THE ROLE OF EXEMPLAR COMPARISON IN PRESCHOOLERS’ INTERPRETATIONS OF NOVEL OBJECT LABELS

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by

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CHAPTER 1

INTRODUCTION

The Task Of Learning Novel Labels For Novel Objects

The central problem that children face in learning the meaning of any word is that of identifying the conceptual information that the word conveys. Even the seemingly simple task of learning a novel object label requires that the child sort through an indefinitely large set of property combinations to identify one that captures the label’s meaning (Brown, 1956; Markman, 1989). In each label learning episode, the child must determine the relative importance of obvious properties such as an object’s shape, size, color, texture, material composition, and parts, as well as less obvious properties such as an object’s internal structure or intended function.

The child’s task is further complicated by the fact that object labels are often causally linked to “core” properties that are hidden or only occasionally manifest, but correlated with more accessible surface properties (Matan & Carey, 2001). For example, a typical cup is labeled cup because it was designed to hold and dispense liquid into a human mouth. This is true even when the person who made the cup is unavailable for comment, and when the cup is not being used for this purpose (e.g., stored in a cabinet, or covering a spider). Cup is correlated with highly accessible object features such as shape or size, but only to the extent that those properties support its often elusive intended function (e.g., shape must support liquid containment, and size must support human use). The nature of relationships among concepts and percepts thus requires young word
learners to infer core properties of novel objects, and represent those properties according to the most meaningful visible correlates (Bloom, 2000).

The visible components that best predict an object’s core properties and its label are different for different classes of objects (Tyler, Moss, Durrant-Peatfield, & Levy, 2000). For example, the core property for many man-made objects (e.g., shoe) is intended function (e.g., to protect feet), which might be best predicted by and represented as a set of physical properties that allow an object to carry out its designated function (e.g., certain shapes, sizes, and materials are ideal for a shoe to function properly). The core property for many natural objects (e.g., apple) on the other hand, is organic makeup which might be best predicted by and represented as a different set of physical properties (e.g., shape, texture, and color).

The criteria for accurate labeling are so complex that even word experts (adults) find it difficult to identify them, let alone teach them (Solomon, Medin, & Lynch, 1999). Ultimately, the child’s success depends on the criteria that he or she develops to zero in on the properties most relevant in a particular word learning episode (i.e., apparent properties that best predict core properties).

One potentially useful technique for identifying the conceptual properties that various labels convey is to make comparisons among exemplars of the same category. According to Gentner’s (1983; 1989) Structure Mapping Theory of Analogy, preschoolers focus attention on the surface features of a single novel object. However, when presented with more than one member of a novel category, the child engages in a form of comparison that draws attention away from surface features toward deeper, more
meaningful properties of that category. Moore (2006) tested this idea as it applies to preschoolers’ representation of function when interpreting novel object labels. More specifically, he wanted to see whether children who typically focus on overall object shape when interpreting novel labels would shift their focus to subtle functional details if they saw the function demonstrated by two exemplars of the category prior to learning the label. Children in Moore’s study did attend more to function, but younger children needed more “helpful” comparison conditions than older children did before they incorporated function into their representation of a novel object label.

The goals of this dissertation are to explain these age differences, and ultimately to shed light on the developmental role comparison plays in children’s interpretations of novel object labels. Experiment 1 examines the possibility that the younger children in Moore’s (2006) study had insufficient memory resources to meet the demands of certain comparison conditions. Experiment 2 examines the possibility that the older children in Moore’s study had acquired enough knowledge about the importance of function to make the comparison process redundant.

A pattern that emerged when the results from the first two experiments were put in the context of Moore’s (2006) findings suggested that preschoolers’ approach to exemplar comparison and label interpretation might differ depending on the ontological kind (animate or inanimate) of the novel object presented in a given word learning episode. One possibility is that preschoolers’ tendency to incorporate a particular shared property into their interpretation of a novel label depends on how important that type of property is to the meaning of typical object categories that are of the same ontological
kind as the target object. This proposal will be called the *Ontological Fit Hypothesis*.

Another possibility is that preschoolers use different comparison modes for label interpretation depending on objects’ ontological kind. This proposal will be called the *Ontological Mode Hypothesis*. These two hypotheses are examined in Experiment 3. The findings of these studies will be used to evaluate the role comparison may play in helping preschooler’s figure out the criteria for accurate label interpretation.

Before presenting a more complete rationale for the current series of experiments, the main findings of research on children’s representation of function when learning novel labels will be reviewed. Various ways in which researchers have sought to help children give greater attention to function will then be considered. Finally, Gentner’s (1983; 1989) Structure Mapping Theory of Analogy, and Moore’s (2006) application of it will be introduced.

**How Do Demonstrations of Function Affect Children’s Interpretations of Novel Object Labels?**

Previous research has shown that children younger than six years old tend to neglect functional information when interpreting novel labels for inanimate objects. Slightly older children and adults, in contrast, tend to give appropriate weight to function (Gathercole & Whitfield, 2001; Graham, Williams, & Huber, 1999; Landau, Smith, & Jones, 1998). This pattern is found whether or not the intended function of the artifact has been demonstrated.

The phenomenon of *function neglect* in younger children has been at the forefront of word learning research since the early 1970s when Eve Clark and Katherine Nelson
engaged in a landmark theoretical debate. According to Clark’s (1973) semantic feature hypothesis, children base their interpretation of a novel label on salient perceptual features of a referent object, in particular, overall shape. Alternatively, Nelson’s (1974) functional core theory claimed that children use object function as the basis for novel label interpretation. Since then, many studies have pitted object shape against object function in label learning tasks, and have usually found preschool-age children to give more weight to shape than to function in their generalization of the trained label (Gathercole et al., 2001; Gentner, 1978; Graham et al., 1999; Landau et al., 1998; Merriman, Scott, & Marazita, 1993).

The above findings are both problematic and surprising. They are problematic because function is considered a core property of many basic category labels while shape is not (Matan et al., 2001). The findings are surprising because even infants consider an object’s functionally relevant design to be important in some non-verbal categorization tasks (Madole, Oakes, & Cohen, 1993; Brown, 1990; Smith, Jones, & Landau, 1996). Madole et al. (1993), for example, showed that 14-month-olds will dishabituate to an exemplar of a familiarized shape-based category when a subtle difference in functional design is introduced that does not change overall shape. It seems as if young children understand that function is critical to an object’s category membership, but do not realize that it is also critical to determining the object’s label.

Some theorists have argued that preschoolers may understand the importance of function to a label’s meaning, but are often forced to choose a shape-based interpretation (Baldwin, 1992; Diesendruck, Markson, & Bloom, 2003). An object’s shape is readily
available during most label learning episodes, whereas functional information is often incomplete or absent. It has been shown that when 2-, 3-, and 4-year-olds are encouraged to ask about the meaning of labels for artifacts that are not engaged in their intended function, they tend to inquire about the object’s function (Kemler Nelson, Egan, & Holt, 2004).

Perhaps preschoolers would incorporate object function more frequently if it were made as accessible as object shape during novel label learning. Unfortunately, the results of one study did not support this proposal. In Graham et al. (1999), 3- and 5-year-olds continued to rely on shape for label generalization even when experimenters emphasized object functions and gave the preschoolers direct experience with those functions during label training and label generalization.

An alternative explanation is that a preschooler’s focus is so strongly drawn toward shape that he or she fails to attend to other properties. Smith et al. (1996) claim that preschoolers’ label learning is influenced by a domain-general “dumb attentional mechanism” that prioritizes object shape over other properties. That is, object shape is important for so many other basic perceptual tasks that people are hardwired to devote maximum attention to shape upon encountering a novel object – regardless of the manner in which it is encountered. Indeed, young children exhibit a strong shape bias in a variety of novel categorization and naming tasks in which less salient properties have been emphasized (Diesendruck & Bloom, 2003; Hupp, 2004; Samuelson & Smith, 2005). However, the notion that this bias is strong enough to prevent attention to other properties (i.e., cause function neglect) is not supported. As previously noted, preverbal infants
have demonstrated sensitivity to novel object function in such domains as discrimination (Madole et al., 1993), and problem solving (Brown, 1990). It is only when asked to generalize newly learned object labels that this sensitivity to function seems to wane.

A third possibility is that preschoolers operate on a shape principle specific to the domain of word learning. Smith et al. (1996), for instance, have shown 3-year-olds to be sensitive to novel object function when making similarity judgments, but not when generalizing labels. Perhaps young word learners attend to shape and function, but believe that objects have the same name because they look alike. As such, they would represent object shape and label together, but encode object function separate from the label – even if prior nonverbal tasks had caused them to link shape and function. This proposal has not been supported, however. Several studies have shown that drastic increases to the salience of a novel object’s function via extensive interactive experience or verbal highlighting can cause a young preschooler to use a function-based interpretive strategy for the object’s label (Diesendruck et al., 2003; Kemler Nelson, 1995; Kemler Nelson, 1999; Kemler Nelson, Frankenfield, Morris, & Blair, 2000; Truxaw, Krasnow, Woods, & German, 2006).

A fourth, more likely explanation is that preschoolers realize that shape is not core to the meaning of most object labels, but are not certain of the property – and visible correlate – that is core for any particular novel label. As mentioned previously, the visible components that best predict an object’s core properties and its label are different for different classes of objects (Tyler et al., 2000). A preschooler may initially choose to focus on shape because it serves as a convenient representational placeholder until more
can be learned about the category of reference (Baldwin, 1992; Diesendruck et al., 2003). The fact that an object’s shape is more readily available, less demanding of attention, and more easily represented than the object’s function (or other core properties), makes the shape bias an adaptive approach for encoding novel object labels when quick processing is required – as in the preschooler’s typical language learning situation. Furthermore, shape and function are often highly correlated, making either a reliable basis for determining whether or not a label applies to an unattested object (Mervis, 1987). If a child chooses to rely on object shape in the interest of cognitive efficiency, he or she will succeed in most tasks of reference (e.g., selecting an appropriate label for an object). Function neglect may reflect a preschooler’s reluctance to abandon a strategy that has proven successful in typical word learning situations.

Helping Preschoolers To Overcome Function Neglect

In an effort to understand preschoolers’ reluctance to incorporate function into the representation of a novel object label, researchers have typically sought to create conditions that might encourage children to abandon the shape bias in favor of a function bias. The typical method involves exposing children to a novel object’s function, teaching them a name for the object (called the standard object), and asking them to extend the label to objects with the same function but different shape, or to objects with the same shape but different function (called the generalization objects). If children younger than six are found to consistently extend novel labels to function-matches in a particular study, investigation into the design of the experiment may shed light on why a
child is reluctant to incorporate function, and what it takes for him or her to overcome the reluctance (both experimentally and developmentally).

Among the many manipulations that have been tried, only a few have led preschoolers to favor a function-based strategy. Diesendruck et al. (2003), for example, showed that 3-year-olds would extend novel artifact labels on the basis of function rather than shape if they were explicitly told why each object was designed the way it was. They concluded that preschoolers are sensitive to creator’s intent when deciding whether or not an observed artifact function is core to the meaning of a label. That is, they hold off on incorporating a particular function into the representation of a label until they have evidence that the maker of the artifact designed it for that purpose (but see Truxaw et al., 2006 for an alternative explanation). Truxaw et al. (2006) showed that verbally highlighting the similarities and differences in the shapes and functions of artifacts can lead 3- and 4-year-olds to overcome function neglect. They concluded that preschoolers need functional matches and mismatches explicitly pointed out to them before they will overcome the shape bias in favor of a function bias.

Kemler Nelson and her colleagues have obtained similar results with 2- through 6-year-olds when enriching nonverbal information about function (Kemler Nelson, 1995; Kemler Nelson, 1999; Kemler Nelson et al., 2000). In Kemler Nelson (1995), for example, objects were designed so that functional affordances (the potential to function in a certain way) were easily inferable from each object’s perceptual details. One standard object, for instance, was a musical instrument with strings that could be strummed or plucked. Some generalization objects could clearly afford the same
function (i.e. strings stretched between two points and elevated from the object’s surface); others could clearly not afford the function (e.g., strings imbedded in the surface of the object). Three- through six-year-olds watched as a standard object was engaged in its respective function, and then the youngsters were given ample opportunity to practice the function for themselves. Finally they were trained on the name for the object and asked to extend it to objects that could or could not be used for the demonstrated and practiced function. With the extensive practice and easily inferable functions, even the youngest children were inclined to extend the novel object labels on the basis of function.

While each of the above research teams explains their findings in a different theoretical way, the data converge on one idea: as the child’s knowledge about a novel object’s function increases through explicit instruction or interactive experience, he or she becomes more likely to incorporate the function into a representation of the object’s label. The irony is that a preschooler is usually helped to incorporate function into the representation of a novel object label only after the object’s function is made significantly less novel.

_Gentner’s Structure Mapping Theory Of Analogy_

Some explanation is necessary regarding how children learn to incorporate function when direct instruction or extensive experience is lacking. Too many novel artifact functions exist for a child to receive adequate instruction or experience for each and every one of them. Preschoolers must be learning about the importance of novel object functions in some additional ways.
Gentner’s (1983, 1989) Structure Mapping Theory of Analogy suggests that people are naturally inclined to compare deep elements of situations that share surface features. When a person identifies a novel situation as analogous to a previous one, he or she is inclined to shift attention away from the surface similarities that identified the analogy, and focus on comparing deep properties that are likely to be core to the meaning of the analogy (a process known as *structural alignment*). This notion has been demonstrated in the domain of problem solving for both adults (e.g., Gick & Holyoak, 1980) and toddlers (e.g., Singer-Freeman & Bauer, 2008). In applying this idea to the context of function neglect, when a novel object reminds a child of a previously encountered object, he or she should deemphasize overall shape and emphasize shared functional features when learning a label for the most recent object.

Gentner and her colleagues have helped preschoolers to overcome the shape bias in favor of more mature lexical extension strategies (including function biases) simply through exposing them to two or more exemplars of an object category (Gentner & Namy, 1999; 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 one object (e.g., a bicycle) to a similarly shaped object (e.g., folded pair of glasses) rather than to a different-shaped object of the same taxonomic kind (e.g., skateboard). However, when the novel label was applied to two members of the same taxonomic kind (e.g., a bicycle and a scooter), 4-year-olds showed the opposite tendency. These findings suggest that simply having the opportunity to compare two objects can invite preschoolers to engage in a form of analogical reasoning that zeroes in
on core relational properties of object categories. Unfortunately methodological limitations of Gentner’s studies prevent interpretations that are directly applicable to function neglect. Moore’s (2006) study and the current study were designed to address these limitations, and to further understand the role that exemplar comparison plays in novel label learning (see Table 1 for a summary of methodological changes)

Table 1 - Differences between Gentner's and Moore's methodologies

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Labeled objects were familiar</td>
<td>Labeled objects were novel</td>
<td>Function neglect is specific to novel label learning</td>
</tr>
<tr>
<td>Comparison objects were familiar</td>
<td>Some comparison objects were familiar, others were novel</td>
<td></td>
</tr>
<tr>
<td>Presentation of objects to be compared was simultaneous</td>
<td>Presentation of objects to be compared was sequential</td>
<td>Everyday comparison opportunities often rely on memory for one of the objects</td>
</tr>
<tr>
<td>All objects were inanimates</td>
<td>Some objects were inanimates, others were animates</td>
<td>Structure mapping theory assumes that object kind has little impact on the effects of comparison</td>
</tr>
<tr>
<td>Taxonomy was the key property for categorization</td>
<td>Function was the key property for categorization</td>
<td>To accurately assess what a preschool-aged child is attending to, the focus of attention must be tangible</td>
</tr>
</tbody>
</table>
Moore’s 2006 Study

Moore (2006) examined whether presenting separate demonstrations of the function shared by two objects – an event that frequently occurs in the natural course of word learning – might help young children to overcome their function neglect. Based on Gentner’s (1983; 1989) theory, he hypothesized that preschoolers would respond to a second demonstration by engaging in a form of analogical reasoning that focuses on relational properties. Consequently, the children would incorporate function, which is a relational property, into their interpretation of the object’s label. This prediction was made for both animate and inanimate objects.

The preschoolers in Moore’s (2006) study did incorporate function into their interpretations of novel labels in some conditions. In terms of Gentner’s (1983; 1989) theory, when preschoolers were given the opportunity to compare two exemplars of a category in analogous functional contexts, their attention was drawn toward important relational properties (i.e., function). However, the overall pattern of results suggested that children at different ages require different comparison conditions before they can or will incorporate function into their representation of a novel label for an object. Older 4-year-olds incorporated function when it was demonstrated in two novel objects or in a familiar and then a novel object. Young 4-year-olds, however, only incorporated function in the latter condition. Three-year-olds not only required that a familiar object be used in the first demonstration, but also that the demonstration with the novel object be accompanied by a verbal reminder of the familiar object demonstration.
While some age differences were expected, the pattern among 4-year-olds was somewhat puzzling [see Figure 1]. Older 4-year-olds were not at ceiling, but their level of performance in the familiar condition was no better than their performance in the novel condition. If younger 4-year-olds benefited from seeing a familiar object demonstration, why didn’t older 4-year-olds? Moore speculated that these age differences were a reflection of differences in general memory processes and/or the accumulation of general object knowledge.

Figure 1 - Proportion of trials on which 4-year-olds chose function-matched object
The goals of Experiments 1 and 2 were to further test these speculations, and more importantly, to shed light on how comparison guides children’s incorporation of demonstrated function in representations of novel object labels. In Experiment 1, Moore’s (2006) task was altered to determine whether reducing memory requirements would help younger 4-year-olds to incorporate function into label representations without the help of a familiar exemplar (as older 4-year-olds had been able to do). In Experiment 2, the comparison component of Moore’s task was eliminated to see if older 4-year-olds’ general object knowledge would be sufficiently sophisticated for them to emphasize function when it was demonstrated in only a single novel object.

The results of the first two experiments warranted a reanalysis of previous data with items separated according to ontological kind (animate and inanimate). The outcome suggested that while preschoolers’ attention to function may be heightened by certain age-appropriate comparison conditions, the decision to incorporate function (or any other property) into a label’s representation may partially depend on the child’s working knowledge of the ontological category to which a novel object belongs. The goal of Experiment 3 was to determine whether the different decisions result from diagnostic criteria that distinguish basic level animate categories from basic level inanimate categories, or from interpretive strategies that distinguish typical animate labels from typical inanimate labels.
CHAPTER 2
EXPERIMENT 1

_Do Successive Demonstrations Of Function Help Younger Four Year Olds Overcome Function Neglect?_

In everyday object label learning, children must retrieve past exemplars of object categories, compare the novel object in front of them with these representations, then decide which properties to incorporate in their interpretation of the label. If the retrieval process fails, the child will have no opportunity to make comparisons, and attention may not be drawn to the core properties shared by the objects. For example, the 3-year-olds in Moore’s (2006) study only incorporated function into their representation of a novel label for a novel object when verbally reminded of a similar-functioning familiar object that they had seen previously. This result suggests that preschoolers may sometimes ignore function not because the comparison process fails to highlight important object properties, but because retrieval difficulty prevents comparison from occurring in the first place.

The goal of the current experiment was to examine whether retrieval difficulty may also account for the function neglect that Moore (2006) observed in younger 4-year-olds. As already described in Chapter 1 [see Figure 1], this age group incorporated functional information in their interpretation of a novel label for a novel object when the same function that was demonstrated for this object had been previously demonstrated for a familiar object. For example, children saw a screw-driving function demonstrated for a
typical screwdriver, and later saw that same function demonstrated for a novel object. Still later, they were told that the novel object was called a “blicket” and were asked to extend the label to one of two novel objects: one that could drive screws, or one that could not. Younger 4-year-olds in this condition tended to choose the object that could drive screws. However, children this age did not show this effect when the function had been previously demonstrated for a different novel object. For example, children who saw a screw-driving function demonstrated for one novel object, and then for the “blicket”, showed no systematic tendency to choose the object that could drive screws when asked to extend the label.

Younger 4-year-olds in Moore’s (2006) study may not have been able to make exemplar comparisons in the novel-novel condition because they failed to retrieve the demonstration of the first object’s function when they subsequently observed the same function in the object for which the novel label was trained. In Moore’s training procedure, children watched as the unique function for each of four different objects was demonstrated in sequence. Afterward, they watched as each of these functions was demonstrated by the respective novel training object. On average, the delay between demonstrations of the same function for two objects was about two minutes. Perhaps young preschoolers’ representations of novel object demonstrations were not strong enough for easy retrieval after such a delay, whereas representations of familiar object demonstrations may have been.

In the current experiment, the same materials used in Moore’s (2006) novel-novel condition were used (see Appendix A for descriptions of the stimulus sets), but the delay
between demonstrations of the same function was eliminated. Because the elimination of
the delay should reduce memory demands, younger 4-year-olds’ performance in this
modified novel-novel condition was hypothesized to reflect the same level of attention to
function that Moore observed in all 4-year-olds within the familiar-novel condition, and
in older 4-year-olds within the original novel-novel condition. Support for this
hypothesis would suggest that there are no real differences between younger and older 4-
year-olds regarding the role that comparison plays in novel word interpretation. That is,
comparison of novel objects draws attention to core properties shared by the objects, but
the opportunity for younger children to make comparisons is limited by their memory
resources.

**Method**

**Participants**

Twenty (11 male, 9 female) young 4-yr-olds (M = 4-3 (4 years, 3 months); range
= 4-1 to 4-5) were recruited from daycares surrounding Kent, Ohio. The children were
assigned to one of two groups counterbalanced for the function demonstrated in the
standard object. The children were tested individually in a quiet room of their daycares
and received stickers for participation.

**Materials**

Stimuli consisted of four sets of five novel objects each (see Appendix A for
descriptions). Two sets consisted of inanimate artifacts. The objects in the other two sets
were representative of animate beings. Each *standard*, the to-be-labeled object in the set,
was designed with the capability to perform two distinct functions. For example, the standard object in the “blicket” set had a small nozzle on the top so it could function as a spritzer, and a small bit on the bottom so it could function as a screwdriver [see Figure 2 for an image of this set]. The remaining objects in each set were designed with the capability of performing only one of the two functions. Two of these objects were perceptually dissimilar from the standard and acted as the *demonstration* objects. For example, one demonstration object looked different from the standard blicket, but had a spritzing nozzle. The other looked different from the standard blicket, but had a screw-driving bit. Demonstration objects were used to introduce each function, but were never labeled. The objects were not labeled because comparison is assumed to be a domain general attentional process, and any domain specific process that could affect attention (repeated labeling) might introduce a confound. The final two objects in each set were perceptually similar to the standard and acted as the *generalization* objects. For example, one potential blicket had a spritzing nozzle and looked a lot like the standard (though slightly larger and a different color), but lacked a screw-driving bit. The other potential blicket had a screw-driving bit and looked a lot like the standard (though slightly smaller and a different color), but lacked a spritzing nozzle. The functions of generalization objects were never demonstrated so that function-based label generalization could be attributed to attention to functional parts rather than to matching observed activity.

This design allowed for the generation of two counterbalanced conditions with identical labeling and test phases. For example, half of the children observed a demonstration object being used to screw in screws, and then saw the blicket being used
to screw in screws. The remaining children observed the other demonstration object being used to spritz liquid, and then saw the blicket being used to spritz liquid. Both groups were told that the standard was called a blicket, and then asked to decide which of the two generalization objects was also called a blicket.

Figure 2 - Sample object set for Experiment 1

<table>
<thead>
<tr>
<th>Demonstration Objects</th>
<th>Standard Object</th>
<th>Generalization Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version A (Sprayer)</td>
<td>Sprayer and Screwdriver</td>
<td>“ Blicket”</td>
</tr>
<tr>
<td>Version B (Screwdriver)</td>
<td>“ Blicket”</td>
<td></td>
</tr>
</tbody>
</table>

Thirty-second video clips demonstrating the function of each object were created for all but the generalization objects. Each demonstration object clip showed a novel object performing its intended function. Each standard object appeared in two clips to demonstrate the functions it shared with each of the demonstration objects. Clips depicting identical functions differed only with respect to the object performing the function. For example, two otherwise identical clips showed a man using either the demonstration screwdriver or the standard blicket to drive in a screw. In the
counterbalanced version, two otherwise identical clips showed a man using either the demonstration spritzer 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 video clips were compiled into two counterbalanced sequences of eight clips each. For each sequence, the first two clips depicted a demonstration object performing its function, followed by the respective standard performing that same function. The second, third, and fourth pairs of clips in the sequence were like the first pair except the stimuli were from the other three object sets. The basic layout for the video versions is depicted in Appendix B.

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 approximately three feet from the television and a small crate was placed between them. 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 clip depicting a demonstration object, the experimenter stopped the video and told the child he or she would be watching another clip a lot like the first, but it would have something different in it. The first standard object was taken out of the crate and held up in front of the child, but beyond his or her reach. Next, the child was asked to look for the standard object in the upcoming clip, and the video was restarted. If the child did not
point to the object within the first 3 seconds of the clip, the experimenter pointed it out to him or her. Upon completion of the standard object clip, the video was stopped and the child was trained and tested on a label for the standard (see Appendix D for a partial script of this procedure).

**Training and Test Phase.** After the first pair of clips, the experimenter directed the child’s attention back to the standard object, and provided a novel label for the object. For example, in training the name for the blicket, the experimenter held the standard and said, “You see this thing from the video you just watched? 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 between the child and experimenter. The child was instructed to not play with the objects. 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?”).

The entire procedure was repeated for the remaining three stimulus sets. Order of stimulus set presentation was random across participants. It is important to note that in Moore’s (2006) design, all four demonstration clips were shown, then all four standard clips were shown, and finally all four labels were trained and tested. The current design eliminates the lag between demonstrations of the same function, as well as the lag between the demonstration and test phases, thus reducing the load on memory and increasing the opportunity for comparison.

**Scoring.** A child’s choice was marked correct if the object that he or she selected could perform the function that had been demonstrated with the standard in the video.
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 rather than the one that had the spritzing part. Correct candidates were controlled for side bias (two left and two right) and size bias (two big and two small). Because of the various controls, if comparison leads children to focus on size, shape, color, irrelevant parts, or some combination of these, average performance should not differ from chance (2 out of 4 correct). However, if comparison leads children to focus on function, average performance should be above chance.

**Results**

The mean rate of correct choice did not differ by gender or video version ($t(18) < 1$ for both), so scores were collapsed for the main analysis. Mean rate of correct choice did not differ significantly from chance ($M = .56, SD = .29$), $t(19) < 1$. Exposure to successive exemplars of the same function failed to help younger 4-year-olds overcome function neglect. Even when novel comparison objects were encountered one immediately after another, the preschoolers still did not zero in on the appropriate functional properties in their object label interpretations. This result is evidence that function neglect shown by this age group in response to two novel comparison objects is not merely due to limitations of the children’s working memory.
CHAPTER 3

EXPERIMENT 2

Will Older Four Year Olds Incorporate Function Without The Opportunity To Compare Exemplars?

While children typically do not overcome function neglect in novel label learning until around six years of age (e.g., Merriman et al., 1993), some function-based interpretations may arise at earlier ages because of the knowledge of object function that the child has already accumulated. Four-year-olds may be in a transitional period in which they start to realize that object function is as predictive of a label’s meaning as object shape is. They may begin to rely less on comparison of individual objects and more on their general knowledge about object function, thus increasing the frequency of function-based novel label interpretations.

Older 4-year-olds in Moore’s (2006) study responded similarly when given the opportunity to make comparisons between two different types of object pairs: familiar-novel pairs, and novel-novel pairs. The failure of exemplar familiarity to increase the older 4-year-olds’ incorporation of function may have been the result of their no longer using comparison to direct their attention to core properties. Instead, they may have been basing label interpretations on their growing appreciation for how important object function is to the meaning of many of the object labels in their vocabulary. The above chance but below ceiling performance of Moore’s older 4-year-olds in each of the two
conditions may reflect the transition from an already mature comparison strategy to a still-maturing knowledge-based strategy.

The goal of the current experiment was to see whether older 4-year-olds would still incorporate function into novel label interpretations in Moore’s (2006) paradigm when the opportunity for exemplar comparison was eliminated. That is, would children of this age reliably make function-based interpretations of novel object labels if they saw each function demonstrated in only one novel object? If older 4-year-olds are using function knowledge rather than exemplar comparison to zero in on important functional features of an object category, it should not matter whether they see the function demonstrated by one or two objects. The knowledge the child brings to the experiment should be the only thing that matters.

If older 4-year-olds use knowledge rather than exemplar comparison to interpret novel object labels, then they should respond to a novel-once version of Moore’s (2006) procedure by incorporating function into their interpretations of novel object labels. Past research warns that a single exposure to an object function may not be sufficient for getting children of this age to make function-based interpretations of novel labels (e.g., Merriman, et al., 1993). In anticipation of this possibility, an additional novel-twice condition was included to provide the same degree of exposure to function that Moore (2006) provided, without creating the opportunity for exemplar comparison. According to one study (Namy, Gentner, & Clepper, 2007), comparing exemplars that are too similar to one another will fail to draw a child’s attention to the core properties of a category. In the novel-twice condition of the current experiment, exemplars were
identical, so the effects of comparison could not account for any function-based interpretations that may occur.

The strongest version of the knowledge-rather-than-comparison hypothesis would be supported if children in both the novel-twice and novel-once conditions made function-based label interpretations more often than would be expected by chance. A weaker version would be supported if children in the novel-twice condition reliably incorporated function into novel label interpretations, but children in the novel-once condition did not. This pattern of results would suggest that older 4-year-olds have adequate knowledge to interpret novel object labels appropriately, but may not have full access to this knowledge. Furthermore, it would indicate that repeated exposure to a particular function even if only in the same object is one way to get older 4-year-olds to tap into their general knowledge of function. Any outcome other than the above would suggest that something besides or beyond knowledge and comparison influence how older 4-year-olds represent function in their interpretations of novel object labels.

Method

Participants

Twenty-four (7 male, 17 female) older 4-yr-olds ($M = 4-9$; range = 4-6 to 4-11) were recruited from daycares surrounding Kent, Ohio. The children were assigned to two conditions: twelve in a novel-once condition ($M = 4-9$; range = 4-6 to 4-11), and twelve in a novel-twice condition ($M = 4-9$; range = 4-6 to 4-11). Gender was as balanced as possible across conditions (3 male, 9 female in the novel-once group, and 4 male, 8
female in the novel-twice group). 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

The standard and generalization objects from Experiment 1 [see Appendix A] were used for the current experiment. Demonstration objects were not used. The 30 second standard object video clips from Experiment 1 were recompiled into four new sequences of object function demonstrations. In the novel-once condition, the sequence showed each standard object engaged in one of its functions (4 clips in total). For the novel-twice condition, the sequence used in the novel-once condition was shown twice (8 clips in total). A counterbalanced version of the videos depicted standard objects engaged in their other functions. See Appendix C for the basic layout of the videos.

Procedure

The procedure was identical to that of Experiment 1, with three exceptions. First, all objects were placed in front of the child before starting the novel-once video, or before starting the second set of clips in the novel-twice video. Second, each child watched his or her respective video version in its entirety, and helped to find the standard objects in the video prior to learning any names for the objects. Finally, after the entire video ended, the objects were hidden from view, and then the training-testing phase for all objects occurred in sequence (train-test stimulus set 1, train-test stimulus set 2, etc.). Scoring was the same as in Experiment 1.
Results

The mean rate of correct choice did not differ by gender or video version within either condition (*t*(10) < 1 for all), so scores were collapsed for the main analyses. The mean rate of selecting function matches was identical in the two groups (*M* = .63), *t*(22) < 1 so the data were collapsed across the two conditions to be compared to chance. The older 4-year-olds in these conditions indeed chose function matches significantly more often than would be expected by chance (*M* = .63, *SD* = .22), *t*(21) = 2.77, *p* = .01. This pattern suggests that older 4-year-olds may not need comparison conditions to help them zero in on relational properties such as object function as long as they have the appropriate knowledge to supplement their novel label interpretations. It also suggests that older 4-year-olds may not even need repeated exposures to a function before they can access the appropriate knowledge.

The above findings alone support a strong version of the knowledge-rather-than-comparison hypothesis which could readily explain the puzzling findings of Moore (2006). That is, comparison may have benefited younger but not older 4-year-olds simply because the older children no longer used exemplar comparison as a basis for novel label interpretations. However, when the current results are put in the context of Moore’s findings, an interesting pattern emerges that suggests that exemplar comparison and knowledge of ontological kind may have an interactive effect on older 4-year-olds’ novel label interpretations. That is, they may still benefit from exemplar comparison, but in a different way than previously thought. In Chapter 4, the nature and extent of the
above interaction will be examined via a reanalysis of Moore’s (2006) data from younger preschoolers, and via a 3rd experiment with older 4-year-olds.
CHAPTER 4

EXPERIMENT 3

*What Role Does Ontology Play In Preschoolers’ Representation Of Different Kinds of Relational Properties?*

Throughout the current studies and those of Moore (2006), a preschooler’s interpretation of a novel label for either an inanimate or animate object was deemed accurate when the child extended the label on the basis of a critical functional part. This method of scoring was based on the assumption (Gentner, 1983; 1989) that comparison draws a child’s attention away from surface features (e.g., the shape of an object) toward deeper relational properties of a problem (e.g., the way objects interact with each other and their surroundings) regardless of the particular components that make up the problem. If the proposed mechanism operates in this way, the type of objects involved in exemplar comparison should not affect the likelihood of incorporating a particular relational property (i.e., function) into interpretations of novel labels for those objects.

For all conditions developed within Moore’s paradigm, there were no statistically significant effects of ontological kind (inanimate vs. animate), suggesting that Gentner’s assumption was accurate.

However, in looking more closely at the responses for inanimate objects across the two studies with older 4-year-olds, there was a monotonic increase in proportion of function-based label extensions (and monotonic decrease in SD) from poor to good
comparison conditions [see Figure 3]. Furthermore, older 4-year-olds from Moore’s (2006) study who had the opportunity to engage in exemplar comparison (Novel-Novel and Familiar-Novel conditions), picked function matches for inanimate objects at a rate significantly greater than chance, \((M = .77, SD = .25), t(23) = 5.21, p < .01\). The older 4-year-olds in Experiment 2 of the current study who did not have the opportunity to engage in exemplar comparison (Novel-Once and Novel-Twice conditions), picked function matches for inanimate objects at a rate equivalent to chance, \((M = .54, SD = .36), t(23) < 1\). The trend for animate objects (though not statistically significant) was actually in the opposite direction [see Figure 3]. This unexpected interaction between ontological kind and training suggests that preschoolers (at least older 4-year-olds) may use both knowledge of ontological kind and comparison of exemplars to decide whether a particular relational property should be included in their interpretation of a label for a novel object.
Figure 3 - Proportion of function-based interpretations for animate and inanimate objects for older 4-year-olds in Moore (2006) and Experiment 2 of the current study.

While these results call some of the assumptions of Gentner’s (1983, 1989) theory into question, they are rather encouraging from an ecological standpoint because the “rules” for labeling are different for objects of different ontological kinds (Tyler et al., 2000). The appropriateness of a label for an inanimate object category (e.g., bulldozer) can often be predicted by the presence or absence of a functional part (e.g., an end loading bucket), but the appropriateness of a label for an animate object category (e.g., frog) cannot be predicted by the presence or absence of a specific functional part (e.g., legs, eyes, or long tongue). In addition, labels typically used for inanimate objects frequently refer to the basic level category to which the object belongs (common noun), and rarely refer to the individual exemplar (proper noun). However, labels typically used...
for animate objects may sometimes refer to the individual object and sometimes refer to the basic level category to which the object belongs. Neither the exemplar comparison strategy proposed by Gentner nor the knowledge-based strategy proposed in Experiment 2 of the current study considers the potential effects that ontology might have on children’s interpretations of labels for those objects.

The data from older 4-year-olds in Moore’s (2006) study and the current one suggests that exemplar comparison helps preschoolers to overcome function neglect, but the underlying mechanisms operate within certain ontological boundaries. When older 4-year-olds interpreted labels for inanimate objects, exemplar comparison led them to give more weight to functional parts than they typically would. When these same children interpreted labels for animate objects, conditions of exemplar comparison had little to no effect on how much weight they gave to functional parts. A truly adaptive label learning mechanism requires the type of sensitivity to ontological kind that is reflected in this pattern of responses.

*The Emerging Ontology Of Younger 4-Year-Olds And 3-Year-Olds*

One question that remains is whether younger 4-year-olds and 3-year-olds already display sensitivity to ontological kind. When first looking at the results from Moore’s (2006) studies and Experiment 1 of the current study, it appeared that younger children responded to comparison by zeroing in on the function shared by two exemplars, regardless of the object’s kind. When children did not incorporate function into their representations of novel labels, it was attributed to the ineffectiveness of a particular comparison condition. However, any effects of sensitivity to ontological differences may
have been masked by a lack of statistically significant item effects – as was the case in
the initial analysis for older 4-year-olds.

To determine whether younger children were indeed sensitive to ontological
category when engaging in comparison, Moore’s (2006) data for younger 4-year-olds and
3-year-olds were reanalyzed with item responses separated by ontological kind [see
Figure 4]. For inanimate objects, children in these younger age groups did make more
function-based label interpretations as comparison was made easier. However, the
increases were not as dramatic as those found for older 4-year-olds, and similar increases
– sometimes stronger – were evident in the pattern of responses for animate objects.
Still, several comparison conditions resulted in above chance function-based
interpretations for inanimate object labels, but no comparison condition led to above
chance function-based interpretations for animate object labels.
Figure 4 - Proportion of function-based interpretations for 3-year-olds and younger 4-year-olds in comparison conditions from Moore (2006)
The above results suggest that comparison initially leads preschoolers to give more weight to an object’s demonstrated function when interpreting a label for that object (i.e. overcome function neglect). For children between 3 and 4½ years of age, this process does not adequately discriminate between animate and inanimate objects. While above chance performance did vary by ontological kind and comparison conditions for children within this age range, a meaningful interaction of ontological kind and comparison is not clear until sometime later (i.e. 4½ to 5 years of age). It seems that preschoolers between 3 and 4½ years of age are beginning to develop the ontological constraint that will eventually complement the role that comparison plays in older 4-year-olds’ representations of novel labels.

The pattern of novel label interpretation coincides with children’s development of biological concepts. Even infants can discriminate between animate and inanimate objects, but children do not have a mature understanding of what makes the two ontological kinds different (e.g., inheritance, growth, illness) until around 5 or 6 years of age – with major advancements in understanding occurring from 3 to 4 years of age (see Waxman, 2005, for a review). Perhaps young preschoolers realize that labels for animate and inanimate objects should be interpreted differently, but have yet to learn the specific boundaries that separate the ontological kinds. Comparison may first lead to the development of these boundaries, and later lead to their utilization as constraints for novel label learning.
The Ontology Of Older 4-Year-Olds

As mentioned previously, it seems as if older 4-year-olds are aware of ontological boundaries, but do not fully utilize them in novel label learning until they have the opportunity to engage in exemplar comparison. One puzzling aspect of older 4-year-olds’ ontology was found in the pattern of responses for animate objects. Even without the opportunity for exemplar comparison, children in this age group did not exhibit function neglect when interpreting labels for objects that were representative of animate beings. In fact, the finding from Experiment 2 that older 4-year-olds did not need comparison to overcome function neglect was entirely carried by interpretations of animate object labels – function neglect was still evident in interpretations of inanimate object labels. It seems as if older 4-year-olds’ approach to word learning is qualitatively different for animate and inanimate labels. Before comparison, they tend not to incorporate inanimate object function but do tend to incorporate animate object function into novel label interpretations. After comparison, they tend to incorporate inanimate object function, but their tendency to incorporate animate object function into novel label interpretations is no stronger (and possibly weaker).

The pattern for animate items is difficult to interpret because the methodology of the contributing experiments was based on an assumed mechanism that is not sensitive to ontological differences in the same way that older 4-year-olds seem to be. In essence, the children were expected to ignore what they may have already known about categorization of animate objects, and use the particular strategy of exemplar comparison to increase attention to a particular relational property that is diagnostic of inanimate but not animate
category membership (i.e., functional part). It is not surprising that the pattern of function-based label interpretations was clearer for inanimates than for animates.

One question that remains is whether the effect resulted from a mismatch between what the child expected to notice through comparison (shared properties that are diagnostic of animate category membership) and what the child actually noticed through comparison (shared properties that are diagnostic of inanimate category membership), or from a mismatch between the strategy that the experimenter expected the child to use (comparison for both animates and inanimates) and the strategy that the child actually used (comparison for inanimates but contrast for animates). Experiment 3 is designed to determine which of these two novel explanations is most accurate.

*The Ontological Fit Hypothesis*

One possible explanation for the puzzling pattern of responses is that children’s level of attention to particular object properties depends on the expectations that they hold for a particular ontological category. Children may know that inanimate category labels are typically tied to a particular function, and have the expectation that inanimate objects are likely to be engaged in functions. The child may ironically attend less to a particular function of a single inanimate object simply because the demonstration of it does not violate his or her expectations. When the child sees a second instance of the same function, it may remind him or her that the objects belong to a broader category (inanimate) of objects, and that label interpretation must adhere to the rules for that ontological kind. This, in turn, may increase attention to the particular function that was
shared by the two exemplars. On the other hand, children may know that animate
category labels are typically not tied to a particular function. The child may ironically
attend more to a particular function of a single animate object simply because the
demonstration of it violates his or her expectations. When the child sees a second
instance of the same function, it may bring to mind the rules of animate label
interpretation, and he or she may become confused as to why the same function was
highlighted in two exemplars of an animate category. If the same expectation is violated
twice, the child is left to decide between the rules of animate categorization (i.e., function
is not of primary importance for animate category labels) and the rules of comparison
(i.e., shared deep properties are of primary importance for category labels).

The Ontological Mode Hypothesis

A second possible explanation for the puzzling pattern is that older 4-year-olds
approach interpretation of animate and inanimate labels in qualitatively different ways.
That is, the rules of comparison may be secondary to the rules of ontological
categorization. The Ontological Mode Hypothesis states that preschoolers prioritize the
individual (individuation mode) when interpreting labels for animate objects, but
prioritize the category (integration mode) when interpreting labels for inanimate objects.
As a result, 4½-year-old may respond to comparison opportunities in the anticipated way
when learning labels for inanimate objects (overcome function neglect), but not when
learning labels for animate objects. This is because comparison complements integration,
but does not complement – or even counters – individuation.
Previous research has shown that preschoolers tend to individuate animate objects more so than inanimate objects (e.g., Merriman & Evey, 2005). When the researchers incidentally labeled only one of two similarly-shaped animate objects (outside the context of label training), 3-year-olds tended to reject the possibility that the passed over object might have the same label. However, they did not show this tendency with inanimate objects. In other words, they thought that the label for the animate referred to an individual but that the label for the inanimate referred to a category. The existence of the two modes of processing, and the tendency to individuate animates has been backed up by fMRI data in adults (Mason & Macrae, 2004). Mason and Macrae showed that right hemispheric activity increases during individuation tasks, but left hemispheric activity increases during categorization tasks. Furthermore, processing of animate objects in either type of task was more efficient when presented to the left visual field (right hemisphere), suggesting that people tend to think of animates as individuals. This pattern of findings is probably a reflection of having learned the importance of distinguishing among beings from the same animate category. A mother, for example, serves a different purpose than a father, and thus these two members of the human category need to be represented individually. A preschooler may also realize that such distinctions are not as important for members of the same inanimate category. A red bottle, for example, serves the same purpose as a blue bottle, and thus these two need not be represented individually. This difference is reflected in the use of generic modifiers (e.g., red or blue) when specific members of an inanimate category need to be distinguished, and the use of proper nouns (e.g., Tom or Mary) when specific members of an animate category need to
be identified. While one could use proper names for inanimate objects (e.g., Bob the bottle) and generic modifiers for animate beings (e.g., the hairy human), this labeling system is not very useful in everyday communication.

Armed with this understanding, children may focus attention on properties that are likely to be unique to a particular animate object for which they are learning a label. If preschoolers see a novel animate object engaged in some behavior/function, they may identify the functional part as something that could help distinguish the observed animate from past and future animates. When asked to extend a label learned for the object to an unattested object, children must categorize on the basis of properties that were attended to during individuation (e.g., behavior/function). If, on the other hand, preschoolers see a novel animate object engaged in a behavior/function that was recently demonstrated by a different animate, they can no longer rely on the functional part as a distinguishing property and must shift attention elsewhere. When asked to extend a label learned for the second object to an unattested object, children must decide which attended-to property is most relevant: that highlighted by comparison (e.g., the shared function), or that highlighted by individuation (e.g., anything but the shared function). The two competing processes would lead to unpredictable label extension across different comparison conditions.

Following the logic of this argument, preschoolers should tend towards integration of inanimate objects when learning novel labels for those objects. As such, they are likely to focus on broad features of an individual object that will maximize the extendibility of a novel label for that object (i.e., overall shape). Preschoolers may be
reluctant to attach meaning to a specific functional part of an inanimate object because objects of this ontological kind are often used for functions that are not core to the meaning of a novel label (e.g., the handle of a knife can be tapped around the sealed lid of a jar to loosen it). Basing label interpretation on a single part of an inanimate object would drastically reduce the generalizability of the label and thus undermine the primary goal of integration. When interpreting a label for an individual inanimate object, preschoolers may require confirmation of the importance of a particular function before they will incorporate it into their representation of a novel label. Comparison may provide the necessary confirmation (manifest as overcoming function neglect).

Deciding Between The Hypotheses: Experiment 3

In light of the above hypotheses, it is important to answer the following question: Will older 4-year-olds’ pattern of responses across ontological kind reverse or stay the same if the target property in comparison and no-comparison word learning conditions is diagnostic of animate category membership. In other words, how will comparison affect older 4-year-olds’ tendency to incorporate properties that are typically core features for animate categories (i.e., head shape (e.g., Quinn & Eimas, 1996) and texture (e.g., Jones, Smith, & Landau, 1991))? In the previous experiments, comparison increased the likelihood that older 4-year-olds would represent a property that is a typical core feature for inanimate categories (functional part), but only when learning labels for inanimate objects. In the following experiment, the match-mismatch of properties to ontological kind will be reversed.
The Ontological Fit Hypothesis would predict that comparison will increase the likelihood that older 4-year-olds would represent head shape and texture only when interpreting labels for animate objects (pattern reversal). Children exposed to one exemplar of an animate category may interpret some labels on the basis of head shape and texture, but those exposed to two exemplars should do so on a more consistent basis. This is because comparison should remind children that each exemplar belongs to the “animate” category for which head shape and texture tend to be very important. However, the preschoolers’ tendency to incorporate “head” shape and texture into representations of inanimate object labels should be maintained across conditions of comparison. Comparison may increase attention to the properties, but this should be offset by the reminder that “head” shape and texture are not important to the labeling of inanimate object categories.

The Ontological Mode Hypothesis would predict that older 4-year-olds’ interpretation of animate object labels would not differ across comparison conditions, but interpretation of inanimate object labels would (same pattern as in Moore’s study). Because older 4-year-olds adopt an individuation mode when interpreting labels for animate objects, seeing two animate beings with similar head shape and texture could only draw attention toward any contrasting properties rather than to the shared properties. Comparison of animates for the purpose of individuating them may even make incorporation of head shape and texture less likely. In contrast, because older 4-year-olds operate in integration mode when interpreting labels for inanimate objects, seeing two inanimate beings with similar “head” shape and texture will draw attention toward shared
properties rather than contrasting properties. As such comparison of inanimates should make incorporation of “head” shape and texture more likely.

**Method**

**Participants**

Thirty-two (19 male, 13 female) older 4-year-olds ($M = 4.9$; range = 4.6 to 5.0) were recruited from daycares surrounding Kent, Ohio. The children were assigned to one of two conditions: sixteen in a single exemplar condition ($M = 4.9$; range = 4.6 to 4.11), and sixteen in a dual exemplar condition ($M = 4.9$; range = 4.6 to 5.0). Gender was as balanced as possible across conditions (9 male, 7 female in the single exemplar condition, and 10 male, 6 female in the dual exemplar condition). In each group, children learned labels for both animate and inanimate objects. Participants from each group were subdivided into groups of eight for counterbalancing the particular sets of animate and inanimate objects used for training and testing. Children were tested individually in a quiet room of their daycares and received a small gift for their participation.

**Materials**

Four stimulus sets, each containing twelve novel objects were used. Half the objects in each set were animate [see Figure 5A for example]. The other half consisted of an inanimate “twin” for each of the six animate objects [see Figure 5B for example]. The twins shared the same size, colors, textures, “head” shapes, and organization of parts, but where the animate twin had legs and a face, the inanimate twin had ambulatory
mechanics and ornamentation respectively (see Appendix E for images of the remaining three sets).

Each subset of six objects (i.e., the animates or the inanimates) contained two demonstration objects, two standard objects\(^1\), and two generalization objects. All objects within each subset had a similar overall shape. One demonstration object and one standard object (called demo-set-1) matched with respect to a particular head shape (e.g., star-like) and texture (e.g., felt-like). The other demonstration object and the other standard object (called demo-set 2) matched with respect to a different head shape (e.g., bucket-like) and texture (e.g., smooth). One generalization object was similar to the standard from demo-set-1 with regard to size, color, and body shape, but similar to the standard from demo-set-2 with regard to texture (e.g., smooth) and head shape (e.g., bucket-like). The other generalization object was similar to the standard from demo-set-1 with regard to head shape (e.g., star-like) and texture (e.g., felt-like), but was similar to the standard from demo-set-2 with regard to size, color, and body shape.

Twenty second video clips were created for all but the generalization objects (32 clips in all). Activities depicted in all clips were more representative of animate behavior than of inanimate function. The activities included up and down motion, horizontal movement, upward movement, spinning, swimming, flying, and walking. A two-exemplar and a one exemplar DVD were compiled so that all clips were accessible via a menu. Order in which the clips were presented was randomized for each participant.

\(^1\) In contrast to the stimulus sets used in previous experiments, it was necessary to have two separate standard objects for counterbalancing. It is possible to have two functional parts on a single standard, but it is not possible to have two meaningful “head” shapes and textures on a single standard.
Figure 5A - Sample animate object set for Experiment 3

<table>
<thead>
<tr>
<th>Demonstrations Objects</th>
<th>Standard Objects</th>
<th>Generalization Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demo-Set-1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Texture and Head Shape 1</strong> (felt-like and star-shaped)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
<td><img src="image3" alt="Image" /></td>
</tr>
<tr>
<td><strong>Activity: Bipedal Walking</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Demo-Set-2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Texture and Head Shape 2</strong> (smooth and bucket-shaped)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
<td><img src="image6" alt="Image" /></td>
</tr>
</tbody>
</table>

**Solid line**: properties shared are core to animate categorization (head shape & texture)

**Dotted line**: properties shared are not core to categorization (color, size, body style)
Figure 5B - Sample inanimate object set for Experiment 3

<table>
<thead>
<tr>
<th>Demonstration Objects</th>
<th>Standard Objects</th>
<th>Generalization Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demo-Set-1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture and Head Shape 1 (felt-like and star-shaped)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Texture and Head Shape 2 (smooth and bucket-shaped)</td>
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<td></td>
</tr>
<tr>
<td>Demo-Set-2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Solid line:** properties shared are core to animate categorization (head shape & texture)

**Dotted line:** properties shared are not core to categorization (color, size, body style)
Procedure

Children were brought individually into a quiet room of their preschool where a 13” Sanyo television and a Panasonic DVD player were sitting on a portable stand. Two chairs were placed approximately three feet away with a crate in between them. Each child was asked to sit in one of the chairs and the experimenter (the author) sat in the other. The experimenter told the child that they were going to watch some video clips with objects the child had never seen before, and that they would be learning the names for some of the objects. The experimenter then proceeded with the demonstration, training, and testing procedure.

Dual exemplar condition. The experimenter displayed a demonstration object (e.g., from demo-set-1 of animates) for the child and asked him or her to help find the object in the upcoming video. Upon completion of the clip, the object was hidden from view and the child was told that they were about to watch another clip a lot like the first one, but it would have a new object in it. The experimenter then brought out the standard object from that same demo set and asked the child to help find the object in the upcoming video. Afterward, the video was paused and a label was trained for the standard object. The standard was then hidden from view and the generalization objects for that set were brought out. The child was then asked which of the two objects has the same name as the standard. After the child answered, the experimenter put the generalization objects away and the procedure was repeated for the remaining three stimulus sets.
Single exemplar condition. The procedure was identical to the dual-exemplar procedure with one exception. The demonstration object component (including the video clip) was removed.

Children in each condition were exposed to animate objects from two sets and inanimate objects from the remaining two sets. Each participant was matched to another participant so that one was exposed to the “twins” of the other’s object sets (e.g., [animate1-animate2-inanimate3-inanimate4] and [inanimate1-inanimate2-animate3-animate4]). The demonstration objects and “correct” generalization objects were counterbalanced across participants. In other words half saw demo-set 1 and should have chosen generalization object 1 at test. The other half saw demo-set 2 and should have chosen generalization object 2 at test. In addition, half of the “correct” generalization objects were presented to the child’s left, and half were presented to the child’s right. Finally, half of the “correct” generalization objects were the smaller of two, and half were the larger of two. These controls should prevent arbitrary biases and preferences from confounding the effects of ontological kind and comparison.

Scoring. Participants’ responses were counted as “correct” if the generalization object chosen shared its “head” shape and texture with the label trained object. Two scores were tallied for each participant: proportion correct on animate items, and proportion correct on inanimate items. To fully support the Ontological Fit Hypothesis, scores for animate objects should be higher in the two exemplar condition than in the one exemplar condition, but scores for inanimate objects should not differ across comparison conditions. To fully support the Ontological Mode Hypothesis, scores for inanimate
objects should be higher in the two exemplar condition than in the one exemplar condition, but scores for animate objects should not differ across comparison conditions.

**Results**

A mixed-design ANOVA with item type (animate vs. inanimate) as the within subjects measure, and comparison condition (single vs. dual exemplar) as the between subjects measure was conducted on proportion of animate-based (head shape and texture) label generalizations. The item by condition interaction was significant, $F(1, 30) = 6.63, p = .02$. Simple effects tests revealed a significant effect of condition only for the animate items, $F(1, 30) = 5.22, p = .03$. For animate objects, children in the single-exemplar condition incorporated head shape and texture into their interpretations of labels more often than those in the dual-exemplar condition did ($M_s = 0.81$ and 0.56, respectively). For inanimate objects, the trend was in the opposite direction (0.47 and 0.59, respectively), thought not significant, $F(1,30) = 1.32, p = .26$ [Figure 6 summarizes these means].
Figure 6 - Proportion of trials on which 4-year-olds chose head shape and texture matched object.

The above results directly counter the main prediction of the Ontological Fit Hypothesis: comparison led to less rather than greater incorporation of head shape and texture into interpretation of labels for animate objects. While the results rule out the Ontological Fit Hypothesis, they only partially support the Ontological Mode Hypothesis. Full support would have required replication of the statistical pattern from the previous studies. That is, the combined effects of comparison and integration of inanimate objects should have significantly boosted attention to “head” shape and texture. Furthermore, the opposing effects of comparison and individuation on attention to head shape and texture of animate objects should have nullified one another. Nevertheless, the directions of the
observed trends were consistent with the basic claims of the Ontological Mode Hypothesis. Possible reasons for the discrepancy across experiments will be discussed in the next chapter.
CHAPTER 5

GENERAL DISCUSSION

Summary of Main Findings and Implications

The effect of exemplar comparison on children’s interpretations of novel labels for different types of novel objects was examined via a reanalysis of data from Moore’s 2006 study and three new experiments. According to Gentner’s (1983; 1989) Structure Mapping Theory of Analogy, exemplar comparison draws attention away from superficial properties of objects toward more meaningful relational properties. Moore’s (2006) study provided evidence for one instantiation of this idea. Specifically, up to around 4½ years of age, children responded to age-appropriate comparison conditions by increasing attention to functional object parts that they otherwise ignored when interpreting novel labels for those objects.

One problem with Moore’s (2006) findings was that a particular element of comparison (i.e., familiarity with one comparison object) increased attention to object function in younger 4-year-olds, but not in older 4-year-olds. Younger 4-year-olds displayed function neglect when both comparison objects were novel, but not when one was familiar and one was novel. Older 4-year-olds succeeded where the younger 4-year-olds failed (i.e., in the novel-novel condition) suggesting developmental improvement. However, older 4-year-olds’ rate of success in the familiar-novel condition was not at ceiling and was no better than that of younger 4-year-olds. The results of Experiment 1
of the current study suggested that the “failure” of younger 4-year-olds in the novel-novel condition could not be explained by underdeveloped general memory processes. Even when the memory requirements of the comparison task were all but eliminated, younger 4-year-olds continued to display function neglect in the novel-novel condition. The results of Experiment 2 of the current study suggested that the “success” of the older 4-year-olds could not be attributed to comparison. Even when the comparison component of the word learning task was eliminated, this age group continued to incorporate function. Taken together, these findings indicate that comparison may play different roles across the development of word learning skills.

To better understand how the role of comparison changes across development of word learning skills, it was useful to reanalyze the previous experiments with responses separated according to ontological kind. For 3-year-olds and younger 4-year-olds, comparison of function operated similarly on the children’s label interpretations for animate and inanimate objects. In general, the more “helpful” the comparison condition, the more likely the youngsters were to incorporate shared function into interpretation of labels for both types of objects. For older 4-year-olds, however, comparison of function operated differently on the children’s interpretations of labels for animate and inanimate objects. More “helpful” comparison conditions led to greater incorporation of function into interpretation of labels for inanimate objects, but the trend was actually in the opposite direction for animate objects. To summarize, exemplar comparison in younger label learners indeed drew attention away from superficial properties and toward shared relational properties of novel objects. For older label learners, though, the effect of
exemplar comparison was constrained by the ontological kind of the objects being compared.

In Experiment 3, older 4-year-olds displayed the same basic pattern with regard to head shape and texture that this age group displayed in the previous experiments with regard to function. This result suggests that the ontological constraint on comparison is likely to be a function of processing mode (Ontological Mode Hypothesis), and unlikely to be a function of property-to-kind fit (Ontological Fit Hypothesis). By 4½ years of age, preschoolers tend to process animate objects as unique individuals and inanimate objects as members of a category. This rather mature understanding of how labels typically refer to objects of different ontological kinds may very well have emerged from early comparison processes. The growing tendency to individuate animate objects evidently supersedes the tendency to extract commonalities when comparing any two objects. The tendency to integrate inanimate objects, on the other hand, is likely to encourage the tendency to extract commonalities among these types of objects.

The current findings regarding how children extract the meanings of different types of novel object labels through their own efforts in exemplar comparison are alone quite satisfying. These findings may also have implications for the development of better methods for teaching vocabulary to young children. First, it may be quite useful to point out familiar objects that have the same type of core property as a novel object category for which a preschooler is learning a label, especially if the novel category is inanimate. On the other hand, if the novel category is animate it may be useful to point out familiar animate objects that contrast with the novel animate object category for which the label is
being reduced, especially when working with older preschoolers. In either case, the teacher should encourage the child to engage in the type of processing that will most likely lead to mature label interpretation.

*Limitations of the Current Experiments*

One limitation of the current investigation was the lack of parallel statistical findings across experiments with older 4-year-olds. The direction of the findings from Moore’s (2006) study and Experiment 2 of the current study was the same as was found in Experiment 3 of the current study, but the statistically significant differences were not consistent. Whether targeting function or head shape and texture, the trend with regard to animate objects was for preschoolers to pay more attention to these properties when they were observed in a single exemplar rather than in two exemplars. The trend with regard to inanimate objects was for preschoolers to pay more attention to function or head shape and texture when these properties were observed in two exemplars rather than in one. However, in the experiments in which the target property was function, the effect of comparison condition (i.e., one vs. two exemplars) was significant for inanimates, but not for animates. In Experiment 3, in which the target properties were head shape and texture, the effect of comparison condition was significant for animates, but not for animates.

This inconsistency may just be a consequence of sampling error. The current experiments did not have sufficient statistical power to consistently detect small to medium-size effects. A second contributor to the inconsistency may lie in the particular
stimulus sets used. For the experiments in which the target property was function, one set of animate objects consisted of what might be better described as animate-inanimate hybrids because the target functions were carried out by mechanical rather than biological parts. Furthermore, while every attempt was made to have the final experiment parallel to the original one, a perfect analogue was neither sensible nor feasible. In the end, the final experiment had fewer conditions, was less demanding of memory resources, and had more control for confounds.

Theoretical explanations for the inconsistency may also be tenable. While a strict version of the Ontological Mode Hypothesis emphasizes process rather than property, a more accurate version may give some consideration to property. Head shape and texture may be privileged properties of animate objects, while function may be a privileged property of inanimate objects. Perhaps the pull of comparison against individuation in animates is greatest when the target property is privileged, thus resulting in a significant effect for animates only when head shape and texture are the shared properties. Likewise, the combined effects of comparison and individuation on inanimates may be greatest when the target property is privileged, thus resulting in a significant effect for artifacts only when function is the shared property.

Another limitation of the current set of studies is that all developmental findings were based on cross-sectional data and analyses. Though no cohort effects were anticipated, it is possible that some of the inconsistencies were due to sampling problems. Future work should see if the current findings hold up within a longitudinal research design.
Due to geographic region of testing, a final limitation of the current study is that the sample was not very diverse with regard to SES, ethnicity, or race. The lack of diversity may limit the generalizability of the findings and implications. Future work should try to replicate the findings with more diverse samples.

**Future Directions**

Future work should attempt to replicate the function neglect results with stimuli that adhere to strict ontological boundaries. To see a clear difference in the way animate and inanimate objects labels are interpreted, the difference between the form-to-function relationship of animates and inanimates need to be clear. That is, animate object functions should be tied to functioning biological parts, while inanimate object functions should be tied to functioning mechanical parts.

A second question to answer is whether or not younger preschooler (i.e., less than 4½ years old) would make ontological distinctions based on head-shape and texture. When the target property was function, there was some limited evidence that 3-year-olds’ and younger 4-year-olds’ comparison processes were sensitive to ontological kind of the objects being compared. Would this same type of sensitivity be apparent when head shape and texture are the target properties? This would further inform how the different modes of processing develop for the different ontological categories.

A third possible future direction would examine the effects of naming on the modes of processing. In the current set of experiments, only the standard object was labeled. This procedure was followed to prevent any effects repeated labeling might have on the
comparison process. It would be interesting to find out what the effect of repeated labeling is, especially for animate categories. According to results obtained by Waxman and Markow (1995), infants are more likely to categorize objects when labels are paired with them than when tones are paired with them. If this is the case, the obstacle that individuation tendencies present for older 4-year-olds may be countered by labeling the demonstration objects as well as the standard objects.

**General Conclusions**

When similar objects are encountered close in time, young children may focus on properties that the objects have in common. This tendency to integrate exemplars may be motivated by a desire to construct the category to which the pair of objects belongs. In other circumstances, however, youngsters’ attention may be drawn to contrasting properties of a pair of similar objects. This tendency may be motivated by a desire to individuate the objects, that is, to establish distinct individual representations for each. Preschoolers may be more likely to individuate animates than artifacts because in their experience animates are more likely than artifacts to be important as individuals.

Preschoolers are susceptible to the influence of both integration and individuation processes. In older preschoolers, in particular, the opportunity for exemplar comparison (i.e., the two exemplar condition) influenced their interpretation of a label that was introduced for one of the exemplars. This effect depended on ontological kind, more specifically, on whether the two objects were artifacts or animates. For artifacts, the children tended to integrate the exemplars, and so, increased the weight given to shared
properties in their interpretation of the novel label. In situations in which function was one of the properties that the artifacts shared, exemplar integration helped the children to overcome function neglect. For novel animates, the presentation of a second exemplar had the opposite effect, promoting attention to contrasting properties of the objects. In situations in which the animates shared the properties of head shape and texture, exemplar individuation caused the children to give less weight to these properties in their interpretation of the label that was introduced for the second exemplar.

The general processes of comparison can help the youngest preschoolers to shift attention from shallow properties towards deeper, more meaningful properties. In the context of learning words for artifacts and animates, comparison can help 3-year-olds to overcome their shape bias in favor shared function. Over time, comparison is likely to lead to a better understanding of the differences between basic categories of existence. Consequently, more specific strategies such as integration of inanimate objects and individuation of animate objects emerge. After these processes develop, the integration processes are boosted when a child is given the opportunity to compare exemplars, but the individuation processes are offset or countered by the opportunity to compare exemplars. In sum, the changing role of comparison goes a long way in explaining the development of word learning skills.
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APPENDIX A

STIMULUS SET USED IN MOORE (2006) AND IN EXPERIMENTS 1 AND 2 OF THE CURRENT STUDY.

Inanimate Sets

**Blicket set:** The blicket set consisted of tools that could perform either screwdriving or spritzing functions. The standard blicket had a screwdriving bit on its bottom and a spritzing nozzle on its top. The bodies of the generalization objects were similar in shape to the body of the standard blicket. One generalization object was slightly smaller, and had a screwdriver bit on its bottom but no spritzing nozzle on the top. The other generalization object was slightly larger, and had a spritzing nozzle on the top but no screwdriver bit on the bottom. Demonstration objects were dissimilar to the standard and generalization objects in overall shape. One demonstration object afforded a screwdriving function only, and the other one afforded a spritzing function only.

**Pilson set:** The pilson set consisted of wheeled vehicles that could perform either arrow-launching or bull-dozing functions. The standard pilson had an end-loading scoop on the front and an arrow launcher attached on the back. The bodies of the generalization objects were similar in shape to the body of the standard pilson. One generalization object was slightly smaller, and had an arrow launcher on its back but no end-loading scoop on the front. The other generalization object was slightly larger, and had an end-loading scoop on the front but no arrow launcher on the back. Demonstration objects were dissimilar to the standard and generalization objects in overall shape. One
demonstration object afforded a bull-dozing function only, and the other one afforded an arrow launching function only.

Animate Sets

**Zav set**: The zav set consisted of slug-like creatures that could perform either milk-producing or insect-catching functions. The standard zav had an extendable tongue used to capture insects on the front and a milk producing appendage on the back. The bodies of the generalization objects were similar in shape to the body of the standard zav. One generalization object was slightly smaller, and had a milk-producing appendage on its back but no extendable tongue on the front. The other generalization object was slightly larger, and had an extendable tongue on the front but no milk-producing appendage on the back. Demonstration objects were dissimilar to the standard and generalization objects in overall shape. One demonstration object afforded a milk-producing function only, and the other one afforded an insect catching function only.

**Zimbiddy set**: The zimbiddy set consisted of egg-shaped humanoids that could perform either water-bringing or light-providing functions. The standard zimbiddy had a water vessel attached to its hand and a small flashlight attached to its head. The bodies of the generalization objects were similar in shape to the body of the standard zimbiddy. One generalization object was slightly smaller, and had flashlight attached to its head but no water vessel attached to its hand. The other generalization object was slightly larger, and had a water vessel attached to its hand, but no flashlight attached to its head.
Demonstration objects were dissimilar to the standard and generalization objects in overall shape. One demonstration object afforded a water-bringing function only, and the other one afforded a light-providing function only.
# APPENDIX B

## VIDEO LAYOUT FOR EXPERIMENT 1

<table>
<thead>
<tr>
<th>Version A</th>
<th>Version B</th>
</tr>
</thead>
</table>
| 1. Farmer milks novel creature  
* “Zav” brought out for child to see  
* Farmer milks “Zav” in video  
* Label Training  
* “Zav” put away  
* Generalization test | 1. Novel creature captures bug with tongue  
* “Zav” brought out for child to see  
* “Zav” captures bug in video  
* Label Training  
* “Zav” put away  
* Generalization test |
| 2. Novel object used to spritz a dog  
* “Blicket” brought out for child to see  
* “Blicket” in video used to spritz dog  
* Label Training  
* “Blicket” put away  
* Generalization test | 2. Novel object used to drive a screw  
* “Blicket” brought out for child to see  
* “Blicket” in video used to drive a screw  
* Label Training  
* “Blicket” put away  
* Generalization test |
| 3. Novel object bull-dozes dirt  
* “Pilson” brought out for child to see  
* “Pilson” in video bull-dozes dirt  
* Label Training  
* “Pilson” put away  
* Generalization test | 3. Novel object shoots arrow at dragon  
* “Pilson” brought out for child to see  
* “Pilson” in video used to slay dragon  
* Label Training  
* “Pilson” put away  
* Generalization test |
| 4. Novel creature brings water to toddler  
* “Zimbiddy” brought out for child to see  
* “Zimbiddy” in video brings water  
* Label Training  
* “Zimbiddy” put away  
* Generalization test | 4. Novel creature provides light to stage  
* “Zimbiddy” brought out  
* “Zimbiddy” in video provides light  
* Label Training  
* “Zimbiddy” put away  
* Generalization test |
## APPENDIX C

### VIDEO LAYOUT FOR EXPERIMENT 2

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<thead>
<tr>
<th>Version A</th>
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<tr>
<td>Farmer milks the zav</td>
<td>Zav captures bug with tongue</td>
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<tr>
<td>Blicket used to spritz a dog</td>
<td>Blicket used to screw in screw</td>
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<tr>
<td>Pilson dozes dirt</td>
<td>Pilson used to slay dragon</td>
</tr>
<tr>
<td>Zimbiddy brings water to toddler</td>
<td>Zimbiddy provides light on stage</td>
</tr>
</tbody>
</table>

Exact sequence repeated for dual exemplar condition
APPENDIX D

SAMPLE SCRIPT OF THE TYPE OF LANGUAGE
USED FOR EXPERIMENTS 1 AND 2

[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 clip. E pauses video and places the target standard object
in view of C but out of his or her reach]

E: Now, we are going to watch another clip a lot like the one you just saw. Only this time
I need your help finding this thing [E holds up standard object]. When you see this in the
video, I want you to point to it on the TV screen. See if you can find it before I can. [E
continues to hold standard object in child’s view, but shifts it in front of the TV so the
child can see both the object and the video at once] “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.].

[E stops video]

E: Now I am going to teach you the name for the thing 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 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). Can you point to the (object label)? [C chooses object]. Thank you! Now I know what to call this.

[Repeat procedure for each object set].

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

STIMULUS SETS FOR PROPOSED EXPERIMENT 3

<table>
<thead>
<tr>
<th>Texture and Head Shape 1 (fabric and hat-shaped)</th>
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<th>Standard Objects</th>
<th>Generalization Objects</th>
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<td>Demo-Set-1</td>
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<tr>
<td>Texture and Head Shape 2 (woven and rectangular)</td>
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<tr>
<td>Demo-Set-2</td>
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</tr>
</tbody>
</table>

**Solid line:** properties shared are core to animate categorization (head shape & texture)

**Dotted line:** properties shared are not core to categorization (color, size, body style)

Activity: Up and Down Hopping
<table>
<thead>
<tr>
<th>Texture and Head Shape 1 (fabric and hat-shaped)</th>
<th>Demonstration Objects</th>
<th>Standard Objects</th>
<th>Generalization Objects</th>
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<tr>
<th>Texture and Head Shape 2 (woven and rectangular)</th>
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<th>Standard Objects</th>
<th>Generalization Objects</th>
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**Solid line:** properties shared are core to animate categorization (head shape & texture)

**Dotted line:** properties shared are not core to categorization (color, size, body style)
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<thead>
<tr>
<th></th>
<th>Demonstration Objects</th>
<th>Standard Objects</th>
<th>Generalization Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Activity:</strong> Jumping Forward</td>
<td></td>
<td></td>
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<tr>
<td><strong>Texture and Head Shape 1</strong></td>
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<td></td>
</tr>
<tr>
<td>(furry and conical)</td>
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<td><strong>Texture and Head Shape 2</strong></td>
<td>Demo-Set-2</td>
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<tr>
<td>(scaly and spherical)</td>
<td><img src="image4" alt="Image" /></td>
<td><img src="image5" alt="Image" /></td>
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</tr>
</tbody>
</table>

**Solid line:** properties shared are core to animate categorization (head shape & texture)

**Dotted line:** properties shared are not core to categorization (color, size, body style)
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<tr>
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<th>Standard Objects</th>
<th>Generalization Objects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demo-Set-1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Texture and Head Shape 1</strong> (furry and conical)</td>
<td><img src="image1" alt="Image" /></td>
<td><img src="image2" alt="Image" /></td>
</tr>
<tr>
<td><strong>Texture and Head Shape 2</strong> (scaly and spherical)</td>
<td><img src="image3" alt="Image" /></td>
<td><img src="image4" alt="Image" /></td>
</tr>
<tr>
<td><strong>Demo-Set-2</strong></td>
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</tbody>
</table>

Solid line: properties shared are core to animate categorization (head shape & texture)
Dotted line: properties shared are not core to categorization (color, size, body style)
<table>
<thead>
<tr>
<th>Demonstration Objects</th>
<th>Standard Objects</th>
<th>Generalization Objects</th>
</tr>
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<tbody>
<tr>
<td><strong>Demo-Set-1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Texture and Head Shape 1</strong> (smooth and oval-shaped)</td>
<td>![Diagram of smooth and oval-shaped objects]</td>
<td>![Diagram of smooth and oval-shaped objects]</td>
</tr>
<tr>
<td><strong>Texture and Head Shape 2</strong> (ribbed and rectangle-shaped)</td>
<td>![Diagram of ribbed and rectangle-shaped objects]</td>
<td>![Diagram of ribbed and rectangle-shaped objects]</td>
</tr>
<tr>
<td><strong>Demo-Set-2</strong></td>
<td></td>
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**Solid line:** properties shared are core to animate categorization (head shape & texture)

**Dotted line:** properties shared are not core to categorization (color, size, body style)
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<tbody>
<tr>
<td>Demo-Set-1</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><img src="image1" alt="Image of demonstration objects" /></td>
<td><img src="image2" alt="Image of standard objects" /></td>
<td><img src="image3" alt="Image of generalization objects" /></td>
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</tr>
<tr>
<td><img src="image4" alt="Image of demonstration objects" /></td>
<td><img src="image5" alt="Image of standard objects" /></td>
<td><img src="image6" alt="Image of generalization objects" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Texture and Head Shape 2 (ribbed and rectangle-shaped)</th>
<th>Demonstration Objects</th>
<th>Standard Objects</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Demo-Set-2</td>
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<tr>
<td><img src="image7" alt="Image of demonstration objects" /></td>
<td><img src="image8" alt="Image of standard objects" /></td>
<td><img src="image9" alt="Image of generalization objects" /></td>
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<td><img src="image10" alt="Image of demonstration objects" /></td>
<td><img src="image11" alt="Image of standard objects" /></td>
<td><img src="image12" alt="Image of generalization objects" /></td>
<td></td>
</tr>
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**Activity:** Spinning like a top

**Solid line:** properties shared are core to animate categorization (head shape & texture)

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