HELPING PRESCHOOLERS TO OVERCOME FUNCTION NEGLECT IN OBJECT WORD LEARNING: THE EFFECT OF EXPOSURE TO TWO EXEMPLARS

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by

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Introduction

Children are remarkably adept at learning words (Carey & Bartlett, 1978; Rice, 1990; Woodward, Markman, & Fitzsimmons, 1994). They often interpret novel words accurately after only a single exposure even when the meaning is not explicitly taught to them. They then demonstrate appropriate application of these words in entirely new situations. This is true for most types of word learning, but it is especially evident in the acquisition of labels for novel objects.

Considering the virtually endless number of meanings a word could have, the young child’s ability to accurately interpret new words is truly amazing (Markman, 1989; Quine, 1960). Upon first hearing a novel word a youngster could interpret it as a general or specific action, object, part, idea, or feature within the immediate or past environment. It is the child’s task to derive the appropriate meaning from available cues. For each relevant cue, numerous irrelevant cues are often available, and need to be disregarded. Furthermore, each word learning episode presents a unique set of cues. Yet children frequently derive the appropriate meanings of words.

One possible reason why children are so successful at determining the meanings of new words is that they learn to attend to general cues that are available across multiple contexts and are reliable guides to word meaning (Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002). Researchers have identified social, linguistic, and physical
cues that direct children toward the appropriate dimensions in word learning episodes (see Woodward, & Markman, 1998).

One problem, however, is that these cues do not always provide correct interpretations; they only have a high probability of doing so. For example, overall shape and the presence of certain functional parts are both good predictors of whether a noun that has been learned for one set of objects can be extended to an unattested object. If a child encounters an object that looks like a cup with a concave body and an attached handle, it is very likely a cup. In certain situations, accurate interpretation requires the child to resist the import of these cues, however, and rely on specific information that he or she might otherwise ignore. When shown a funnel with a concave body and an attached handle, a child should resist the import of the “cup” cues and attend to the hole that prevents the object from functioning as a cup. However, young children often use the former cues and make overextension errors, using a label to denote an entity that is not an acceptable exemplar of the word (Mervis, 1987). These errors indicate that children have difficulty overcoming certain biases when less salient information becomes important. Piaget (1970) considered this kind of cognitive inflexibility, which he called centration, to be a hallmark of preoperational cognition.

In object word learning, preschoolers often centrate on overall shape of the object and ignore other information. In particular, they tend to give too little attention to object function, even when the function has been demonstrated for them. Slightly older children and adults, however, usually give appropriate weight to function even when it has not been demonstrated (Gathercole & Whitfield, 2001; Graham, Williams, & Huber, 1999;
Landau, Smith, & Jones, 1998; Merriman, Scott, & Marazita, 1993). The purpose of the current research is to examine ways in which younger children might be helped to overcome such function neglect in object word learning.

Possible explanations for children’s function neglect will be reviewed. Gentner’s (1983, 1989) structure-mapping theory of analogy, which suggests a way to direct children’s attention away from salient perceptual features in favor of abstract relational properties, will then be discussed. Two experiments that apply components of this theory to function neglect in word learning will then be reported. Finally, the findings will be discussed as part of a broader body of research concerning ways in which young children can be helped to overcome function neglect.

In both natural objects and common artifacts, form and function are highly correlated, which makes either property a good indicator of the labels that apply to an object and of the categories to which the object belongs. Matan and Carey (2001) state:

“Natural kinds have causally deep, hidden properties which determine their surface properties and their behavior in causal interactions with other entities in the world…. [For artifacts,] the intended function is the factor which determines the artifact’s surface properties, the actual functions it can serve (the intended function as well as others) and its kind” (p. 2).

Whatever underlying cause is responsible for making a particular object an exemplar of a particular label constrains the forms the object can take and the functions it can serve. As such, children should expect form and function to predict one another and both to predict the name of an object.

If both form and function are good cues for lexical extension, an important question is why young children initially rely more on form than function. One possibility
is that form is more readily available. As long as an object is visible, its form is apparent and available for processing. In contrast, an object’s function may only be apparent during a demonstration of the function. A static object’s function must be inferred from the object’s structure. It makes sense that the child would rely more often on form than function because form is available more often than function.

This availability explanation, however, cannot account for why young children neglect function even when it has been demonstrated. An alternative explanation is that children simply do not attend to function. Perhaps from the child’s perspective, what an object looks like greatly overshadows what it does, thus preventing representation of the function. Findings do not support this suggestion, however. Sensitivity to function information has been observed in 14 month olds’ dishabituation to object changes (Madole, Oakes, & Cohen, 1993), in 18 month olds’ problem solving (Brown, 1990), and in 3-year-olds’ judgments of similarities (Smith, Jones, & Landau, 1996). Often, young children do encode function information but tend not to use it to guide lexical extension, relying instead on overall object shape (see Graham, Williams, & Huber, 1999 for brief review).

Another possibility is that reliance on shape is the only lexical extension strategy that youngsters know. Perhaps a child encodes both form and function information, but believes overall shape to be what makes a particular object a referent of a particular label. This notion is also not supported. Several studies have shown that drastically increasing salience of function via extensive interactive experience or verbal highlighting can lead younger children to extend a label based on function rather than on form (e.g., Corrigan
and Schommer, 1984; Graham, Williams, & Huber, 1999; Kemler Nelson, 1999; Truxaw, Krasnow, Woods, & German, 2006).

It seems then, that function neglect in early word learning may result from strategy selection. Young children may know that form and function are both good indicators of the appropriateness of a label, and they may be able to use either as a basis for lexical extension, but they initially choose to rely on form because it is usually the easier strategy (see Rosch et al., 1976). Unless function is made extremely salient the child simply does not think to incorporate it into the meaning of the label.

Another important question is why children come to focus more on function as they get older. The answer probably lies in the relative importance that form and function have in natural and artificial categories. As stated above, in most word learning situations reliance on either form or function will lead to appropriate interpretations because the two are so highly correlated. When the two come in conflict, however, function – because it is a core property – tends to be the more reliable cue (see Rosch et al., 1976). That is, if two objects look different but have the same function or look the same but have different functions, function will generally be the appropriate guide to labeling. Very few object labels require greater attention to form than to function (e.g., cube, pyramid). Thus over-reliance on form and neglect of function – the young child’s initial strategy – is more likely than the opposite to result in overextension errors. Over time the child gains a more mature understanding of the relative importance of form and function. The child eventually changes his or her default strategy; and the frequency of
overextension errors, in particular ones based on function neglect, declines with age (Keil, 1989; Naiges & Gelman, 1995; Thomson, & Chapman, 1977).

If function-based lexical extension is more advanced than the child’s initial strategy, an important empirical question follows: are there ways other than extreme increase in salience of a function that can help children overcome function neglect at earlier ages? The main goal of the current study was to examine one such intervention: exposure to two exemplars of a function. That is, would children make novel lexical decisions on the basis of non-salient function information after seeing the function briefly demonstrated by two different objects?

Gentner’s (1983, 1989) structure-mapping theory of analogy suggests that a child’s attention is likely to shift away from surface features of an object toward deeper properties (e.g., function) when he or she is exposed to a second instance of a category. Exposure to two instances of a category is hypothesized to invite the individual to make comparisons that accentuate characteristics he or she might neglect if exposed to either instance alone. When a child sees a car, for example, he or she may be drawn to salient perceptual features such as the overall shape. The child’s concept of a car may include less apparent features such as “has a motor” or “transports people”, but this information is neglected. If a child sees a second car, however, he or she is likely to engage in comparison, and attention will be drawn toward those features that did not come to mind after seeing only one car.

In addition to comparison, the child employs the process of structural alignment, which is mapping individual object representations onto higher-order categorical
structures in which deep properties are given more emphasis than surface properties (see Gentner, 2005). When asked if a third object is of the same kind, the child should attempt to map it onto the higher-order categorical structure rather than onto the framework of either individual object. The characteristics that were not emphasized by one exemplar, but were emphasized by comparison of two exemplars (e.g., functionality) become the new basis for categorization and lexical extension.

Gentner and colleagues have recently shown that exposure to two exemplars indeed invites comparison, initiates structural alignment, draws attention to deeper properties, and leads to lexical extension based on those deep properties (Gentner, & Namy, 1999; Gentner & Namy, 2004; Gentner & Ratterman, 1991; Gentner, Rattermann, Markman, & Kotovsky, 1995; Kotovsky & Gentner, 1996, Namy & Gentner, 2002). In Gentner and Namy (1999), for example, 4-year-olds extended a novel label for an apple to a similarly shaped object (e.g., balloon) rather than to a different-shaped object of the same taxonomic kind (e.g., banana). However, when the novel label was applied to an apple and a pear, 4-year-olds extended the label more often to the banana than to the balloon. It is important to note that exposure to two exemplars could have drawn attention to shared surface-level properties (the pear and apple look more like the balloon than the banana), but it drew attention to deeper shared properties instead.

One limitation of Gentner’s studies is that stimuli were highly familiar to the children (e.g., fruits, bicycles). Her tasks only show that a child is capable of learning an alternate label for a preexisting category. A novel label applied to both an apple and a
pear, for example, is just a different word for fruit. Thus, it is an open question whether the same shifts in child attention would occur when learning novel object categories.

The structure-mapping theory also presents a second methodological limitation. Comparison and structural alignment seem to require well-developed representations that include deep properties of all individual items. For example, a child has to know the hidden properties that make apples, pears, and bananas members of the fruit category to be able to align the conceptual structures. Proper lexical extension in Gentner’s tasks requires the child to shift attention away from physical features toward preexisting conceptual features. In early lexical extension, however, the child may not have access to such information. The first time a child is exposed to a banana, for example, few (if any) perceptual cues are available that allow the child to infer the deep properties linking the banana with an apple and a pear. In the same way, a static novel object may not provide the child with necessary function information.

The current experiments were designed to determine whether mere exposure to two exemplars of the same function could alleviate 3- and 4-year-olds’ function neglect for novel objects. The children observed an object perform a function, and later watched as a second object performed the same function. After viewing this last event, which always involved a novel object, they were taught a novel label for this object (henceforth referred to as the standard.) Children were expected to extract the function common to two objects, form an object category based on this function, and map the trained label onto the category. Moreover, they were expected to identify the part of the standard that was necessary for performing its function.
For example, one standard had a screwdriver head on the bottom, and children watched this object used as a screwdriver. After being taught the label for the object, the children were asked to choose an exemplar of the label from a pair of additional novel objects (henceforth referred to as the generalization objects). Both of these objects resembled the standard in shape and other surface properties, but only one possessed the crucial functional part. Because the children had never been shown how the generalization objects functioned, a significant tendency to select the correct object (i.e., the one that could perform the standard’s demonstrated function) would indicate that at least some had identified the part that was crucial to the standard’s function.

Two differences between the approach taken in the current studies and that taken in the experiments by Gentner and colleagues may prove to be important. First, Gentner and colleagues focused on deep properties without clearly identifying the nature of those deep properties. The current study focused on a particular deep property – function – that could clearly be linked to subtle perceptual features of the object. This focus was necessary in order to apply Gentner’s claims about the effect of multiple exemplars to the alleviation of function neglect in novel object label learning. Second, Gentner and colleagues always presented the related exemplars simultaneously, whereas the current experimenter presented them interleaved within a sequence of demonstrations. The latter procedure adds an extra component of difficulty that could lead to conservative estimates of experimental effects.
Study 1

The first goal of Experiment 1 was to determine whether young children still show function neglect when presented with two exemplars of the same function. In particular, would exposure to two exemplars of a function draw 4-year-olds’ attention away from salient perceptual properties towards a subtle but necessary functional part? If so, children who are exposed to two exemplars of a function should extend a label trained for one of the objects – the standard – to an unattested novel object based on whether the objects share the same functional part. The results of previous studies suggest the presence of a salient functional part and a single demonstration of a function are not sufficient to attenuate function neglect in 4- and 5-year-olds’ object label learning (e.g., Gentner, 1978; Graham, Williams, & Huber, 1999). It is unlikely that the presence of subtle functional parts in the current study would produce any effect. Thus, if the 4-year-olds in Experiment 1 extend a label on the basis of function above chance level it is reasonable to attribute it to the two exposures.

The second goal of Experiment 1 was to compare the effectiveness of two kinds of exemplar pair presentations: familiar-novel and novel-novel. For half the children, the exemplar that was presented before the standard object was a familiar object that performed its familiar function (e.g., a bulldozer moving dirt). The children were then shown the novel standard performing this same function (e.g., a strange-looking vehicle moving dirt). Afterward, the children were taught a name for the standard. The
remaining children experienced the same sequence of events, except that the first exemplar that they viewed was also a novel object. This novel object was also presented performing the same function as the standard object (e.g., it was another unusual-looking vehicle moving dirt). If children are using comparison and structural alignment to bring attention to deeper properties, a familiar object should facilitate the process more than a novel object should. In the first condition, children would be attempting to map a novel structure onto a well-formed, organized framework; in the second, they would be mapping a novel structure onto a newly-formed framework that is likely less well organized.

The last goal of Experiment 1 was to examine the effects of age. The processes of comparison and structural alignment require the child to hold a fair amount of information in working memory and to shift attention away from surface properties to deep properties. With age, the ability to maintain and manage such information improves (see Halford, 1998). Thus older 4-year-olds may be more capable of performing the processes in question.
Method

Participants

Forty-eight preschoolers (26 male, 22 female) were recruited from daycares surrounding Kent, Ohio. The children were assigned to four groups: twelve older 4-year-olds in a familiar-novel group \((M = 4.8 \text{ (4 years, 8 months); range = 4.6 to 4.11)})\), twelve older 4-year-olds in a novel-novel group \((M = 4.8; \text{ range = 4.6 to 4.11)})\), twelve younger 4-year-olds in a familiar-novel group \((M = 4.2; \text{ range = 4.0 to 4.5})\), and twelve younger 4-year-olds in a novel-novel group \((M = 4.3; \text{ range = 4.0 to 4.5})\). Gender was balanced across conditions, but slightly unbalanced across age groups (6 male, 6 female in each group of older 4-year-olds; and 7 male, 5 female in each group of younger 4-year-olds). Each group was sub-divided into two groups counterbalanced for function observed in the standard object. The children were tested individually in a quiet room of their daycares and received stickers for participation.

Materials

_Familiar-Novel Condition._ Stimuli consisted of four sets (two animate and two inanimate) of five objects each. Two of the objects were familiar to preschoolers, and their functions served as the basis for designing the remaining objects – a triad of perceptually similar novel objects. For example, one set included a common screwdriver and a common spray bottle. A novel object, the standard, was designed to look distinct
from both familiar objects, but to possess the part needed to function similarly to each. For example, the standard object that was labeled “blicket” was unique in overall appearance but included a screwdriver part on the bottom and a nozzle on the top. These parts allowed it to be used as a screwdriver or a sprayer. Two more novel objects, the generalization objects, were designed to look like the standard object, but each possessed only one functional part, and so could perform only one of the two functions. In the blicket set, for example, one generalization object had a screwdriver part but no nozzle; while the other generalization object had a nozzle but no screwdriver part [see Figure 1 on next page].

This design allowed for the generation of two counterbalanced conditions with identical test phases. For example, half of the children saw only the screwdriver function demonstrated by the screwdriver and then by the blicket. The remaining children saw only the spray function demonstrated by the spray bottle and then by the blicket. However, at test, all children saw the same two test objects and were asked to decide which one was a blicket.
Figure 1. Sample object set for Familiar-novel condition.

Thirty-second video clips demonstrating the function of each object were created for all but the generalization objects. Each familiar object clip showed a familiar object performing its familiar function. Each standard object appeared in two clips to demonstrate the function it shared with each of the familiar objects in its respective stimulus set. Clips depicting identical functions differed only by the object performing the function. For example, two otherwise identical woodshop clips showed a man using either a screwdriver or the standard blicket to drive in a screw. In the counterbalanced version, two otherwise identical grooming clips showed a man using either a sprayer or the standard blicket to spray a dog. All clips included background music and narration to hold the child’s attention. In all, sixteen clips were filmed.

The clips were compiled into two counterbalanced eight-clip video versions. For each version, the first four clips consisted of the familiar objects performing their functions. The second four clips were identical to the first four except that the familiar
objects were replaced by the standard objects performing the same functions. The basic
layout for the video versions is depicted in Appendix A.

**Novel-Novel Condition.** The Novel-Novel stimuli were identical to the Familiar-
Novel stimuli except that all familiar objects were replaced with perceptually distinct but
function-matched novel objects. In the blicket set, for example, the novel object that
replaced the screwdriver had a screwdriver part, but did not otherwise resemble a typical
screwdriver or the members of the blicket triad [see Figure 2]. The video clips depicting
familiar objects and their functions were also replaced with clips depicting the novel
objects and their functions.

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<th>Standard Object</th>
<th>Generalization Objects</th>
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</tr>
<tr>
<td><strong>Version B</strong> (Screwdriver)</td>
<td>“Blicket”</td>
<td><img src="image2.png" alt="Image" /></td>
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**Figure 2.** Sample object set for Novel-novel condition.

**Procedure**

**Demonstration Phase.** Each child was brought into a quiet room in their daycare
where a thirteen-inch Sanyo television and a Panasonic DVD player sat on top of a
portable stand. Two chairs were placed side-by-side approximately three feet from the television. After the experimenter (the author) established rapport with the child, he sat in one of the chairs, instructed the child to sit in the other chair, told the child to watch and listen very carefully, and started the video. After the first four clips, the video was paused and all four standard objects were presented for the child to view. The objects were placed out of reach to prevent any effects of interacting with the objects. The experimenter explained that they would be watching four more clips a lot like the first four, and the child would be searching the video for the objects in front of him or her. Prior to each clip, the experimenter told the child which object to look for.

Training and Test Phase. After watching the entire video all objects were placed out of the child’s view, the chairs were rotated to face one another, and a table was placed between the child and experimenter. Next, a standard object was placed on the table out of the child’s reach, and the child was taught a name for it. For example, in training the name for the blicket, the experimenter held the standard and said, “Remember this from the video? This is a ‘blicket’. Can you say ‘blicket’?” The standard was then removed from view and the two generalization objects were placed on the table out of the child’s reach. Finally, the child was asked which one of the generalization objects had the name that had been trained for the standard (e.g., “Which one is a blicket?”). This procedure was repeated for the remaining three stimulus sets. Order of stimulus set presentation was random across participants. A child’s choice was marked correct if the object that was selected could perform the function that had been demonstrated with the standard in the video that the child had viewed. For example, if the screwdriver function of the
blicket had been demonstrated in the video, the correct response was to choose the
generalization object that had the screwdriver part. Correct candidates were controlled
for side bias (two left and two right) and size bias (two big and two small). See
Appendix B for a script of the procedure.
Results and Discussion

A 2 (condition: familiar-novel vs. novel-novel) X 2 (age: young 4-year-olds vs. old 4-year-olds) analysis of variance of rates of correct choice was conducted. The analysis yielded a main effect of age, $F(1, 44) = 4.35, p < .05$, but no main effect of condition, $F(1, 44) = 1.93, p > .10$. The age by condition interaction was also significant, $F(1, 44) = 4.35, p = .04$, indicating a differential effect of condition for the two age groups. Simple effects tests revealed a significant effect of condition in young 4-year-olds, $F(1,44) = 6.04, p = .02$, but no effect of condition in older 4-year-olds, $F < 1$. The results are summarized in Figure 3.

![Figure 3](image.png)

*Figure 3.* Proportion of trials on which children chose function-matched object
A developmental trend was evident. Older 4-year-olds were helped to overcome function neglect by observing two objects performing the same function ($M = .71, SD = .20, n = 24$). Such a scenario, irrespective of whether only one or both functional exemplars were novel objects, presumably shifted older 4-year-olds’ attention from overall object shape to a subtle but essential functional part – possibly via the processes of comparison and structural alignment (Namy & Gentner, 2002).

Exposure to two novel exemplars of the same function, however, was not sufficient to help younger 4-year-olds overcome function neglect as indicated by performance in the novel-novel condition ($M = .48, SD = .20$). Children in this age range needed the additional help that was provided by the familiarity of the first object ($M = .69, SD = .22$). This age group may be capable of engaging in comparison and structural alignment only when a novel functional exemplar can be mapped onto a well-established conceptual structure. Whether the null effect of the novel-novel presentation is attributable to difficulty initiating comparison and/or executing structural alignment remains a question for future research.

Given that the performance of older 4-year-olds in the novel-novel condition was far from ceiling, the finding that they received no extra benefit from seeing a familiar object perform the function first may be important. One possible explanation is that this age group’s working memory capacity allows them to compare and align two novel conceptual structures just as readily as a familiar and a novel conceptual structure. Another possibility is that because of their greater experience with the familiar objects on which the stimulus sets were based and greater practice in basing interpretation of labels
on function, these children could extract the relevant functional information from the first novel exemplar that they observed. For example, perhaps the first novel screwdriver reminded the child of familiar screwdrivers. The noted similarities invited the child to make deeper comparisons between the first novel screwdriver and a previous representation of a screwdriver. This borrowed conceptual structure might allow for latent mapping of the second novel object onto a well-established conceptual structure. Once again, however, the actual reason for the null effect of exemplar type remains an open ended question beyond the scope of the current research.
Study 2

The first goal of Experiment 2 was to determine whether even younger children, 3-year-olds, could be helped to overcome function neglect by the procedures that helped the younger 4-year-olds to do so. That is, would they incorporate function in their interpretation of a label for a novel object after watching demonstrations of the function in a familiar object and then in the novel object? Compared to 4-year-olds, 3-year-olds have less control of attention, poorer reasoning ability, less efficient memory processes, and less knowledge about object labels and functions. Younger 4-year-olds needed more help than older 4-year-olds to overcome function neglect, so 3-year-olds may require even more. For this reason, the novel-novel condition that did not help the younger 4-year-olds was dropped from Experiment 2, and an augmented familiar-novel condition was added. In the latter, called the familiar-novel-hint condition, the experimenter used verbal means to encourage the 3-year-olds to compare the standard object to its corresponding familiar object.

Namy and Gentner (2002) suggest that comparison is a prerequisite to overcoming function neglect. Although observing two objects exemplify the same function “invites” the child to make deep property comparisons, he or she will only benefit upon acceptance of that invitation. Namy and Gentner demonstrated that encouragement to engage in comparison (e.g., “See how these are the same kinds of things?” p. 12) increased the likelihood that a young child would take deeper properties
into account. In the current experiment, the same procedures as in the familiar-novel condition of Experiment 1 were administered. However, half the participants received additional help in the form of verbal hints.
Method

Participants

Thirty-two preschoolers (16 male, 16 female) were recruited from daycares surrounding Kent, Ohio. The children were assigned to two groups: a familiar-novel group ($M = 3.6$; range $= 3.1$ to $3.11$; $n = 16$), and a familiar-novel-hint group ($M = 3.6$; range $= 3.2$ to $3.11$; $n = 16$). Each group was sub-divided into two groups counterbalanced for function observed in the standard object. The children were tested individually in a quiet room of their daycares and received stickers for participation.

Materials

Materials used for both conditions were identical to those used in the familiar-novel condition of Experiment 1.

Procedure

The procedures for the familiar-novel condition were identical to those used for this condition in Experiment 1. The procedures for the familiar-novel-hint condition deviated in three ways, however. First, during each familiar object clip, the experimenter drew attention to the target object by using its label and instructing the child to watch it closely. During the screwdriver clip, for example, the experimenter said, “Watch the screwdriver. Do you see the screwdriver? Watch the screwdriver closely.”
Second, during each novel object clip the experimenter reminded the child of the familiar object clip, told the child that the novel object was going to replace the familiar object, and asked the child to help find the novel object in the new clip. Prior to the standard blicket clip, for example, the experimenter said, “Remember when you watched the screwdriver movie? Now we are going to watch that same movie… only this time, the screwdriver will not be in it, but this will be [hold up standard]. Help me find this where the screwdriver used to be.”

Finally, during the name training phase just prior to testing, the experimenter reminded the child that the standard object had been in a movie just like the one that the familiar object had been in. During the training of blicket, for example, the experimenter said, “Remember when you watched the screwdriver movie? Remember when you watched another movie a lot like it with this in it instead of the screwdriver [holds up blicket]? Well, this thing is called a blicket.” The remainder of the procedure was the same as in the other conditions. See Appendix B for a script of the procedure.
Results and Discussion

A 2 condition (familiar-novel vs. familiar-novel-hint) analysis of variance of rates of correct choice was conducted. Rates in the familiar-novel-hint condition ($M = .62, SD = .18$) exceeded those in the familiar-novel condition ($M = .48, SD = .19$), $F(1,30) = 4.48$, $p < .05$. Furthermore, rates in the latter condition were at chance level indicating that exposure to a familiar and a novel exemplar of the same function was not sufficient to engage the 3-year-olds in the processes necessary to incorporate function in their interpretation of the trained label. The children who received verbal hints throughout the procedure, however, were helped to overcome function neglect, $t(15) = 2.74$, $p = .01$ [see Figure 4]. Thus when given verbal hints that direct them to the function shared by a familiar and a novel exemplar, 3-year-olds can take function into account in object label learning.

The verbal instructions may have promoted the child’s tendencies to engage in comparison and structural alignment, thus drawing attention to function. Mere exposure to two exemplars may invite such a comparison; but the 3-year-old may require at least one well-established conceptual structure along with some guidance from a word-expert to be able to respond successfully to such an invitation.
Figure 4. Proportion of trials on which children chose function-matched object
General Discussion

Two experiments demonstrated that 3- and 4-year-olds can be helped to overcome function neglect in object word learning. Young children can extract the function common to two objects, form an object category based on this function, and map a trained label onto the category. The results also support the conclusion that as preschool-age children grow older, they require less and less help to extract the relevant information from two exemplars of the same function. In Experiment 2, 3-year-olds were able to extract function information from two exemplars, and incorporate this information in their interpretation of a novel label when the first exemplar was familiar and an adult verbally highlighted the functional similarity between the exemplars. They did not show this ability to extract and incorporate function information, however, when the first exemplar was familiar and no verbal highlighting was provided. In Experiment 1, young 4-year-olds succeeded under the latter conditions. However, in the same experiment, this age group did not succeed when both exemplars of the function were novel. Older 4-year-olds were able to extract and incorporate function regardless of whether the first exemplar was familiar or novel.

To frame these results in terms of Gentner’s structure-mapping theory (Gentner, 1983), over the preschool years the child becomes increasingly likely to make relevant comparisons between objects and to use structural alignment to draw attention to shared function properties. Exposure to more than one exemplar of a function is not always
sufficient to vanquish function neglect in object word learning. The child must seize the opportunity to engage in comparison and structural alignment. In addition, he or she must have the cognitive resources to execute the processes on a particular pair of objects. Finally, he or she must deem the function important enough to be included in the meaning of the label. The likelihood that a younger preschooler will execute this combination of processes increases when the child is tacitly encouraged to compare objects, or when one comparison object (and its function) are already known by the child.

A major limitation of the results of the current studies is that they leave plenty of room for speculation regarding why certain groups were more likely than others to overcome function neglect. At least two – but likely more – phenomena could explain the age-related trends in the results, namely, the accumulation of object knowledge and improvement in memory processes. As they get older, children accumulate both item-specific and domain-general knowledge that may promote their extracting the function exemplified by two objects and incorporating it in a novel label’s meaning. Previous research has demonstrated that youngsters are more likely to take function into account when they have had direct and extensive experience with the training and generalization objects (Kemler-Nelson, 1999); when they have been explicitly informed about the specific objects’ functions (Diesendruck, Markson, & Bloom, 2003); and when they have been explicitly instructed to note differences in form and/or function between the label-trained object(s) and the candidate generalization objects (Truxaw et al., 2006). Other studies have shown that a general increase in function-based lexical extension occurs as the child gets older (e.g., Merriman, Scott, & Marazita, 1993), indicating the possible
importance of increasing domain-general knowledge in the age-related decline in function neglect.

In the current study, the 3-year-olds may not have had enough experience engaging in the processes of comparison and structural alignment to know when to initiate them. Furthermore, they likely had less out-of–lab experience than the other groups had with the familiar object categories that served as bases for the stimulus sets. Younger 4-year-olds may not have had enough experience generating complex representations of novel objects to encode the importance of a functional part in such a short demonstration. Furthermore, the youngsters may not have had sufficient experience with the familiar object categories for a novel object to remind them of previously stored representations. In either case, the younger 4-year-olds in the novel-novel condition would have been working with weaker representations than the other three groups of 4-year-olds. Finally, older 4-year-olds had enough experience with the familiar object categories to be reminded of them upon presentation of a novel object. In addition, they may have engaged in the relevant processes enough times to make the execution of them effortless.

Changes in memory processes may also contribute to the developmental trends observed in the current investigation. The processes of inferring function, making comparisons, aligning structure, and mapping a label onto the newly formed category all presumably require working memory resources. The interleaved sequence format of the current study may have made the working memory requirements even greater. Not only did the children have to engage in all these processes, but they also had to simultaneously
maintain four to eight separate demonstrations in memory. Consequently, 3-year-olds in the familiar-novel condition may not have remembered the first set of demonstrations upon viewing the second set of demonstrations. Perhaps the verbal cuing in the familiar-novel-hint condition was enough to retrieve memories of the events involving the first exemplar, and so allowed the children to make the necessary comparisons. The younger 4-year-olds may not have had sufficient capacity to maintain two novel representations while carrying out the relevant processes. Perhaps the added representational efficiency provided by the structure of the familiar object freed up enough space in working memory to execute the processes. Finally, the older 4-year-olds may have had sufficient capacity to maintain any two representations while engaging in the relevant processes.

Further research is necessary to identify the roles that experience, working memory demands, and other phenomena may play with respect to effect that multiple exemplars have on children’s tendency to incorporate function in their interpretation of a novel object label. The role of object experience could be assessed simply by measuring or manipulating the amount of experience that a child has with a particular set of object exemplars.

A particularly important question is whether merely exposing 3-year-olds to a familiar and a novel exemplar of the same function can help them overcome function neglect when demands on working memory resources are minimized. The demands of the current paradigm could be reduced by presenting the two exemplars in immediate succession, and proceeding immediately to name training and generalization testing. If these procedural changes helped 3-year-olds overcome function neglect in a familiar-
novel condition, the next important goal would be to determine whether they would also help 3-year-olds and young 4-year-olds when both exemplars were novel.

An individual difference approach to the question of the role of working memory demands could also be taken. For example, young 4-year-olds could be given tests of their working memory capacity, such as nonword repetition or auditory digit span (see Adams & Gathercole, 1995). If their scores on the test were found to correlate positively with their rate of correct responding in the familiar-novel condition, this finding would support the conclusion that a child’s benefit from seeing the two exemplars in this condition depends on whether he or she has sufficient working memory to process the exemplars and their relations.

Regarding the effect of verbally highlighting the functional similarities between exemplars, future research should address whether such highlighting would help younger 4-year-olds overcome function neglect in a novel-novel condition, just as it helped the 3-year-olds in the familiar-novel condition. Additionally, future studies should examine which features of the verbal highlighting procedure benefit the child, and which have no effect. Children may not have needed all three hints offered in Experiment 2 to engage in comparison. Perhaps the familiar labels used during the familiar demonstrations reminded the child that function is critically attached to many labels’ meanings. It could also be that hearing the label once again during demonstration of the novel exemplar’s function prompted the children to map the known word onto the novel object. If that was the case, at time of test, the child might have assumed the new word was just an alternate
term for the familiar object category. Various factors during each point of the procedure could be responsible for the effect and need to be disentangled.

Another important question is whether older 4-year-olds actually benefit from observing two rather than one exemplar of a function. Neither Experiment 1 nor 2 included a single exemplar control condition. Previous research findings suggest that older 4-year-olds would not extract and incorporate function information if function were only demonstrated in the novel training object (and not in the novel generalization test objects) (e.g., Graham, Williams, & Huber, 1999). However, the degree to which this age group benefited from seeing the initial exemplar in the novel-novel condition can only be gauged by comparing performance in this condition to that of older 4-year-olds in a novel only condition (i.e., one in which the initial exemplars of the novel-novel condition are not presented.)

If as expected, older 4-year-olds were to fail to incorporate function information, the question of whether verbal hints would help when only a single exemplar is presented could be addressed. In the current paradigm, because the novel object functions are based on familiar object functions, the older 4-year-olds who see only one exemplar may be helped to overcome function neglect by an adult pointing out that the novel object is similar to an object the child already knows a name for (e.g., “This next object is like a screwdriver in some ways but not in all ways.”)

Finally, as already argued, function neglect may be a matter of strategy selection. The child faces a choice between generalizing a novel label based on the overall shape of the training object or based on its perceived function. It may be beneficial to frame
future research according to Seigler’s (1996, 2000) overlapping waves model of strategy development. This particular model seems to be a good fit for the observed pattern of results. The model predicts that a child will adaptively select the most efficient strategy he or she has available for a particular problem, and will gradually replace immature strategies with more appropriate ones over time. Based on the salience of form, the high correlation form has with function, and the sheer amount of new words a child must learn, it is certainly adaptive for young children to use the “quick and dirty” form-based strategy as a default. As accuracy of meaning becomes more important than speed of acquisition, however, it makes sense that the child would move towards the more appropriate function-based strategy. Siegler’s model (e.g., Shrager & Seigler, 1998) also predicts that developmental change in strategy selection is an intricate interaction among processes (e.g., comparison and structural alignment), mental representations (e.g., familiar vs. novel representations), and cognitive capacities (e.g., working memory).

More important than the conceptual match provided by Seigler are the empirical suggestions he offers. In a global sense, he maintains that to understand development, it is best to study the portion between two endpoints. Chen & Siegler (2000) advocate using the microgenetic method in which the focus of observation is on the change in a child during the time leading up to adoption of a more mature kind of thinking. It may be useful to track 3- to 5-year-olds’ function neglect on a monthly or even weekly basis to see how their thinking progresses. Specific elements of Seigler’s theory may also guide predictions pertinent to function neglect. As mentioned above, the interactions between processes, representations, and capacities are very important to developmental change.
Moreover, they are hypothesized to relate to change in logical and testable ways. As such, the overlapping waves approach provides a solid foundation on which to build an empirical understanding of this interesting trend in language development.
References


Video layout for Experiments 1 and 2

<table>
<thead>
<tr>
<th>Version A</th>
<th>Version B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object 1A produces milk for a farmer</td>
<td>Object 1B captures spider with tongue</td>
</tr>
<tr>
<td>Object 2A sprays a dog</td>
<td>Object 2B screws in screw</td>
</tr>
<tr>
<td>Object 3A moves dirt</td>
<td>Object 3B fends off dragon</td>
</tr>
<tr>
<td>Object 4A brings water to toddler</td>
<td>Object 4B gives light for photographer</td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td>Break – novel objects brought out</td>
<td>Break – novel objects brought out</td>
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<tr>
<td></td>
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<tr>
<td>Standard 1 produces milk for a farmer</td>
<td>Standard 1 captures spider with tongue</td>
</tr>
<tr>
<td>Standard 2 sprays a dog</td>
<td>Standard 2 screws in screw</td>
</tr>
<tr>
<td>Standard 3 moves dirt</td>
<td>Standard 3 fends off dragon</td>
</tr>
<tr>
<td>Standard 4 brings water to toddler</td>
<td>Standard 4 gives light for photographer</td>
</tr>
</tbody>
</table>
Script for Novel-Novel and Familiar-Novel Conditions

[Experimenter (E) makes small talk until Child (C) is comfortable.]

E: We are going to watch a short video. I want you to sit really still and pay close attention to it. [C watches first four clips. E pauses video and places the four standard objects in view of C but out of his or her reach]

E: Now, we are going to watch four more clips a lot like the ones you just saw. Only this time I need your help finding these things [E points to standard objects]. When you see one of these, I want you to point to it on the TV screen. See if you can find them before I do. [E holds up object for first clip] “Okay, let’s try to find this one.” [E unpauses video. If C has not pointed by fifteen seconds into the clip, E points the object out. Repeat for the remaining three clips].

[E stops video and places all objects out of C’s view]

E: Now I am going to teach you the names for the four things you helped me find in the video. I also have some other things in this big box but I do not know what to call them. I need your help. [Ten gallon lidded crate placed between C and E. E slides lid forward still keeping the objects hidden from C.]

E: [E holds up first standard object] Do you remember this thing from the video? This is called a (object label). Can you say (object label)? [C repeats word. E hides standard object and pulls two comparison objects from the crate]. Now, one of these is also a (object label) but the other is not. I need your help figuring out which one is a (object label).
label). Can you point to the (object label)? [C chooses object]. Thank you! Now I know what to call this. [Repeat for each object set].

E: You have been such a big help today! Thank you very much!
Script for Familiar-Novel-Hint condition

[Experimenter (E) makes small talk until Child (C) is comfortable.]

E: We are going to watch a short video. I want you to sit real still and pay close attention to it.

E: In this first clip I want you to watch the (familiar object label). Do you see the (familiar object)? Watch the (familiar object) closely. [C watches clip... Repeated for the remaining three clips]

[Experimenter pauses video and places the four standard objects in view of C]

E: Now, we are going to watch four more clips a lot like the ones you just saw. You will see these things [E point to standard objects] instead of the other things.

E: [E holds up object for first clip] Remember when you watched the (familiar object) movie? Now we are going to watch that same movie... only this time, the (familiar object) will not be in it, but this will be [E holds up standard]. Help me find this where the (familiar object) used to be. [E unpauses video and C finds the object... Repeated for the remaining three clips].

[E stops video and places all objects out of C’s view]

E: Now I am going to teach you the names for the four things you helped me find in the video. I also have some other things in this big box but I do not know what to call them. I need your help. [Ten gallon lidded crate placed between C and E. E slides lid forward still keeping the objects hidden from C.]
E: [E holds up first standard object] Remember when you watched the (familiar object) movie? Remember when you watched another movie a lot like it with this in it [holds up blicket] instead of the (familiar object)? Well, this thing is called a (novel object name). Can you say (object label)? [C repeats word. E hides standard object and pulls two comparison objects from the crate]. Now, one of these is also a (object label) but the other is not. I need your help figuring out which one is a (object label). Can you point to the (object label)? [C chooses object]. Thank you! Now I know what to call this. [Repeat for each object set].

E: You have been such a big help today! Thank you very much!