novel adjectives, children are likely to extend the novel adjective to other objects of the same material only if the objects are familiar to them. (Hall, Waxman, & Hurwitz, 1993). Thus, young children can extend the novel adjective "plush" to other objects of the same material if the plush objects are familiar to the child e.g. a shoe, but not if the objects are unfamiliar to the child, e.g. a widget, even when the children are provided with an adjectival syntactic frame. This finding has been interpreted as evidence that children are biased to expect a novel word to refer to a kind of

object. By this account children should extend novel words to other objects of the same shape if the object is unfamiliar to them and children should extend novel words to objects sharing some other property when the object is familiar to them.

However, Landau, Smith, and Jones (1992) and Smith, Jones, and Landau (1992) have shown that young children can generalize novel adjectives to other objects that match in material. These results are seemingly at odds with Hall, Waxman, & Hurwitz (1993) because the objects presented to children in these studies were unfamiliar objects and thus by Hall et al's proposal children should initially interpret the novel words as referring to objects of the same shape or object kind.

In addition, other research has shown that children take the specific perceptual properties of objects into account when extending novel words. For example, several researchers (Soja, 1992; Dickinson, 1988; but see Markman & Wachel, 1988 for contradictory findings) have demonstrated that children extend novel nouns to solid objects with the same shape, but children extend novel nouns to non-solid substances with the same material as an exemplar. Further, Imai and Gentner (1997) have shown that children as young as two years of age generalize simple objects, complex objects, and substances differently.

Based on these previous results, we propose an additional constraint that may guide whether children are likely to extend a novel word to objects that match an exemplar in shape vs. objects that match in other properties. We call this the perceptual complexity hypothesis. By this hypothesis, complex objects, objects like tractors with multiple parts may be labeled by more possible words than simple objects, like ball. This may foster attention to shape if these other labels point to properties (wheels, smokestack, engine) are themselves correlated with shape. Thus, we predict that attention to shape should be a stronger pull when the objects are complex than when they are simple. This idea is supported by previous findings by Imai and Gentner (1997) that show when Japanese 2 year olds

are presented with simple objects or materials they are likely to extend by material. However, when Japanese 2 year olds are presented with complex objects they are likely to extend by shape.

We test this idea by presenting children with objects that are either perceptually simple or complex and objects that are either familiar or unfamiliar. If perceptual complexity matters for word extension we would expect children to more readily select objects that match in material when the objects are simple. However, if the perceptual complexity of the objects is unimportant for word learning we would expect to see no differences between the complex and simple objects. In Experiment 1 we present the novel words in an adjectival frame. In Experiment 2 we present the novel words in a count noun frame.

### Experiment 1

In Experiment 1 we ask whether children are more likely to extend novel adjectives to objects of the same material or shape when the objects are simple or complex and familiar or unfamiliar. We do so by providing children with a novel word in an adjectival syntactic frame. Previous work has shown that when novel words are presented in an adjectival frame children may match by material kind (Hall, Waxman, & Hurwitz, 1993; Landau, Smith, & Jones, 1992; Smith, Jones, & Landau, 1992).

### Method

**Participants** Fifty-six 4-year-olds participated. Half were male and half were female. The four year olds ranged in age from 48 to 59 months. Fourteen children (7 boys and 7 girls) were randomly assigned to each of four conditions. Children were tested individually in their preschools during normal school hours or in the laboratory.

**Design** Subjects were assigned to one of four conditions. In each condition the stimuli presented varied in the level of shape complexity (simple vs. complex) and familiarity (familiar or unfamiliar). Simple shapes were defined as objects that were composed of one or two parts whereas complex shapes were defined as objects that were composed of many parts. We assessed the shape complexity of the objects by asking 10 undergraduates to rate each of the 48 objects used in the experiment on shape complexity using a 5-point scale. Objects that were judged as not very complex were given a score of 1 and objects that were judged as very complex were given a score of 5. Table 1 shows the mean complexity ratings for each of the four conditions. As can be seen objects in the simple conditions were judged as less complex than objects in the complex conditions.

Table 1: Shape Complexity Ratings for the Four Conditions

Condition	Rating
Simple familiar	1.41 (.59)
Simple unfamiliar	1.53 (.61)
Complex familiar	3.72 (.97)
Complex unfamiliar	3.94 (.91)

We defined objects as familiar if they were listed on the MacArthur Communicative Development Inventory: Words and Sentences, (Fenson et al, 1994) a checklist of words known to 50% of all children by 30 months of age. However, two objects, heart and bucket/pail, were not included on the MacArthur, but pre-testing indicated these objects were known by many four-year-old children. To ensure that unfamiliar objects were truly unfamiliar to children, the unfamiliar objects were made in the laboratory and did not resemble any nameable objects.

Four triads of objects were used in each condition. In each triad there was a target object, a shape matching object and a material matching object. The shape matching object matched the target in shape and object kind but differed in material kind and related properties such as color and texture. The material matching object matched the target in material kind and related properties but differed in shape and object kind. Figure 1 shows an example of a triad from each of the four conditions. In each condition the exemplar object matched one object by material and one by shape. The four material matches were blue plush, natural wood, silver metal, and paper.




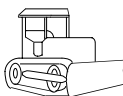

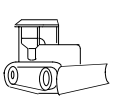




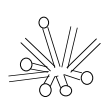

	Exemplar (blue plush)	Material match (blue plush)	Shape match (yellow plastic)
simple familiar	 ball	 heart	 ball
complex familiar	 tractor	 bug	 tractor
simple unfamiliar			
complex unfamiliar			

Figure 1 Examples of stimuli for the four conditions of Experiments 1 and 2.

**Procedure** In each condition of the adjective extension trials children were presented with an exemplar object while the experimenter labeled it with a novel adjective. For example, “See this? This is very wuggish. Can you say wuggish?” A shape match and a material match were then placed in front of the child, and the child was asked, “Can you find another one that is very wuggish?” This process was repeated for all four sets in the condition. The words blickish, fepish, wuggish, and zavish were used as the novel adjectives. The novel adjectives and the adjective syntax were taken from Hall, Waxman, and Hurwitz (1993).

Children were next presented with familiarity trials to ensure that the familiar objects were indeed familiar and the unfamiliar objects were unfamiliar to the children. Children were first “trained” to answer the familiarity trials by first presenting them with one familiar object (a shoe). Children were asked “What is this? What’s this called?” Children were liberally praised for correctly labeling the shoe. Children were next presented with two unfamiliar objects and again asked “What is this? What’s this called?” Children were liberally praised if they responded “I don’t know.” If children labeled the unfamiliar object the experimenter responded by telling the child that it was appropriate to say “I don’t know” if they did not know the name of the object and children were encouraged to reply “I don’t know” and were again liberally praised. Children were then randomly presented with the 12 stimulus objects from the adjective extension trials and asked of each “What is this? What’s this called?” During these 12 trials children were not provided with feedback.

## Results and Discussion

We first asked whether the objects we deemed as familiar were indeed familiar to children and the objects we deemed unfamiliar were indeed unfamiliar. Children responded with an appropriate label for the objects in the simple familiar condition 97% of the time on average and for objects in the complex familiar condition 91% on average. In contrast children responded that they did not know the name of the objects in the simple unfamiliar condition 89% of the time on average and for the objects in the complex unfamiliar condition 71% of the time on average. The remainder of responses in the two unfamiliar conditions involved children providing a description of the object, e.g. a green thing, an inappropriate object name, e.g. that looks like a tooth, correctly naming a piece of the object, e.g. it has a ribbon on it, or providing the novel adjective, e.g. wuggish. Thus, the results of the familiarity trials confirm that the objects in the two familiar conditions were largely familiar to children and the objects in the two unfamiliar conditions were largely unfamiliar to children.

We next examined children’s performance in the adjective extension trials. Figure 2 shows the mean number of material matching selections children made in each of the four conditions. As can be seen, the number of material choices was higher in the two simple conditions than in the two complex conditions. An ANOVA conducted on the number of material choices confirmed this and revealed a main effect of complexity  $F(1,52) = 25.19, p < .01$ , but no effects of familiarity (power = .36) and no interaction (power = .21). Thus the results suggest that the shape complexity of the object, and not children’s familiarity with the object, affects whether children generalize a novel adjective to a material match or to a shape match.

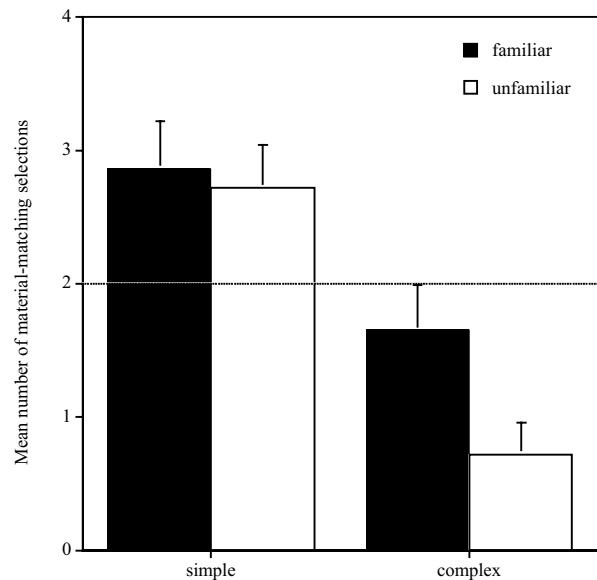


Figure 2. The number of material matching selections for the four conditions of Experiment 1.

We next compared children’s selections to chance. If children responded randomly they would be expected to make material match selections in 2 of the 4 trials. The results showed that children made more material match selections than expected by chance in the simple familiar condition,  $t(13) = 2.38, p < .05$ , and in the simple unfamiliar condition,  $t(13) = 2.22, p < .05$ . Children also made less material matches than expected by chance in the complex unfamiliar condition,  $t(13) = -5.26, p < .01$ . Thus children exceed the number of material matches predicted by chance performance in the two simple conditions, but selected equal to or less material matches than predicted by chance in the two complex conditions.

Finally we asked whether knowing the object name made individual children more or less likely to match that object by material. One object included in the study made a nice test case for this question. We selected “sprinkler” as a complex familiar object in part because it was listed on the MacArthur Communicative

Developmental Inventory indicating that over 50% of all 30 month olds had produced the term. Thus we expected that 4-year-old children should be able to readily identify the object. However, only seven of the fourteen 48-60 month olds were able to appropriately identify the object as a “sprinkler” or a “sprayer”. We thus asked whether correctly labeling the object coincided with more or less material choice matches. Table 2 presents the distribution of material and object matches for the 7 children who produced “sprinkler” and the 7 children who responded “I don’t know” when asked what the sprinkler was. As can be seen the distributions are exactly equal suggesting that the ability to produce the basic level object name does not affect whether children are more or less likely to make a material kind selection.

Table 2: Number of material and object selections for children who did and did not produce the label “sprinkler”

	produced “sprinkler”	did not produce “sprinkler”
Object match	4	4
Material match	3	3

However, one possible explanation for our results could be that children are selecting material matches in the two simple conditions, not because they are correctly identifying the novel word as an adjective and correctly extending the word to objects that match in material in the simple object conditions, but instead that children are selecting material matches for other reasons. To test this possibility, in Experiment 2 we present children with the same sets of objects but use a count noun syntactic frame. Because count noun syntax has been shown to encourage extension to objects that match in shape, if the results of Experiment 1 are not due to idiosyncratic properties of our stimuli we would expect children in Experiment 2, who are presented with the same stimuli to make many more shape selections than material selections, regardless of the complexity of the stimuli.

## Experiment 2

In Experiment 2 we again ask whether children are more likely to extend novel words to objects of the same material or shape when the objects are simple or complex and familiar or unfamiliar. We do so by providing children with a novel word in a count noun syntactic frame.

### Method

**Participants** Fifty-six 4-year-olds participated. Half were male and half were female. The four year olds

ranged in age from 4;0 to 4;11. Fourteen children (7 boys and 7 girls) were randomly assigned to each of four conditions. Children were tested individually in their preschools during normal school hours.

**Stimuli and Design** The stimuli and design were identical to Experiment 1

**Procedure** The procedure was identical to Experiment 1 with one exception. The novel word was provided to children in a count noun syntax (instead of adjective syntax). For example, “See this? This is a wug. Can you say wug?”

### Results

To confirm the findings of the first experiment, we again asked whether the objects we deemed as familiar were indeed familiar to children and the objects we deemed unfamiliar were indeed unfamiliar. Children responded with an appropriate label for the objects in the simple familiar condition 97% of the time on average and for objects in the complex familiar condition 91% on average. In contrast children responded that they did not know the name of the objects in the simple unfamiliar condition 97% of the time on average and for the objects in the complex unfamiliar condition 91% of the time on average. The remainder of responses in the two unfamiliar conditions involved children providing a description of the object, e.g. a green thing, an inappropriate object name, e.g. that looks like a tooth, correctly naming a piece of the object, e.g. it has a ribbon on it, or providing the novel noun, e.g. a wug. Thus, the results of the familiarity trials confirm that the objects in the two familiar conditions were largely familiar to children and the objects in the two unfamiliar conditions were largely unfamiliar to children.

We next examined children’s performance in the extension trials. Figure 3 shows the mean number of material matching selections children made in each of the four conditions. As can be seen, children generalized the novel name to the material matching object infrequently in all four conditions. An ANOVA conducted on the number of material choices revealed no main effects and no interactions. Thus, when children are provided with count noun form class cues, neither the shape complexity of the objects or children’s familiarity with the basic level label of the objects affect whether children generalize a novel count noun to a material match or to a shape match. That is, children generalize by shape regardless of the particular object and its perceptual properties.

We next compared children’s selections to chance. If children responded randomly they would be expected to make material match selections in 2 of the 4 trials. The results showed that children made less material match

selections than expected by chance in all conditions: the simple familiar condition,  $t(13) = -6.27$ ,  $p < .01$ , the simple unfamiliar condition,  $t(13) = -7.87$ ,  $p < .01$ , the complex familiar condition,  $t(13) = -15.69$ ,  $p < .01$ , and the complex unfamiliar condition,  $t(13) = -8.63$ ,  $p < .01$ . Thus these results confirm that children made less material matches, that is more shape matches, than expected by chance regardless of the particular object condition.

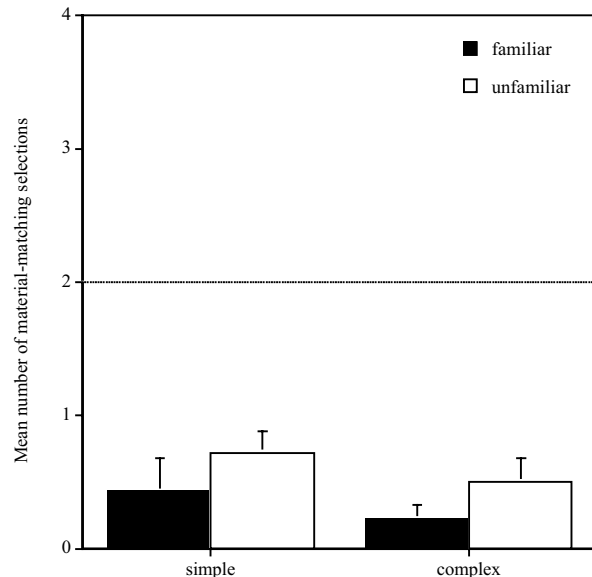


Figure 3. The number of material matching selections for the four conditions of Experiment 2.

## General Discussion

Thus, the results suggest that given a count noun syntactical frame children selected objects that matched the exemplar by shape. However, given an adjectival syntactical frame children more often selected objects that matched the exemplar by material in the two simple-object conditions and shape in the two complex object conditions.

These results conflict with previous findings that children extend novel adjectives to objects of the same material only when the object kinds are familiar to the child. One possibility for this discrepancy is that the unfamiliar stimuli selected by Hall Waxman, and Hurwitz (1993) may have been inadvertently more complex than the familiar stimuli. Because Hall Waxman, and Hurwitz sought to control for taxonomic kind between the two conditions, the types of items that were unfamiliar to children may have also been slightly more complex than items that were familiar to children. For example, in the familiar condition one set of stimuli contained a cup and a spoon. In the unfamiliar condition the analogous set contained a garlic press and

an apple corer. Thus the stimuli used in Hall Waxman, and Hurwitz may have inadvertently confounded familiarity with complexity.

These findings may help by providing a unifying explanation for discrepant results in the literature. One reason why some research (Hall, Waxman, & Hurwitz, 1993; Markman & Wachel, 1988) may have found that familiarity is necessary for enabling children to extend novel words by properties other than shape may have much to do with the perceptual properties of the stimuli presented to children.

## Acknowledgements

This study was supported in part by a National Institute of Mental Health grant F31MH12614 to the first author

## References

- Dickinson, D. (1988). Learning names for materials: Factors limiting and constraining hypotheses about word meaning. *Cognitive Development*, 3, 15-35.
- Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D., & Pethick, S. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development*, 5, whole serial number 242.
- Hall, D. G., Waxman, S. R., & Hurwitz (1993). How two- and four-year-old children interpret adjectives and count nouns. *Child Development*, 64, 1651-1664.
- Imai, M. & Gentner, D. (1997). A cross-linguistic study of early word meaning: Universal ontology and linguistic influence *Cognition*, 62, 169-200.
- Markman, E. & Wachel, G. (1988). Children's use of mutual exclusivity to constrain the meanings of words. *Cognitive Psychology*, 20, 121-157.
- Soja, N. (1992). Inferences about the meanings of nouns: The relationship between perception and syntax. *Cognitive Development*, 7, 29-45.