INDIVIDUATING ARTIFACTS AND GROUPING ANIMALS: AN OBJECT’S REPRESENTATION INFLUENCES CHILDREN’S GENERALIZATION OF ITS LABEL

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Summary

After hearing a novel label for an object, young children typically generalize it based on shape and/or function. Label generalization may also be affected by the specificity of children’s pre-existing representation of the object. The more detailed this representation, the less likely children may be to extend the label to other objects.

A previous study obtained support for this hypothesis in 4-year-olds, but not in younger children or adults. The goal of the dissertation was to test this representation specificity hypothesis in first graders. In Experiments 1 and 2, first graders were presented with novel artifacts or toy creatures. Children were asked to find a target object in a large set of objects. In the similar condition, two of these objects were very similar to the target object. In the dissimilar condition, none of the objects were similar to it. Children were hypothesized to develop a more detailed representation of the target object in the similar condition. Children were taught a name for the training object and then asked to extend it to other objects. For artifacts, children performed in a manner consistent with the representation specificity hypothesis, extending the label to fewer objects in the similar than in the dissimilar condition. However, for toy animals, this response pattern was reversed. Experiment 3 investigated one explanation for why results were different for animals than for artifacts. According to the shared context hypothesis, children interpret grouping to be a cue to category membership for similar animals, but not for similar artifacts.
To test this hypothesis, children were shown photographs of a target object in various grouping contexts. They were then taught a label for the target object and asked to extend it to other objects. Children's label extension for animals was influenced by grouping context, whereas their label extension for artifacts was not. Thus, first graders tend to abide by the representation specificity hypothesis for artifacts, but the shared context hypothesis for animals. Ways in which these results may relate to other findings concerning children’s acquisition of categories and word meanings are discussed.
Introduction

From a very young age, children are able to make a fairly accurate interpretation of a novel word after hearing it used for only one or two exemplars (Houston-Price, Plunkett, & Harris, 2005; Woodward, Markman, & Fitzsimmons, 1994). Depending on the child and the circumstances, interpretation of the word depends on cues to speaker intention (Baldwin, 1993; Akhtar & Tomasello, 2000), the syntactic contexts in which the word occurs (Hall & Graham, 1999; Naigles, 1996), salient properties of the word’s exemplar(s) (Jones, Smith, & Landau, 1991; Hollich et al., 2000; Houston-Price, Plunkett, & Duffy, 2006), and what other words the child knows (Markman, 1989; Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002).

The current investigation examined another factor that may affect how a child interprets a novel object label, namely, his or her pre-existing representation of the individual object for which the label is introduced. Specifically, it addressed whether requiring the child to distinguish an object from similar objects would influence his or her interpretation of a label subsequently introduced for the object. Children were expected to form a detailed representation of the object so as to avoid confusing it with the similar objects, and to make some of the details in this representation of the individual object part of the representation that they constructed for the category denoted by a label for the object. Consequently, the child would generalize the label less broadly because the child would only accept the label for like-shaped objects that also matched on some of these
details (e.g., color, size, pattern). Children who had not first individuated the training object were expected to ignore these details and so generalize the label more broadly, accepting all or nearly all like-shaped objects. This proposal shall be referred to as the representation specificity hypothesis.

For example, suppose two children had never seen a hammer before nor heard the word *hammer*. Suppose the first child was shown a ball peen hammer and told that it was a hammer. This child would likely accept that this label could be applied to most other types of hammer because the child may not have a reason to represent the details about the object that are specific to ball peen hammers (i.e., its “ball” part). Suppose a second child was also shown a ball peen hammer, but then was asked to pick it out from a set of hammers. He or she would likely develop a representation of the ball peen hammer that included its “ball” part because this part was important for distinguishing it from other hammers. According to the representation specificity hypothesis, if the child were later told that this object was a “hammer,” he or she would be less likely than the first child to accept this label for hammers that lacked the “ball” part. The child would generalize the label less broadly than if he or she had not first formed a highly detailed representation of the object that was used to train the label.

**Cognitive Basis for Representation Specificity**

The representation specificity hypothesis reflects the general assumption that the representation a child forms of an object in a nonlinguistic context influences the child’s interpretation of a label that is subsequently introduced for the object. Infants do form categories for many objects before learning their names (Mareschal & Quinn, 2001;
Rovee-Collier & Gulya, 2000; Rovee-Collier, 1999). These categories are based on infants’ experiences playing with and seeing these objects in their environment. Several accounts have proposed that once infants start learning words, their interpretation of the names for familiar kinds of objects will be influenced by the categories they have already formed for these objects (Macnamara, 1972; Mayor & Plunkett, 2010; Mervis, 1987; Piaget, 1964).

Merriman, Schuster, and Hager (1991) demonstrated the influence of preexisting categories on object label interpretations in three experiments. In Experiment 3, 3-year-olds and adults examined one of two sets of toy animals. One set was organized by color, hair, and ear type, such that four objects had a dark blue body, purple hair, and round ears and the other four had an aqua body, no hair, and smaller pointed ears. The other set contained some of these same objects, but was organized by size and the presence/absence of legs (i.e., four were small and four-legged and the other four were large and legless.) After the objects were removed, a label was introduced for one of the objects that had been a member of both sets. Both the children and adults generalized the label to objects that matched the labeled object in color, hair, and ear type more often if they had examined the set organized by these properties than if they had examined the other set. The properties that organized a set were given more weight in participants’ decisions about the nature of the category that the label expressed.

Although the experiments by Merriman et al. (1991) provide evidence that the representation of an object that is formed during a nonlinguistic task can influence the interpretation of a name for that object, their experiments did not address the
representation specificity hypothesis per se. This hypothesis can only be tested by examining how broadly children generalize a label that has been introduced for either an individuated or non-individuated object. According to the hypothesis, a child who individuates an object (i.e., forms a highly detailed representation of it) will construct a more detailed categorical representation of the object’s label than other children will. The more detailed the representation of the category, the narrower the extension of the category’s label. That is, any object that resembles the individuated object in shape, but not in its details, will be excluded from the category. The gist of the hypothesis is that labels that are introduced for individuated objects will be more like subordinate labels (e.g., ball peen hammer), whereas labels that are introduced for non-individuated objects will be more like basic level labels (e.g., hammer).

Our proposal that the level of detail in the child’s representation of an individual object influences his or her categorical interpretation of a label for the object is consistent with the claim that children show dimensional inertia (Merriman, 1999; Hammer & Diesendruck, 2005) or attentional persistence (Kersten, Goldstone, & Shaffert, 1998; Kruschke, 1996) in word learning. Both of these terms have been used to describe the tendency for people who have learned to attend to a particular stimulus dimension when interpreting one or several words to continue to attend to the same dimension when interpreting other novel words. For example, Kersten et al. (1998, Experiment 3) taught adults pairs of verbs for the movements of a bug-like creature. One verb referred to a movement in which the creature moved its legs in a particular pattern and traveled along a particular path. The other verb referred to a movement that involved a different type of
leg movement and path. Thus, it was possible to learn to distinguish the verbs by attending to just the creature’s manner of leg movement or just the path along which the creature traveled. The participants showed better learning of the leg movements associated with each verb if they were first taught a pair of verbs for other movements of the creature that differed in type of leg movement, but did not differ in the path that the creature traveled.

Sloutsky (2003) proposed that an attentional mechanism may help children weigh some features as more important than others when learning novel object categories. He argues that some features naturally grab one’s attention while the salience of other features may change across context. If children assign weight to a particular feature and it is diagnostic, it might increase the attentional weights of other correlated features. For example, when 2- and 3-year-olds were asked to generalize a learned label to other novel objects, they attended to both shape and texture if the objects presented had eyes. When the same objects were presented without eyes, children attended only to shape (Booth & Waxman, 2002; Jones et al., 1992). Similarly, Smith, Jones, and Landau (1996) found that young children’s generalization of names for novel objects was influenced by the relative salience of perceptual features. Children were shown a set of objects, each having a distinct shape and distinct parts. They were also shown another object that was designed so that, depending on condition, the shape or parts were salient. When asked to generalize a novel label to novel objects, children generalized on the basis of shape when shape was made salient and on parts when parts were made salient.
One argument that might be raised against the representation specificity hypothesis is that numerous studies have shown that young children tend to generalize a novel count noun to objects that share the same basic shape (Imai, Gentner, & Uchida, 1994; Landau, Smith, & Jones, 1988; 1992) and/or function (Diesendruck & Bloom, 2003; Kemler Nelson, Russell, Duke, & Jones, 2000), but that differ on several other properties (e.g., color, size). However, other studies have found that the experience of comparing and/or contrasting an object with similar objects influences children’s generalization of a label for the object (Gentner & Namy, 1999; Merriman, Schuster, & Hager, 1991; Namy & Gentner, 2002; Xu & Tennenbaum, 2007). For example, Xu and Tennenbaum (2007) found that preschoolers and adults generalized a novel label less broadly if they had heard it used for a single exemplar (e.g., Dalmatian) than if they had heard it used for three members of the same basic-level category (e.g., Dalmatian, terrier, and mutt). They generalized the label even less broadly if they had heard it used for three members of the same subordinate category (e.g., three Dalmatians).

Previous Investigation of Representation Specificity

The only previous investigation to have tested the representation specificity hypothesis was conducted by Hartin and Merriman (2014). In their first experiment, 3- and 4-year-olds received several trials in which they were taught a label for a novel object then were tested on their generalization of the label to other objects. Before the label was taught, the children were asked to identify the training object in two arrays of objects. In the similar foils condition, two of the foil objects in these arrays had the same
overall shape, as well as many of the same parts, as the training object. In the dissimilar foils condition, none of the objects in the arrays shared these properties with the training object. The purpose of the similar foils condition was to require children to pay more attention to the target object by forcing them to keep it distinct from highly similar objects. The similar foils condition was designed so that children would need to represent more information about the object than just its overall shape (e.g., color, texture, specific parts) in order to individuate it from the other two similarly shaped foil objects. Keeping the target object distinct from dissimilar objects was expected to require less attention; the children need only represent general information about the objects, such as its overall shape. Thus, children in the similar foils condition were expected to generalize a label taught for the target object less broadly than children in the dissimilar foils condition; the former group should only generalize a label to objects that share some of the specific details included in their initial representation of the target object.

As predicted, 4-year-olds tended to generalize the label to fewer objects in the similar than in the dissimilar foils condition. However, 3-year-olds’ label generalization was unaffected by condition. Furthermore, whereas 4-year-olds showed the predicted effect for labels for artifacts, their generalization of labels for toy animals showed only a nonsignificant trend in the predicted direction. In a second study, adults’ label generalization for artifacts and toy animals was observed to be unaffected by whether they had picked the training object out from among similar or dissimilar foils. Thus,
Hartin and Merriman’s (2014) investigation provided rather limited support for the representation specificity hypothesis.

The goal of the dissertation was to examine whether an older group of children, namely, first graders, would show representation specificity in their generalization of a novel label. Before considering the cognitive developmental literature that is relevant to this question, the failure to find support for the representation specificity hypothesis in 3-year-olds and adults will be addressed.

There may be several reasons why the label generalization of 3-year-olds in Hartin and Merriman’s (2014) study was unaffected by the similarity of the foil objects that they had to distinguish from the target object. Although 3-year-olds may have formed a more detailed representation of the object when they individuated it from the highly similar foils, their representation may not have been as enduring as the representation formed by the 4-year-olds. Information included in their initial object representations might have been lost by the time they were presented with the label generalization task due to forgetting or interference from the task. Four-year-olds may just be better than 3-year-olds at maintaining or retrieving information about the physical features of an object or a group of objects. If this is the case, helping 3-year-olds maintain their initial representation of an object across tasks might promote their use of this information when deciding whether other objects share the same name as the target object. Other studies have demonstrated that giving preschoolers cues in various forms improves their memory performance in a variety of tasks (Freeman & Lacohee, 1994; Kliegel & Jager, 2007; Saltmarsh & Mitchell, 1999).
Three-year-olds’ failure to demonstrate representation specificity may also have been due to their finding the label generalization task to be too demanding. After being taught a name for the target object, children were presented with five objects at once and were asked to consider whether the name generalized to any of these objects. They might have been so overwhelmed by having to consider five objects at once that they did not consult their original representation of the target object when selecting from among them, but only considered the physical similarities between the objects (i.e., basing their label generalization on the objects’ overall shape). The breadth of 3-year-olds’ label generalization was comparable in the similar and dissimilar foils conditions such that the majority generalized the label to all the objects that shared the same overall shape. Three-year-olds might have shown representation specificity if they had been tested on the generalization objects one at a time.

Results from Vlach, Ankowski, and Sandhofer (2012) show that very young children’s performance in a generalization task can be affected by whether objects are presented simultaneously or one at a time. Two-year-olds in their study were shown novel objects using simultaneous (all four objects presented at once), immediate sequential (four objects presented in immediate succession), or spaced sequential presentation (a 30 second play period occurred between the presentation of each object). When tested immediately, children were more likely to generalize a newly introduced label to the test object that matched the labeled object in overall shape when objects were presented simultaneously than when presented in either of the sequential formats.
However, when tested just 15 minutes later, children in the spaced sequential condition demonstrated higher performance than children in the other conditions.

Vlach et al. argued that it did not require much cognitive effort for children to retrieve and generalize the labels to objects in the simultaneous condition. Since all of the objects remained visible in the simultaneous condition, children did not have to recall previous instances. In the spaced sequential condition, however, children were required to recall the instances that they had previously encountered. These findings are in line with other studies that demonstrate more effortful retrieval conditions during learning tend to promote long-term performance (Karpicke & Roediger, 2007; Pyc & Rawson, 2009).

Regarding Hartin and Merriman’s (2014) finding that adults’ label generalization was unaffected by whether they had distinguished the target object from similar versus the dissimilar foils, it may be that adults have more firmly-established approaches to interpreting an object’s label that are independent of how the individual object may have been represented for a search or recognition task. Relatedly, adults may believe that the specificity of the representation of an object as an individual is unrelated to its representation as an instance of a category. For example, it is common to represent one’s car or set of keys as being distinct from someone else’s, but these representations of individuals do influence how one interprets the scope of the categories denoted by car or key. It is important for a person to keep his or her car distinct from another’s car, but they both still belong to the same basic level category.
The difference between adults’ and preschoolers’ label generalization in Hartin and Merriman (2014) may also reflect perceived differences in the way the objects in the study were structured. Kloos and Sloutsky (2008) argue that object categories can be defined as dense or sparse and adults and young children represent these types of categories differently. A dense category is one defined by the presence of multiple correlated features, whereas a sparse category is often defined by an inclusion rule (e.g., a shape is a triangle if it includes exactly three sides). They found that, while 4- and 5-year-olds represented dense and sparse categories on the basis of overall similarity, adults represented dense categories on the basis of similarity and sparse categories in a rule-based manner. It could be that the adults in Hartin and Merriman’s study established an inclusion rule during their encounters with the objects, whereas the children in their study represented the objects in a similarity-based manner as in Kloos and Sloutsky’s study. Adults may have adopted an inclusion rule that was used by default, regardless of whether they attended to similarities between the objects. Future studies may incorporate ‘why’ questions following participant’s object selections to investigate what informs label generalization.

One last finding of Hartin and Merriman (2014) that needs to be addressed is why 4-year-olds showed representation specificity more strongly for artifacts than for toy animals. One possibility is that children may be more inclined to consider an individual animal to be representative of a category than to construe an individual artifact in this fashion. Gelman (1988) found that second-graders were more likely to generalize a nonobvious attribute that was introduced for an individual to other members of its basic
level category if the individual was an instance of a natural kind (e.g., rabbit, flower, apple) than if it was an artifact. For example, after being shown a brown rabbit and told “This rabbit likes to eat alfalfa”, children were asked whether other objects varying in similarity to the rabbit also like to eat alfalfa (i.e., another brown rabbit, white rabbit, telephone, dog). Not only were second graders more likely to generalize the property to white rabbits, they were also more likely to use generic category labels when justifying their answers (e.g., “All rabbits like to eat alfalfa”).

Although the attribute generalizations of the preschoolers in Gelman’s (1988) study were not affected by whether objects were natural kinds versus animals, Brandone and Gelman (2009) demonstrated that preschoolers were more likely to use generic language (e.g., “They have large eyes.” or “A luzak looks like a CD player.”) for a novel animal than for a novel artifact. Even very young children understand such generic language to communicate that a property is typical of the members of its category rather than restricted to an individual member (Gelman & Raman, 2003; Hollander, Gelman, & Star, 2002). In a study comparing hearing and deaf preschool-age children in both the United States and China, all four groups were observed to produce generic expressions more often in reference to an animal than to an artifact (Goldin-Meadow, Gelman, & Mylander, 2005).

There are also ontological differences (e.g., artifact vs. animal) regarding the questions children tend to ask about individual objects. For example, 3- and 4-year-olds children are more likely to request an object’s generic name when encountering a novel animal, but they are more likely to ask about an individual object’s function when
encountering a novel artifact (Kemler-Nelson, Egan, & Holt, 2004). In asking about the artifact’s function and in their response to the information they receive about the function, the children show no evidence that they consider the function to be a categorical attribute, that is, one that could be performed by all members of the category to which the artifact belongs.

If children are more likely to take a “categorical stance” toward an animal than toward an artifact, they may be more likely to attempt to identify the categorically-relevant properties of an object upon first encountering it if the object is an animal than if it is artifact. If so, then subsequent tasks requiring them to distinguish the object from highly similar objects may have less impact on their interpretation of a categorical label for an animal than for an artifact.

Children may have more experience with animals than artifacts in both tracking individuals and maintaining representations of them that are distinct from representations of the categories to which they belong. Even toddlers will restrict their use of a proper noun (e.g., “Kiv”) to the person, doll, or animal for whom it was introduced, while generalizing a count noun (e.g., “a kiv”) to similar others (Gelman & Taylor, 1984; Katz, Baker, & Macnamara, 1974; Macnamara, 1982). These same studies have shown that when a proper noun is introduced for an artifact, the children do not restrict it to the named object, and may even decide during a later test it as a proper name for an animal. One consequence of children’s greater experience at coordinating individual and categorical representations of animals may be that these two types of representations may
have less impact on each other than individual and categorical representations of artifacts do.

Although Hartin and Merriman (2014) found no significant effect of condition on 4-year-olds’ interpretation of a label for a toy animal, it is possible that older children might respond to distinguishing a novel animal from similar novel animals by constructing a *broader* categorical representation for the animal than they might otherwise. From their encounters with real animals as well as with animals in various media (e.g., story books), children may learn that when an animal appears in the same context as similar animals, the shared context is a cue that they are members of the same basic level category (i.e., the same species). Wolves run in packs and birds of a feather flock together. Presumably, shared context is not as strong a cue that similar artifacts belong to the same basic level category. When a label is introduced for an animal that has been seen next to similar animals, children may infer that the other animals are also exemplars of the label. They may consider the differences between the animals to be relevant to representing each as an individual, but consider the properties they share to be relevant to representing the category to which they belong. Experiment 3 of the dissertation will address this shared context hypothesis in first graders.

In summary, 4-year-olds are the only age group that has been shown to be influenced by representation specificity. And though the 3-year-olds and college students in Hartin and Merriman’s (2014) study were not influenced by representation specificity, it is currently unknown whether older children’s label generalization would be influenced by it. Furthermore, 4-year-old’s label generalization for toy animals in Hartin and
Merriman’s study did not fit the pattern predicted by the representation specificity hypothesis. Therefore, the current studies will incorporate stimuli from artifact and animate categories to determine if object individuation affects older children’s label generalization differently for each category type. To foreshadow the results of the first experiment, the label generalization of first graders conformed with the representation specificity hypothesis when the labels referred to artifacts, but not when the labels referred to animals. Experiments 2 and 3 examined hypotheses for this moderating effect of ontological kind on whether first graders’ interpretation of a novel label conformed with the representational specificity hypothesis.
Experiment 1

The very same materials and procedures that Hartin and Merriman (2014) used to test the representation specificity hypothesis in 3- and 4-year-olds were used to test this hypothesis in first graders. No research has addressed whether first graders' interpretation of an object label will be influenced by their experiences with the object prior to learning its name. On one hand, as suggested regarding adults, they may have firmly-established ways of inferring the meaning of an object's label, independent of how they initially represent the object. On the other hand, the ability to consult an individuated object’s representation during a label generalization experience may be a skill that develops as children get older. Therefore, first graders may be as likely, or even more likely, than preschoolers to be influenced by their initial experiences with an object when interpreting its name.

First graders and preschoolers may also differ in their label generalization for animals. As already noted, second-graders in Gelman’s (1988) studies were more likely to generalize a nonobvious attribute introduced for an individual to other individuals belonging to its basic level category when presented with natural kinds than when presented with artifacts. Gelman argued that natural kinds are more likely than artifacts to be the subject of scientific study and preschoolers’ lack of formal schooling contributes to their relatively inerudite scientific understanding. Substantial change in

Method

Participants

Thirty-two first graders ($M = 7$ years, 4 months, range = 6 years, 8 months – 7 years, 11 months; 13 girls) participated. Children were recruited from grade schools in middle- to upper-class regions of northeast Ohio. Nearly all participants were Caucasian. Half of the children in each age group were assigned to the similar foils condition and half were assigned to the dissimilar foils condition. Every child received a sticker for participating.

Materials

Four tasks were administered: search, recognition, label training, and label generalization. The main objects in these tasks came from four sets of novel artifacts and four sets of novel toy animals. Each set consisted of nine objects: a training object, two similar foil objects, two dissimilar foil objects, and four generalization objects (see Figures 1 and 2). Half of the children were trained and tested only with the artifact sets and half with the toy animal sets. The toy animals were created by altering certain parts in the artifacts, such as adding facial features (eyes, nose, and mouth), replacing wheels with legs, replacing the sponges in one object set with legs, replacing the propellers in
one object set with feet, and replacing knobs in one object set with fish-fins. Object size, color, shape, and texture were not altered.

Conditions differed only with respect to the similarity of the two foil objects to the training object. In the similar foils condition, these two objects had the same overall shape as the training object, but differed in size. One also had the same texture as the training object. In the dissimilar foils condition, the two foil objects differed from the training object in size, shape, texture, and color. The five label generalization objects were the same in each condition: an exact copy of the target object, an object that matched the training object in size and shape, but not texture; two objects that matched the training object in shape, but not size or texture; and an object that had a completely different shape than the training object (the dissimilar object). Additional materials included a two-foot high tub filled with 15 common and uncommon artifacts (shoe, toy car, ball, cup, baby sock, belt, egg slicer, glasses, plastic flower, spoon, watch, plastic funnel, pencil sharpener, tin box, plastic apple), which were used in the search task, and three one-foot high plastic buckets, which were used in the recognition task.

Procedure

The children were tested individually at a table in a quiet testing room. On the floor next to the experimenter, out of the child’s view, was the tub of objects used for the search task, the buckets used for the recognition task, and a cardboard box containing the objects used for the label tasks. Four trials were administered, each involving a different set of training, foil, and generalization objects. Half of the children received the trials in
one order and half received them in the opposite order. On every trial, four tasks were administered in the following order: search, recognition, label training, and label generalization. The particular foil objects used in the search and recognition tasks were expected to affect the representation that the child formed of the individual object before learning a label for it.

1) Search. After establishing rapport, the experimenter said, “We are going to play a game with some funny looking things that you probably haven’t seen before. I’m going to show you some things and hide them. You’ll have to find them. So make sure you look at the things real closely when I bring them out.” The experimenter showed the child the training object, and told the child to look at it closely to try to remember what it looks like. The child was then instructed to close his or her eyes so that the experimenter could hide the training object. (The training object was referred to as “this/that thing”, “it”, or “the one” throughout the search and recognition tasks.) The experimenter placed the training object and the two foil objects into the tub of search objects. The child was asked to open his or her eyes and look in the tub to find the training object. All the children retrieved the correct object. The tub of objects was removed from view. The child was again instructed to look at the training object closely in order to remember what it looked like.

2) Recognition. The child was told that he or she was going to have to find the training object again, and so had to close his or her eyes. The experimenter put three overturned buckets on the table, then hid the training object under one bucket, and hid each foil object under the other two buckets. The child was asked to open his or her eyes,
and then told that the training object was under one of the buckets. The experimenter lifted the buckets one at a time, each time asking whether the object was the one the child had been asked to remember. The training object was always revealed last. Only two children ever incorrectly identified a foil object as the training object. These errors were corrected. Every child recognized the training object after it was revealed from under the bucket. After the recognition task, the buckets and foil objects were removed from view.

3) Label training. Holding the training object in front of the child, the experimenter said, “Do you know what this is called? It’s called a zav. It’s a zav. Can you say zav? [Child repeats it.] Right, this thing is called a zav.” A different novel label (zav, mosby, blicket, pilson) was used for each training object. The training object was then removed from view.

4) Label extension. The experimenter said to the child, “I am going to show you some things, and I want you to tell me whether you think any of them is a (trained label, e.g., zav).” The training object and the four generalization test objects were placed on the table in front of the child in random order. The child was asked, “Do you think any of these is a zav? Show me.” After the child stopped picking, the experimenter said, “Are there any more zavs?” If child said, “Yes,” the experimenter said, “Show me.”

Results and Discussion

Children tended to select the training object and up to three similar objects on label generalization test trials; they chose the dissimilar object on less than 1% of the trials. A 2 (condition) x 2 (ontological kind) factorial analysis of variance of the mean
number of objects selected yielded a significant two-way interaction, $F (1, 28) = 42.94, p < .001$, partial $\eta^2 = .605$. The children selected fewer artifacts in the similar foils condition ($M = 2.41, SD = .64$) than in the dissimilar foils condition ($M = 3.88, SD = .35$), $F (1, 28) = 33.72, p < .001$, partial $\eta^2 = .546$ but selected more toy animals in the similar foils condition ($M = 3.66, SD = .50$) than in the dissimilar foils condition ($M = 2.78, SD = .49$), $F (1, 28) = 11.97, p < .002$, partial $\eta^2 = .261$.

According to the representation specificity hypothesis, children in the similar foils condition should generalize labels less broadly than those in the dissimilar foils condition. Keeping track of the target object was expected to require more attention in the similar foils condition than in the dissimilar foils because children had to keep the target object distinct from highly similar foils objects during the search and recognition tasks. To successfully do this, children in the similar foils condition should have to represent more specific information about the target object than just the object’s overall shape, such as the object’s color or textural features. The representation formed in the dissimilar foils condition where children kept track of the target object amongst dissimilar objects was expected to be less detailed, only including general information, such as overall shape. Children in the dissimilar foils condition were expected to show broader generalization than children in the similar foils condition when asked to extend a label taught for the target object to other objects. First graders’ generalization of labels to novel artifacts was consistent with this prediction. In the similar foils condition, children selected fewer objects during the label generalization task than children in the dissimilar foils condition.
However, children’s generalization of labels for novel animals was the exact opposite of what was predicted by the representation specificity hypothesis. In the similar foils condition, children selected *more* of the toy animals during the label generalization task than children in the dissimilar foils condition. By first grade, children may have learned that when an animal is found in a context with similar animals, the shared context is a cue that they are members of the same basic-level category and as such, have the same basic-level name. An alternative hypothesis needs to be ruled out, however. The tub of objects used in the search task contained the training object, the two foil objects, and fifteen familiar artifacts (which shall be referred to as background objects). So the children saw either three novel toy animals mixed in among numerous familiar artifacts or three novel artifacts mixed in among numerous familiar artifacts. First graders may have been sensitive to the contrast between animals and artifacts in the tub that was evident only when the training object and two foil objects were animals. Perhaps this contrast caused them to represent the target animal as more similar to the two similar animal foils than they otherwise would have. Experiment 2 evaluated these competing hypotheses.
Experiment 2

Experiment 2 tested first graders with procedures and materials that were the identical to those of Experiment 1, except that the familiar artifacts in the tub were replaced by familiar toy animals. If first graders consider shared context to be a cue to membership in the same basic-level category for similar animals, but not for similar artifacts, then they should show the same pattern of responses as the first graders in Experiment 1. That is, labels for artifacts should be generalized less broadly in the similar than in the dissimilar foils condition, but labels for toy animals should be generalized more broadly in the similar than dissimilar foils condition. However, if the results of Experiment 1 were due to whether the ontological kind of the target object and the two foil objects contrasted with the ontological kind of the background objects in the search task, then the children in Experiment 2 should show the opposite pattern of results than those in Experiment 1. Because the fifteen background objects in the new experiment were all familiar toy animals, the target object and the two foil objects only contrasted with these when they were artifacts. Therefore, according to the alternative hypothesis, labels for artifacts should be generalized more broadly in the similar than in the dissimilar foils condition, and labels for toy animals should be generalized less broadly in the similar than in the dissimilar foils condition.
Method

Participants

Thirty-two first graders (M = 90 months, range = 82 – 96; 15 boys) participated. They were recruited from grade schools in middle- to upper-class regions of northeast Ohio. Nearly all participants were Caucasian. Half of the children in each age group were assigned to the similar foils condition and half were assigned to the dissimilar foils condition. Every child received a sticker for participating.

Materials and procedures

These were identical to those of Experiment 1, except that the fifteen familiar artifacts in the tub were replaced by fifteen familiar toy animals (zebra, giraffe, snake, dog, duck, tiger, tyrannosaurus rex, shark, frog, lizard, stegosaurus, triceratops, raptor, and two characters from the Mario Brothers game series).

Results and Discussion

A factorial analysis of variance of the mean number of objects selected in the label generalization task yielded a significant condition x ontological kind interaction, $F(1, 28) = 20.38, p < .001$, partial $\eta^2 = .421$. As in Experiment 1, the first graders selected fewer artifacts in the similar foils condition ($M = 2.72, SD = .78$) than in the dissimilar foils condition ($M = 3.59, SD = .46$), $F(1, 28) = 6.92, p < .02$, partial $\eta^2 = .198$ and selected more toy animals in the similar foils condition ($M = 3.53, SD = .49$) than in the
dissimilar foils condition ($M = 2.28, SD = .84$), $F (1, 28) = 14.12, p < .001$, partial $\eta^2 = .335$.

These results are not consistent with the alternative hypothesis. They support the hypothesis that first graders consider shared context to be a cue to membership in the same basic-level category for similar animals, but not for similar artifacts. Animals of the same species often congregate and it may be that children are more likely to encounter animals of the same kind grouped together than artifacts of the same kind. They may consider the differences between similar animals to be relevant to representing each as an individual, but consider the properties they share to be relevant to representing the category to which they belong. Artifacts of the same basic level category are sometimes found grouped together, but it is also common to encounter thematically-related groups of artifacts. For example, we often see a spoon, fork, and knife grouped together in a place setting. Even though they may look similar, they do not belong to the same basic-level category. They are instead grouped together thematically, or because they are all used to in the context of eating dinner. By first grade, children may have developed this sensitivity to the differential implications of shared context for animals and artifacts, and may use this information to guide their interpretation of labels. The proposal that children interpret shared physical context as a cue that similar animals have the same the name shall be referred to as the shared context hypothesis for animals.

The shared context hypothesis fits with the general assumption that the representation a child forms of an object in a nonlinguistic context can and influence children’s interpretation of a label for that object (Macnamara, 1972; Mayor & Plunkett,
2010; Mervis, 1987; Piaget, 1964; Hartin & Merriman 2014). If a child encounters a group of similar animals, the child’s representation of that experience might include information that those animals belong to the same category. Therefore, he or she might use the original representation of the animals grouped together to determine whether other animals are similar enough to be categorized with the animals that previously appeared in a group. To the child, it might be a suspicious coincidence that similar-looking animals appeared together in a group. Later, when asked to generalize a label taught for one of the animals that appeared in the group to other similar animals, children should generalize more broadly because it is as if the child heard a name applied to all the similar animals in the group instead of just one.
Experiment 3

Experiments 1 and 2 leave several questions unanswered. First, children in these experiments only saw the target object and its two foils grouped together during the recognition task. In the search task, these three objects had been part of large diverse group of objects in a tub. Even in the recognition task, the target object and the two foils were initially concealed under separate buckets. So, children saw them grouped together only very briefly. The main goal of Experiment 3 was to test whether seeing similar animals physically grouped together increased first grade children’s tendency to judge that the animals had the same novel name, compared to seeing each similar animal individually. According to this shared context hypothesis, children who see similar animals grouped together will be more likely to decide that the animals have the same name than children who see the same animals, but each one in isolation or as part of a dissimilar group.

First graders received several trials that involved first viewing pictures of groups of novel objects, then learning a label for an object that was part of each group, and then deciding how broadly to generalize the label. Several pictures were presented, and each included three objects. In the similar group condition, the same three similar objects appeared in each picture. In the dissimilar group condition, each of the pictures depicted the same object in a group with two objects from other categories. According to the shared context hypothesis, children in the similar group condition should generalize
labels for novel animals more broadly than those in the dissimilar group condition. To serve as a control group, children in a third condition were presented with photographs of a single target object instead of groups of objects. This group should also not generalize the labels for animals as broadly as the similar group condition, according to the shared context hypothesis.

As in Experiments 1 and 2, half of the children were tested with novel toy animals and half were tested with novel artifacts. Grouping was not expected to have much, if any, effect on artifacts because children routinely encounter thematically-related groups of similar artifacts (e.g., a tool box, a junk drawer), perhaps just as often as they encounter groups of similar artifacts that all belong to the same basic level category.

Unlike Experiments 1 and 2, the current experiment did not test the representation specificity hypothesis. The search and recognition tasks, which were used in the previous experiments to affect how much detail children incorporated in their representation of an individual object, were not presented. Rather, Experiment 3 tested hypotheses related to the post hoc explanation for first graders’ unexpected tendency in the previous experiments to generalize a label for an animal in a manner that was the opposite of what was predicted by the representation specificity hypothesis. According to this explanation, the so-called shared context hypothesis, first graders consider the grouping of similar animals, but not similar artifacts, to be a cue that each member of the group has the same name. Experiment 3 compared the effects of encountering a novel object in various types of groups (dissimilar group vs. similar group vs. no group) on children’s interpretation of
a label for the object. The dependence of these effects on an object’s ontological kind (i.e., animal versus artifact) was also assessed.

Method

Participants

Ninety-six first graders were recruited from grade schools in middle- to upper-class regions of northeast Ohio. The children were randomly assigned to one of three conditions (dissimilar group vs. similar group vs. no group).

Materials and procedures

In the dissimilar group and similar group conditions, the children viewed twelve photographs, three per trial across four trials. Every photograph depicted three objects. By the end of the experiment, every child viewed twelve different objects three times each. For half of the children, the objects were novel artifacts. For the other half, the objects were novel toy animals. For each ontological kind, the twelve objects consisted of the four target objects and eight similar foils used in Experiments 1 and 2.

Children received four trials, each involving a different target object and label. For children in the similar group condition, three pictures of the target object and its two similar foils were presented on every trial. Only the spatial arrangement of the objects varied across the three pictures. Children in the dissimilar group condition also saw three pictures of the target object next to two other objects on each trial. However, the two
other objects were drawn from the similar foils for other target objects, and differed from picture to picture. See Figures 3a and 3b for the pictures and their order of presentation.

Children in the no-group condition also viewed twelve photographs across four conditions. However, each photograph only included a single target object, which was the same target objects used in the dissimilar group and similar group conditions. The number of times children saw each target object was equal in all three conditions. See Figure 4 for the pictures and their order of presentation.

Each trial began with the presentation of three pictures, one at a time on a laptop screen using PowerPoint. Each photograph was presented for 8 seconds with no delay in between each picture. Before the presentation, each child was told “We are going to look at some pictures. I want you to look at them closely. In the similar and dissimilar group conditions, every time a picture was presented, the child was told, “Look at these.” or “Take a good look at these.” In the no group condition, the child was told, “Look at that” or “Take a good look at that.”

After viewing the first three pictures, children in every condition were taught a label for the target object that had just appeared in the pictures, and then were tested for their generalization of the label. The test was similar to the one used in Experiments 1 and 2, except that it was broken up into two trials and involved two additional objects (the two similar foils). See Figure 5. On the first test trial, the test set included the target object, one of its similar foils, an object that matched the target object in overall shape but not in size or texture, and an object that was perceptually dissimilar to the target object. On the second test trial, the test set included the other similar foil, a test object
that matched the target object in size and shape, and another test object that matched the target object in overall shape but not size and texture.

After being taught a name for each target object, the experimenter said “I’m going to show you some other things.” After bringing out the first test set, the experimenter then said “Do you think any of these are Xs (test word in plural form, e.g., blickets)?” After the child made his or her selections, the experimenter said “Are there any more?” Once the child was finished making selections, the experimenter said “Now I’m going to show you more things.” Upon bringing out the second set of test objects, the experimenter asked each child “Are any of these Xs?” Each child was allowed to select as many or as few objects on these two test trials as he or she saw fit.

After making their selections, children were shown the next three pictures in their condition, then taught a label for the target object that appeared in them, and then tested for their generalization of the label. This procedure was repeated twice more with the remaining pictures and objects.

**Results and Discussion**

A 3 (condition: dissimilar group vs. similar group vs. no group) x 2 (ontological kind: animal vs. artifact) factorial analysis of variance of the mean number of objects selected in label generalization (max = 7) yielded a significant condition x ontological kind interaction, \( F(2, 93) = 4.62, p < .02, \) partial \( \eta^2 = .093. \) Children who were taught labels for novel toy animals selected more exemplars for these labels in the similar group condition \( (M = 4.88, SD = .91) \) than in the dissimilar group condition \( (M = 3.14, SD = \)
Children also selected more exemplars in the similar group condition than in the no group condition ($M = 3.28$, $SD = 1.6$), $t(30) = 3.46$, $p < .005$, $d = 1.26$. For children who were taught labels for novel artifacts, there was no effect of condition, $F(2, 93) < 1$ ($M = 4.14$, 4.14, and 4.02 for the similar group, dissimilar group, and no group conditions, respectively).

Children performed as was predicted by the shared context hypothesis. According to this hypothesis, children in the similar condition should have judged the animals that had appeared next to the target animal in the pictures to belong to the animal’s category and therefore, to share its name. Children in the other two conditions, for whom these animals never appeared next to the target animal in the pictures, should not have shown as great a tendency to later judge them to share the target animal’s name. A 3 (condition: dissimilar group vs. similar group vs. no group) x 2 (ontological kind: animal vs. artifact) factorial analysis of variance was conducted on how frequently children extended the trained labels to these two context objects (i.e., the objects that had appeared in a group with the target object in the similar group condition, but not in the other two conditions). As expected, the condition x ontological kind interaction was significant, $F(2, 93) = 5.39$, $p < .01$, partial $\eta^2 = .107$. Follow-up $t$ test comparisons of the three groups indicated that children more often selected these test objects in the similar group condition ($M = 1.66$, $SD = .38$, max = 2) than in the dissimilar group condition ($M = 0.70$, $SD = .60$, $t(30) = 5.39$, $p < .001$, $d = 1.97$) or the no group condition ($M = 1.05$, $SD = .71$, $t(30) = p < .01$, $d = 1.10$). No significant differences were found between conditions.
regarding the frequency in which artifacts were selected, \( F (2, 93) < 1 \) (\( M = 1.25, 1.25, \) and 1.28 for the similar group, dissimilar group, and no group conditions, respectively).

The results support the hypothesis that experience seeing some similar animals grouped together increases children’s tendency to judge those animals to have the same name. Children in the similar group condition selected more test animals during the label generalization phase than children in the dissimilar group or no group conditions. Moreover, children in the similar group condition selected the animals that they had seen to share a context with the target animal more often than children in the other conditions selected these same animals. The three conditions did not differ in their selection of artifacts. A significant effect of condition was not expected for the artifacts because, in contrast to animals, shared context was not hypothesized to be a cue that similar artifacts have the same name.

First graders who encounter a group of similar animals tend represent those animals as being members of the same category. Presumably, they use this representation to determine whether other animals are similar enough to be categorized with the previously encountered group of animals. The child judges it to be more than a coincidence that similar-looking animals appeared together in a group. Later, when asked to generalize a label taught for one of these animals, children act as if they had heard a name applied to all the similar animals in the group instead of just one.
General Discussion

According to the representation specificity hypothesis, children’s label generalization should be affected by the specificity of their pre-existing representation of an object. With a less detailed representation of an object, children may rely on general perceptual information (e.g., overall shape) when asked to extend a label to other objects. The more detailed this representation, the less likely children may be to generalize the label to other objects. That is, they may be compelled to construct a narrower category for the label’s extension than they would otherwise. Hartin and Merriman (2014) found support for this hypothesis in 4-year-olds, but not in 3-year-olds or college students. The main goal of the dissertation was to test the representation specificity hypothesis in first graders.

In Experiments 1 and 2, first graders in the similar condition performed tasks that required them to pick out a remembered target object from perceptually similar objects. Those in the dissimilar condition performed tasks that merely required them to pick out a remembered target object from perceptually dissimilar objects. After learning a label for the target object, children were asked to decide what other objects were also exemplars of the label. The tasks that involved keeping track of the target object were expected to require more attention to the details of the object in the similar condition than in the dissimilar condition. The representation formed of the object in the dissimilar condition was expected to be less detailed, only including general information, such as overall shape. Consequently, children in the similar condition were expected to show narrower
label generalization than those in the dissimilar condition. The results of both experiments were consistent with this prediction for artifacts, but not for animals. For novel animals, children in the similar condition actually selected more of the toy animals during the label generalization task than children in the dissimilar condition.

The shared context hypothesis was formulated in order to explain this unexpected finding. By first grade, children may have learned that when an animal is found in a context with similar animals, the shared context is a cue that they are members of the same basic-level category and as such, have the same basic-level name. Children do not have this same expectation regarding artifacts because in their experience finding an artifact in a group with other similar artifacts is not a reliable indication that all of the artifacts in the group have the same basic-level name.

Future research is needed to determine whether the shared context hypothesis holds for children in age groups other than the ones examined in this dissertation or in the experiments by Hartin and Merriman (2014). For example, it is unknown whether 5-year-olds’ label generalization for animate categories is influenced by shared context. Hartin and Merriman (2014) found that 5-year-olds’ and first graders’ label generalization for artifacts was influenced by object individuation in that children from both age groups selected fewer objects in the similar foils condition than in the dissimilar. Also, both age groups demonstrated the reverse pattern of label generalization when the objects presented depicted animate categories. It could be that 5-year-olds would also be influenced by the effects of shared context, and if they were tested with the procedures
used in the current Experiment 3, they would exhibit a pattern of label generalization like that of the first graders in Experiment 3.

Experiment 2 ruled out an alternative explanation to the shared context hypothesis regarding the results of Experiment 1. According to this alternative explanation, because all of the background objects in the tub used in the search task in Experiment 1 were artifacts, children in the similar artifacts condition tended to form an especially detailed representation of the target artifact, whereas children in the similar animals condition perceived the target animal and its two similar foil animals as forming a category that stood out from all the other (artifact) objects in the tub. Therefore, they generalized the label for the target artifact very narrowly, but generalized the label for the target animal very broadly. In Experiment 2, all of the background objects that had been used in Experiment 1 were replaced with toys animals. So if the alternative explanation had been valid, results should have been the opposite of those found in Experiment 1. The results were actually the same as Experiment 1, thus supporting the shared context hypothesis over the alternative hypothesis. Note that according to the shared context hypothesis, the similar animals stood out as a category during the search and recognition tasks of Experiments 1 and 2, but this effect did not depend on whether background objects were toy animals or artifacts.

Experiment 3 was designed to directly test the shared context hypothesis for the artifact-animate difference observed in the first two experiments. First graders were shown pictures of a target object alone, accompanied by two similar objects, or accompanied by two unlike objects. After being taught a name for a toy animal, children
in the similar group condition made more selections during label generalization than children in the dissimilar group and no group conditions. Children’s performance in the dissimilar group and no group conditions was not significantly different. The first graders in Experiment 3 performed just as predicted by the shared context hypothesis. According to this hypothesis, children in the similar condition should have judged the animals that had appeared next to the target animal in the pictures to belong to the animal’s category and therefore, to share its name. Children in the other two conditions did not see the test objects appear next to the target object in the pictures and should not have shown as great a tendency to judge them to share the target animal’s name.

The shared context hypothesis assumes that children’s real-world encounters with actual animals or depicted animals take a form that differs from their real-world encounters with actual artifacts or depicted artifacts. Animals are social creatures and are often found congregating with other members of their species (e.g., a pack of wolves, a school of fish). Children see similar animals grouped together in a variety of contexts. For example, children may encounter similar animals grouped together at zoos and farms, and families of animals are often portrayed in story books and television shows.

It is assumed that children do not have an analogous experience with similar artifacts. Children’s label generalization for artifacts was not influenced by whether the target object had appeared in a group of similar artifacts, a group of dissimilar artifacts, or no group of any kind. This result was expected based on the way in which artifacts are found grouped together in real world contexts. Objects from artifact categories are sometimes found grouped together based on basic level category (e.g., shoes are grouped
together in the closet, spoons go in the same place in a drawer), but artifacts from different basic level categories are also often grouped together based on thematic relations. For example, a fork, spoon, and knife look similar in overall appearance and are often found grouped together in a place setting, yet each object belongs to a different basic level category and has a different basic level name.

One implication for accounts of children’s object label acquisition and category learning is that for 4-year-olds and first graders, the way that they represent an individual artifact or animal can influence the representation that they construct for the object’s category. This finding fits with previous studies showing that the specific features that children emphasize when interpreting an object’s categorical label can be affected by opportunities to compare and contrast the object with other objects (Gentner & Namy, 1999; Merriman et al., 1991; Namy & Gentner, 2002; Xu & Tennenbaum, 2007). Furthermore, this effect can occur even if the comparisons and contrasts occur before the label for the object is introduced, as in Merriman et al. (1991).

Additional research is needed to understand the effect of artifact individuation on label interpretation in older children, as well as to determine there are any circumstances in which adults or children younger than 4 years might be influenced by artifact individuation. I have only found one other study that demonstrates that a label’s interpretation can be influenced by object comparisons that occur before the label is introduced (Merriman et al., 1991). In this study the very age groups that did not show an effect in Hartin and Merriman’s (2014) experiments – 3-year-olds and adults -- were influenced by the opportunity to compare and contrast objects prior to learning a name.
for one of them. The procedures used in Merriman et al. differed from the current procedures in many ways. In Merriman et al., participants played with a set of eight similar objects that could be subdivided based on co-varying features (e.g., four were orange and small vehicles and four were red and tall vehicles), then learned a label for one of the objects. In contrast to the current procedure, the object that was labeled had not been singled out during the presentation of the set. Also, the main finding of Merriman et al. did not concern how broadly participants generalized the trained label, but whether they preferred to generalize it to some objects more often than others (i.e., whether they favored test objects that matched the training object on the co-varying features that had organized the set than test objects that matched it on other features).

By the time children enter grade school, it could be that most children have learned that when an animal is found in the same physical context as similar animals, the shared context is a cue that each member of the group of the animals belongs to the same basic-level category and as such, has the same basic-level name. Children may have learned that animals of the same kind tend to congregate in homogeneous groups such as families, packs, herds, or schools. They may not hold a similar belief about artifacts, and so, not infer that similar artifacts that share the same context belong to the same basic level category.

Future research should also explore whether the proposed development of a tendency to infer the animals’ category membership from shared context is related to two other developmental changes that have been found to occur during the preschool years. The first change is an increase in children’s tendency to think of animals as similar in
behavior and internal structure to human beings (Herrmann, Waxman, & Medin, 2010; Rigney & Callanan, 2011). As this anthropocentric way of thinking about animals becomes established, children may begin to use the grouping of similar animals as a cue that the animals are members of the same species because they know that human beings tend to group with other members of their species, that is, other human beings. The other change during early childhood that may be relevant is an increase in the tendency to consider that an object’s relation to other objects, rather than just the object’s intrinsic properties, may be relevant to the meaning of a label for the object (Gentner, Anggoro, & Klibanoff, 2011).
Bibliography


Appendix

Figures

Figure 1: Artifact stimuli used in all four trials

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Figure 2: Animate stimuli used in all four trials

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Figure 3a: Animates in the similar group condition (left block) and the dissimilar group condition (right block)

Figure 3b: Artifacts in the similar group condition (left block) and the dissimilar group condition (right block)
Figure 4: Toy animals (left block) and artifacts (right block) used in the no group condition

Figure 5: Example of different objects that appeared in the test trials