The Role of Symbolic Experience in Learning to use Scale Models

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CHAPTER I

INTRODUCTION

Adults acquire information about the real world from a variety of symbolic systems and artifacts such as spoken language, gestures, written text, maps, models, pictures, and even digital media such as video (Troseth & DeLoache, 1998). As proficient symbol users, we can consult Google maps to check the pace of traffic or send text messages and photos to communicate with friends and family. The ability to understand and use symbols to learn, communicate, and guide behavior is one of the most important developments in human cognition (DeLoache, 1995a). From a very young age, we must learn to navigate a symbolic landscape full of artifacts that have the function of standing for or calling to mind something other than themselves. Some symbolic artifacts closely resemble what they stand for (e.g., a photo, a replica model, an emoji) and some do not (e.g., math symbols, alphabet letters). Symbolic artifacts that look like what they stand for would seem to be easy to figure out, but even these are surprisingly difficult for young children to understand.

Much of the research on children's early understanding and use of symbolic artifacts has been conducted within the context of a problem-solving game known as the object-retrieval task. For instance, a version of the task using a scale model requires that children infer where a toy has been hidden in a room by using their knowledge of where they see a small replica of the toy hidden in a scale model of the room (DeLoache, 1987; 1995a; 1995b). Aside from being the size of a doll house, the model is identical to the full-sized room it represents. Before the age of 3 years, children have great difficulty using a scale model to guide their search behavior (DeLoache, 1987; DeLoache & Burns, 1994; Troseth & DeLoache, 1998).

The key challenge to using a symbol such as a scale model as a source of information is the achievement of *representational insight*, the realization that there is a "stands for" relation between a symbolic object and the thing it stands for, or its referent (DeLoache, 1995a; 1995b). Representational insight can be an explicit understanding that the symbol stands for its referent, such as a when a grandmother uses video chat for the first time and realizes that the image of her grandchild on her phone is a live pictorial representation of what the child is currently doing. Insight can also be an implicit sense of relatedness; a 3-year-old child might notice that what the researcher does in the scale model gives information about events in the full-sized room, but may not be able to express or explain this symbolic relation in words (DeLoache, 1995a).

Achieving *dual representation*, or mentally representing both the concrete and abstract nature of a symbolic artifact simultaneously, is involved in the recognition of a symbolic relation. The achievement of representational insight is often complicated by the dual nature of symbolic artifacts. For instance, in order to use a scale model as a symbol, children must be able to represent it as an object with three-dimensional features (because that is where they see a hiding event); at the same time, they must represent the model as something intended to stand for the larger room. Because the miniature room is very interesting as an object, children under the age of 3 are often limited to contemplating the concrete nature of the model, a captivating object that they may interpret as a possible toy. The model's abstract role, its purpose to represent or stand for the larger room, typically eludes them.

A famous study that shows the importance of dual representation involves a search task that on the surface, looks very similar to the symbolic object retrieval task, but where children could succeed without representing a symbolic relation (DeLoache et al., 1997). In this study, researchers told 2.5-year-old children that a shrinking machine could shrink the full-sized room and toy (a troll doll). After being introduced to a troll doll and the shrinking machine, children listened from an adjoining room as the machine "shrunk" the doll. Upon returning, children found a miniature version of the doll. Then, children watched as the researcher hid the full-sized troll doll in the full-sized room. They went to the control room, listened from there as the machine was activated, and then were asked to return to the search space and recover the now shrunken troll doll from the shrunken room (scale model). If the children believed the researchers, on first seeing the model, they would think of it as *the same room*, only shrunken. The 2.5-year-olds no longer needed to contemplate the dual nature of the model or to understand the model as representing another room; rather the model *was* the room (only shrunken). Needing only to remember where the toy was hidden and recognize a furniture item (the current hiding place) when it changed size, children were highly successful on this search task. It is important to emphasize that when children succeeded, it was not through achieving dual representation of the symbolic object (the model). This task shows that success hinges on whether or not dual representation is required.

DeLoache and colleagues have demonstrated that the achievement of representational insight is influenced by several factors associated with 1) the symbolic artifact, 2) social support in the symbolic situation, and 3) the symbol user. Higher levels of one factor may make up for lower levels of another factor (Troseth et al., 2019). In the section below, I will outline two critical factors related to the symbolic object: symbol-referent similarity and salience of the symbolic artifact. Then, I will discuss the importance of social support in the form of adult instructions on how to engage with the symbol. Finally, I will discuss in more depth the key factor related to the child making sense of a symbolic object: their prior experience with symbols. Symbolization experience has been hypothesized to be the driving force behind age-related increases in success on symbolic tasks like the scale model task (DeLoache, 1995a; 1995b) and is a primary focus of the present research.

Factors Related to the Symbolic Object

For young children, physical similarity between a symbolic artifact and its corresponding referent plays an important role in the achievement of representational insight (DeLoache et al., 1991; Troseth et al., 2007). Children have an easier time detecting the relation between a symbol and its referent when there is a higher degree of *iconicity* or physical resemblance between the two. For instance, in the scale model object-retrieval task, the model contains miniature pieces of furniture that are made to highly resemble the furniture in the adjacent full-sized room in everything but size. The miniature blue chair in the model not only looks exactly like the full-sized blue chair, but it is also placed in the model to match the spatial orientation of the full-sized chair in the room.

Physical differences between the model and the full-sized room in the object-retrieval task can hinder young children from seeing the “stands for” relation between the two spaces. In her original 1987 study, DeLoache found that 2.5-year-olds were unable to use the knowledge of where they saw a toy replica hidden in a scale model to infer the location of a matching, larger toy in a full-sized room that the model represented. The large size difference between the two spaces made it difficult for children to recognize that there was a relation between the model and room. To the children, the model remained a simple toy unrelated to the living room. However, 3-year-olds were able to find the hidden toy despite the marked difference in size between the two spaces. This is not to say that older children do not also need a good amount of similarity between the scale model and room it represents. In one study, when the objects in the model did not look exactly the same as their larger counterparts in the room, such as if a small pink wastecan represented a full-sized tan basket, 3-year-olds struggled to understand the model-room relation (DeLoache et al., 1991). These studies demonstrate that perceptual differences between the furniture in the two spaces make it harder for young children to recognize the model-room relation.

In the standard scale model task, the surface similarities between the model and full-sized room – same spatial arrangement of the furniture across spaces and similar physical appearances of the corresponding pieces – help children map elements from one space to the other (DeLoache, 1995a). This mapping aids children in carrying over the relation between the toy and the hiding location from one space to another. The shift from detecting surface similarities to noticing the overall structural relation between two situations is an important general process in analogical learning (Gentner, 1989; Gentner et al., 2003). In the specific kind of analogy involved in early symbolic reasoning, physical similarity between a symbolic artifact and its referent serves to help children detect the higher order relation between the corresponding spaces.

Other research clarifies that when children succeed on the standard scale model task, they are not merely noticing correspondences between the large and small items. For instance, in one study, 2.5-year-olds were successful (80% correct) at matching the highly similar furniture pieces across spaces (Troseth et al., 2007). Even though children were able to map between corresponding objects across the two spaces, they failed to understand the meaning of those correspondences in the object retrieval task that they participated in immediately afterward (only

21% correct). In contrast, 3-year-olds used the similarities to recognize that what happened in the model stood for events in the room. Therefore, detecting the physical similarities between a symbolic object and its referent can support recognition of the “stands for” relation. However, correspondence detection is not a substitute for representational insight. Children must recognize a higher-level “stands for” relation between the model and room in order to make sense of the meaning of the correspondence and apply their knowledge of the hiding event across spaces.

Despite the value of iconicity in supporting early symbolic insight, the physical features of a symbolic artifact can in some cases obstruct the detection of a symbolic relation and the achievement of dual representation. For young children, symbolic artifacts can sometimes be too *salient,* or attention grabbing as objects, which distracts children from the abstract nature of the symbol (Troseth, et al., 2019). One of the affordances, or functions (Gibson, 1979; Troseth et al., 2019), of the scale model - its possibilities as a toy – can be quite distracting. The model is a small room containing miniature pieces of furniture, similar to a doll house or other small structure (toy garage, barnyard) that children may have experience playing with. The toy-like pieces may draw attention to the physical features of the scale model and away from its representational nature. In one study, 3-year-olds were allowed to play with the scale model for 5 to 10 minutes prior to the standard scale model task (DeLoache, 2000). These children then struggled to use the hiding event in the model to infer the location of corresponding larger toy in the room. The concrete nature of the model became a focal point during play and overshadowed its abstract “stands for” nature.

Symbolic objects with less salient physical features present less of a challenge for young children. For instance, when the model was placed behind a window and kept out of reach of the children, 2.5-year-olds could succeed on the scale model tasks (DeLoache, 2000). Putting a physical barrier between the child and the symbolic object seemed to give the children psychological distance from the object, reducing the impact of the symbolic object's salience and allowing them to focus attention on the object's novel symbolic role in the search task.

Children over the age of 2 have an easier time using 2-dimensional symbolic artifacts when compared to 3-dimensional ones. Pictures (line drawing and photographs) appear to be less distracting as objects than a scale model: their main function is to be looked at and to provide information, rather than to be handled and played with. When shown a photograph of where the toy was hidden, 2.5-year-olds were quite capable of finding a hidden toy in the retrieval task (DeLoache, 1987). This difference in the ease with which children will consider photographs as representations, compared to 3-D objects, can be seen even in late infancy. If a researcher showed children between the ages of 12 and 18 months a photo of an object and pointed towards it (contemplative stance), children were more likely to simply look at the photo than to try to grab it. If the researcher manipulated (jiggled and shook) the photo (exploratory stance), children were more likely to try and grasp, slap, and rub the photo. However, the same was not the case for 3-D objects: regardless of the stance the researcher modeled, the infants manually explored the toys. The infants seemed focused on getting their hands on the 3-D objects and manipulating them. Between 12 and 18 months, infants took on either a "contemplative" or "exploratory" stance towards photographs depending on what was modeled for them (Callaghan et al., 2004). These results demonstrate the important role that social partners play in helping children make sense of how to engage with symbolic artifacts.

Instructions from Social Partners

Because very young children focus on the physical affordances of objects, the majority of very young and inexperienced symbol users require explicit instruction from an experienced social partner to make sense of the relation between a symbol and its referent (Marzolf et al., 1999). For instance, during the scale model task, the researcher gives children an extensive orientation to the model and the full-sized room. She draws attention to the physical and spatial correspondence between the full-sized floral couch in the middle of the room and the miniature floral couch in the middle of the scale model. Through direct instruction children may detect important similarities, as well as disregard irrelevant differences such as size (DeLoache, 1995a). As children are prompted to compare the various components of each space, they may begin to simultaneously represent the concrete and abstract nature of the scale model and recognize the overall symbol-referent relation between the model and the full-sized room, thus achieving representational insight (DeLoache, 1995a). For example, when 3-year-olds are given explicit instructions that emphasize the similarity between the room and its model, they are quite successful at using information from the model to find the hidden toy in the larger room. In contrast, when the correspondences between the model furniture and full-sized furniture are not pointed out, 3-year-olds typically struggle with the scale model task (DeLoache, et al., 1999). Direct instruction may help children attend to surface similarities and to map elements from one space to the other, which can support the achievement of representational insight.

Instructions also serve to highlight an individual's intent to use a symbolic artifact to communicate information. For example, Sharon (2005) added two additional instructions to the standard scale model task that were meant to make the intent of the experimenter and the purpose of the model even clearer. While introducing 2.5-year-old children to the model and the miniature toy that would be hidden, the experimenter explained that the model was made to help the child find the larger toy in the room. Then, prior to the test trials, the experimenter explained that she would help the child find the bigger toy by showing the child where the little toy was hidden. With the additional instructions 2.5-year-olds (who typically struggle with the standard model task) were significantly more successful. Instructions that emphasize the intent of the researcher to use the model as a form of communication can help draw attention to the novel, abstract role of this symbolic artifact and support children in recognizing the symbolic relation.

Symbolization Experience

Besides aspects of the symbolic object itself (iconicity and salience) and instructions from a more experienced symbolizer, another important factor in a child appreciating a particular symbolic relation is their cumulative experience with various symbolic objects and symbol systems (DeLoache, 1995a; 1995b). Long before formal schooling, many children play with alphabet magnets and count along with shows like *Sesame Street*, watch their older siblings draw pictures and their parents write shopping lists, play with toy replica animals, dolls, and vehicles, and spend countless hours flipping through picture books. These varied symbolic experiences across childhood lead to a developmental shift in which children become more sensitive to novel symbolic relations.

Experience with pictures is common in the lives of infants and young children in modern industrial societies (Callaghan et al., 2011; DeLoache & Burns, 1994; Walker et al., 2013). From birth, many children are exposed to images on their clothes and highchairs, in family photos on the walls, on the TV set and computer screen, on product packages, and in books and magazines. Most children and their parents spend countless hours interacting with picture books, learning new words and concepts. Through pictures, children learn about things they have yet to experience in life, such as different dog breeds or types of construction vehicles, as well as imaginary creatures they will never encounter in life. The representational nature of pictures may seem transparent, but making sense of various images and their relation to reality is a challenging task. Infants have to develop “pictorial competence” that includes perceiving, interpreting, understanding, and using pictures (see Troseth et al., 2004).

Between the ages of 9 and 18 months, infants begin to treat pictures as a special class of objects. Younger infants grasp at objects depicted on pictures or videos (that is, they appear to treat the images like real objects). For example, younger infants may attempt to grasp at a mechanical snail as it moves across a screen (Pierroutsakos & Troseth, 2003). By 18 months, they point at the objects depicted on the 2D surfaces instead (DeLoache et al., 1998; Pierroutsakos & DeLoache, 2003; Pierroutsakos & Troseth, 2003). Over time, manual exploration decreases as children develop their understanding of the affordances of 2D images—that while the depicted objects look real, cues to 2-dimensionality (lack of depth cues: motion parallax, etc.) that infants can perceive indicate that these entities are flat images. Experience attempting to interact with 2D images teaches very young children that they cannot play with the depicted objects in the same manner as the real things the images represent. Experiments that tap into children’s prior symbolic experience, in which a researcher names the contents of pictures (similar to what parents do when reading picture books) demonstrate that the understanding that pictures are representations of real objects begins to appear in the second year of life (Ganea et al., 2009; Preissler & Carey, 2004)

As children gain more experience with a variety of symbol systems and artifacts, they develop a general readiness to detect symbolic relations, referred to as *symbolic sensitivity*

(DeLoache, 1995a). Children are exposed to images in picture books and on TV, pretend play with objects, and small replicas of larger objects from an early age. But these experiences alone are not sufficient to increase symbolic sensitivity. Specific experiences interpreting an object as something other than itself prepares children to respond to the abstract rather than concrete nature of new symbolic artifacts (DeLoache, 1995a).

Although young children probably come to the lab with substantial experience with picture books, drawing, and other common symbolic material, it is still very challenging for them to understand and use a *novel* symbolic relation. For instance, 2.5-year-olds enter the scale model task with extensive experience interacting with miniature replicas of larger objects. Toy trains, cars, houses, and animals are just a few of the object's children of this age may already have played with extensively. However, very young children have probably never been asked to use a model room to stand for a particular, real place.

As a strong test of the idea that symbolization experience can lead to representational insight, researchers have given children specific, targeted experience in the lab that might help them understand a new and difficult symbolic relation. Specifically, some studies have demonstrated that experience with an easier symbolic relation can mitigate the challenge of understanding and using a more difficult one (DeLoache, 1991; Marzolf & DeLoache, 1994). Recall that although 2.5-year-olds typically struggle to use a scale model of a room as source of information in the object-retrieval task, they are quite good at using a *picture* of a hiding location in the room to find a hidden toy (DeLoache, 1987). If 2.5-year-olds are given successful experience with the picture version of the retrieval task first, they are capable of using a scale model afterward to find a hidden toy (DeLoache, 1991). The experience using a symbolic relation that 2.5-year-olds already appreciate (i.e., the connection between a picture of a room and the actual room) appeared to support success with a more difficult relation (between a scale model and the room) that they typically do not appreciate.

Just as with pictures, 2.5-year-olds can transfer representational insight from a version of the model-room relation they appreciate, to one they do not. In one study, researchers first gave children experience on a version of the retrieval task in which the scale model and search space were closer in size, with a ratio of 1:2 (Marzolf & DeLoache, 1994). Essentially, the search spaces were two scale models that differed much less in size than the original scale model differed from the room. This task may have been easier for children because both spaces shared even more physical similarity (i.e., appearance and size of the furniture). Also, children may have viewed the two models as “the same kind of thing” (two “dollhouses”) and more easily saw that the researcher used what happened in one to stand for what happened in the other. Even though children’s interest in the two “toy-like” rooms as objects may have been high, another factor (increased similarity) could help children to see a novel “stands for” relation between objects and events in the two spaces. After succeeding on the similar sized model task, the 2.5-year-olds were then able to find a hidden toy using the standard sized (1:16 scale) model-room relation. Their prior symbolic experience helped them to re-interpret the function of the scale model in the standard object retrieval task. Children were even able to transfer their insight from the similar sized model-room relation to a more difficult map-room relation.

The majority of studies exploring transfer of symbolic comprehension from one symbolic relation to another have done so within the context of the object-retrieval task (Marzolf & DeLoache, 1994; Troseth et al., 2019). This design employs the easy-to-hard transfer paradigm used in research on analogical reasoning in young children (DeLoache et al., 2004). In general, analogical transfer occurs when knowledge is mapped from a familiar to an unfamiliar example

(Gentner, 1989; Gentner et al., 2003). Transfer is facilitated by what Gentner (1989) called "structural alignment and mapping"; seeing a connection between individual elements of the first and second examples (the "base" and "transfer" cases) helps the learner to see the overall parallel structure of the two situations and to transfer insights across cases. In most studies exploring the transfer of insight from one symbolic relation to another, both the task that gives children experience, and the harder task involve different versions of the object-retrieval task. The objects in both task versions (e.g., pictures or miniature pieces of furniture and corresponding full-sized items of furniture) are always presented in a similar spatial arrangement, they are perceptually similar (e.g., the pictured piece of furniture and the small object of furniture are both the same color as the large version) and they are used as hiding places for the same game. The surface similarities between the two situations therefore may facilitate the detecting of a new symbol-referent relation that would otherwise go unnoticed by the child. However, holding constant the context in which two different symbolic relations need to be used limits our understanding of what is being transferred (Barnet & Ceci, 2002; Marzolf & DeLoache, 1994). Children might merely have gained an appreciation for object correspondences in the search task, or they might have transferred representational insight across the two versions of the search task, or both.

To date, few studies have explored transfer of insight across situations that do not share a common context. Those studies have also primarily focused on younger children's use of information from video (Troseth, 2003; Troseth et al., 2006). For instance, Troseth (2003) had a group of 2-year-olds watch themselves "live" on their family television at home while they played with toys over a span of two weeks, before they came to the lab. The most important component of the study was that the in-home experience was not directly related to the search task they would do in the lab. At home, children were able to watch as their own actions were displayed “live” on a TV. Every time they moved or made a face, there it was on the TV screen. Following the in-home video experience, children were tasked in the lab with using a live video presentation of an adult hiding a toy in an adjoining room to find the hidden toy. Children watched a monitor that displayed the actions of a researcher they had just met, in a room the children had just explored. Children then had to apply the information they saw on TV to find the hidden toy. If children learned something about the relation between a video and reality at home, they then had to apply that insight to a new context in the lab. The group of children who experienced live video at home performed much better than children who played with the same toys for two weeks at home but did not get the relevant video experience. Most of the children in the home video experience group were also successful the next day in using small photos for information about the hiding location of the toy—even though they had not received any special experience with pictures and this task typically is very difficult for 2-year-olds (e.g., DeLoache & Burns, 1994).

Subsequently, Troseth and her colleagues (Troseth, Casey et al., 2007) showed that children’s everyday experience with live video (e.g., being exposed to live video on the LCD flip-screens of parents’ video cameras during the filming of home videos, and to live video on security monitors in stores) was related to children’s success in the video and picture versions of the object retrieval task in the lab, after controlling for family SES and children’s expressive vocabulary. Also, emerging graphic symbolization at home (children *pretending to* or *actually* writing words and drawing pictures) was related to children’s success at the video object retrieval task.

The findings by Troseth (2003; Troseth, Casey et al., 2007) demonstrate that experience that helps clarify the symbolic relation for children – such as video that clearly represents current reality, specifically live video of oneself – could be transferred across contexts (from home to lab) and tasks (from playing with toys to the retrieval task). In analogical terms, seeing live video of oneself is an optimal situation in which children could align the representation with reality. Children were in control of what could be seen in the representation (the image on the screen) and they could change the representation by changing the represented event (what they were doing). This special experience helped children generalize the idea that another video of someone else (the researcher they had been introduced to) hiding a toy in a room they had just been familiarized with – a different context than their home – could represent a real event.

However, it remains to be seen if providing children with symbolic experience outside the object-retrieval task can help them understand a more difficult symbolic relation such as the connection between a 3-dimensional scale model and the room it represents. As described earlier, a scale model is a very salient physical object, and children may represent it only as a captivating toy, not as a symbol for something else. Thus, the goal of the current study is to examine if giving 2.5-year-olds symbolic experience with objects in the context of a different game can support their achievement of representational insight with a scale model in the object-retrieval task. Study 1 describes the development of a training task meant to give children targeted symbolic experience outside of the context of the object-retrieval task. Study 2 explores the effect of two version of the training task on search performance in the scale model object-retrieval task.

CHAPTER II

STUDY 1 OVERVIEW

The aim of the current study is to expand on research examining 2.5-year-olds' transfer in the symbolic object-retrieval task. The training component in this study does not use the object retrieval problem-solving context. If children transfer what they learn from these dissimilar training tasks to the new context, this result will suggest that they achieved deep representational insight that can generalize across contexts.

Study 1 describes the development of two training tasks to give children experience with symbols (pictures, symbolic actions, and 3-D objects) and their referents, and exposure to the intent of the researcher to use the symbols for the purpose of communicating some goal. The training tasks were adapted from the "comprehension of objects as symbols" tasks created by Tomasello and colleagues (1999). These tasks were developed by the original authors to determine if children understand that an object or pretend gesture (symbolic actions) can be used as a symbolic representation of another object. In Study 1 of the current research, *symbolic object training* was based on Phase 1 of the Tomasello et al. procedure. The researcher asked the child to pick out an object (e.g., a comb) from a set of full-sized objects by showing the child a smaller replica of the target object (e.g., a tiny comb)—an object that children may perceive as "a toy." *Symbolic transformation training* was based on Phase 2 of the same procedure. The researcher first showed the child a cup (an object the child already knew how to use) and then pretended to use the cup as a different object (i.e., as a hat, by putting the cup on her head).

During testing, the researcher used a real hat to request that the child give her the cup – the "pretend hat" that had been symbolically transformed by the adult.

These communication tasks involve similar representational demands as in the object retrieval task: children must understand that when the researcher shows them a tiny toy hiding in a particular place in the scale model, she intends to convey where the large toy will be hidden in the room. Unlike the object-retrieval task, however, the "comprehension of objects as symbols" tasks are meant to assess a child's ability to detect a symbolic relation in a situation with *reduced complexity and cognitive load*, achieved by: 1) removing the need to map multiple objects and locations (i.e., the small toy, hiding events, and furniture in the model with the corresponding larger versions in the room) by presenting single objects as symbols of other single objects, and 2) presenting a simple representational problem without a delay rather than the search task with multiple steps and a brief delay before searching in another room (Tomasello et al., 1999).

In the symbolic object training, children must focus on matching the identity of the replicas and full-sized objects and attend to the researcher's intent to request the full-sized version by holding up the miniature. Children must realize that in the context of the researcher's request, the miniature toy comb "stands for" what the researcher wants (the full-sized comb); this requires that children not become fixated on the toy comb solely as an enticing object. Tomasello and colleagues (1999) reported that 26- and 35-month-olds reached for the miniature object the researcher displayed on 45% and 53% of the trials respectively, rather than selecting from the full-sized ones in front of them; nevertheless, they found that both age groups picked the correct object around 60% and 80% of the time respectively when shown its corresponding miniature. Therefore, we expected that 2.5-year-olds would have a fairly easy time with the symbolic object training.

Symbolic object training may help children gain insight into the symbol-room relation during the model task because practice using individual replicas as symbols, and detecting the researcher's intention in displaying a replica in a communication task, is less complex and cognitively demanding than in the scale model task. It might clarify the intention of an adult to have children look beyond the concrete features of a miniature object and to "see" it in a new role, as standing for another object. Alternatively, the training may merely focus children on correspondence detection, which on its own is not enough to support the achievement of representational insight and children's successful searching in the room (Troseth et al., 2007).

Symbolic transformation training requires that children ignore the concrete properties and affordances of a real object, in order to make sense of the abstract, symbolic, "pretend" role that the researcher has given to the object. The difficulty of this task is much higher than in the symbolic object training task because it requires that children use an object such as a straw with a known conventional use (e.g., to drink out of) as a symbol for another object. Training with the transformation task greatly reduces physical resemblance between the symbol and its referent, making it more difficult for children to detect the symbolic correspondence between the object pairs. Success requires appreciation that the symbolic role of the object is determined by the person using it (i.e., the researcher). Children can only succeed if they comprehend the intent of the researcher to communicate information using the object she holds up, as well as recognize the symbolic correspondence between two dissimilar objects. If children are successful in identifying the transformed objects, they will gain practice with a more complex symbol-referent relation outside the context of the object retrieval task.

The symbolic transformation training may also have more in common with the scale model task. The scale model has an established function when children see it—they interpret it as a toy. Similarly, the objects being transformed already have clear established functions (e.g., the straw is for drinking). Because children have an established function for the model, they need to achieve dual representation and see it as having a different (symbolic) function. This is also required for children to succeed with the transformation task.

Tomasello and colleagues reported that 35-month-olds, but not 26-month-olds, were able to succeed on the symbolic transformations task (around 60% and 30% correct respectively). Thus, it was not clear if the task would be too difficult for the 2.5-year-olds (mean age = 30 months) in the current study or if it could serve as a useful training task. In the case that the transformations proved to be too difficult, a third training task was included which provided a transition from easier to more difficult symbolic relations. This *scaffolded training* began with symbolic object training, followed by transformation training. The idea for this training condition was based on research showing that children can successfully use a difficult symbolic relation after experience with a symbol they already appreciate.

The goal of Study 1 was to determine whether 2.5-year-olds would succeed on one or both training tasks, in order to use them to support children's symbolic understanding in the object retrieval task in Study 2. Additionally, Study 1 was intended to replicate DeLoache's (1987; 1991) scale model procedure and results with 2.5-year-old children in our lab, several decades after DeLoache first demonstrated the challenge of this task. Thus, Study 1 provided a baseline of current performance in this task by this age group. Therefore, children participated in the scale model task before completing our pilot testing of one of the training tasks. This age range was selected because it included the period in which children struggle the most with the scale model task and would be the most likely to benefit from a training task meant to support the achievement of insight with scale models.

Methods

Participants

Participants were 12 children (6 Males) between 29.2 and 33 months (M = 30.87 months; SD = 1.29 months). Children were randomly assigned to participate in DeLoache's standard scale model object-retrieval task followed by a pilot test of one of the three training tasks. The retrieval task data for one child (Female, 31.6 months) was dropped from the study due to experimenter error (the family had recently come in to demonstrate a similar procedure for the filming of a documentary). Participants were recruited via phone and email using the Vanderbilt Department of Psychology and Human Development participant database. Children were given a book as a thank you for participating and parents were compensated for their time with a $10 electronic gift card.

Children who participated had normal hearing, no developmental delays, and were learning English as their primary language. The vast majority of parents identified their child's race as white (91.7%); one parent chose not to disclose this information. None of the parents identified their children's ethnicity as Hispanic. The mean and median level of joint education of the participating parents was "some graduate work," with the sample ranging from "some college/associates degree" to "doctoral degree." The mean household income bracket was $75,000– $100,000, the median was $100,000– $150,000, and the sample ranged from "$30,000" to "over $150,000."

Figure 1

Scale Model Task Apparatuses

Scale Model	Full-sized Room

Measures

Scale model object-retrieval task

Materials: The study took place in two adjoining rooms, a control room and the search room. The entire session was recorded with two video cameras (one in the search room and one in the control room). The objects to be hidden were two toys: a 21.6 cm-tall stuffed Piglet and a 4.5 cm-tall miniature Piglet. The search room measured approximately 6.8 x 3 x 2.7 m. The room featured a round table with a green tablecloth, a sofa with a red blanket placed on it, a blue armchair, a wooden end table with a straw basket on top, and a white pillow, arranged around the walls opposite the doorway where the child would enter.

A scale model of the search room (60.9 x 40.6 x 30.5 cm) was placed on a table in the control room, aligned in the same spatial orientation as the search room. It was constructed of plywood, open at the top and front for easy access, with the furniture arranged around the walls in the same spatial arrangement as in the full-sized room (see Figure 1). The model duplicated the main features and furnishings of the room, including carpeting, the color of the walls, and all the items of furniture. The model furnishings were perceptually similar to their counterparts (e.g., covered with or made of the same material) except for size. The size ratio of the model to room was approximately 1 to 11, which was similar to other versions of the standard model task (see DeLoache, 1987; 1991; Marzolf & DeLoache, 1994).

Procedure: Families visited the lab for one 30-minute session. While children played with toys and met the researcher, parents completed a brief demographic questionnaire. After becoming acquainted with the researcher, children were given an extensive orientation designed to emphasize the correspondence between objects and events in the search room and the model. The researcher began by introducing the children to the larger stuffed animal and room (the search space): "This is Big Piglet, and this is his big room; Big Piglet has lots of things in his room." The researcher named all the items of furniture in the search room. The child was then introduced to the miniature toy and the scale model: "This is Little Piglet, and this is his little room. He has all the same things in his room that Big Piglet has." The researcher again labeled each object within the scale model. She then demonstrated the correspondence between the pieces of furniture in the two spaces by carrying the items of furniture from the model into the room and holding each up to its counterpart: "Look – this is Big Piglet's big basket, and this is Little Piglet's little basket. They both have baskets. Only Big Piglet's basket is big, and Little Piglet's basket is little." Next, the researcher tried to convey the idea that actions within one space have a corresponding action in the other space through a placement trial. She explained to the child that, "Big and Little Piglet like to do the same things. Whatever Little Piglet likes to do in his little room, Big Piglet likes to do the very same thing in his big room. Little Piglet is going to sit right here." As the researcher said this, she placed the miniature toy on the white pillow in the model and requested that the child place the larger stuffed animal in the appropriate position in the search room: “Now you take Big Piglet to his big room and help him sit in the same place as Little Piglet.” Parents either accompanied their child moving between the rooms or sat in the control room completing their paperwork.

Following the orientation and placement trial were four *symbol-based hiding and retrieval trials.* Before each trial, the researcher called the child's attention to the act of hiding the miniature toy in the model, but never referred to the hiding place by name: "Look, Little Piglet is going to hide right in/under here." On each trial, the miniature toy was hidden in a particular, different location in the model (under the chair, in the basket, under the couch blanket, and under the tablecloth on the round table) while the child watched. Then, the researcher told the child, “I’m going to go hide Big Piglet in the same place in his big room.” She left the control room and went into the search room, closing the door. She hid the stuffed animal in the room while an assistant in the control room reminded the child of what was going on: "Now [researcher] is going to hide Big Piglet in his Big room." Then the researcher returned and told the child, “Remember, Big Piglet is hiding in the same place as Little Piglet. Go find him!” If the stuffed animal was not found on the first search, the researcher encouraged the child to keep searching, providing increasingly explicit hints to ensure that the child successfully recovered the toy. To maintain motivation, the child was always shown the correct hiding location at the end of the trial, if they failed to retrieve it on their own. Parents were asked to not give their child any verbal or nonverbal hints, particularly if they needed to encourage their child to participate (e.g., by walking into the search room with the child).

The child was then asked to complete a *memory-based retrieval* by returning to the model and showing the researcher where “Little Piglet” was hidden. This served to determine if the child was able to recall the hiding event in the scale model that they had watched. If so, any failure to retrieve the larger stuffed animal from the search room could not be attributed to lack of memory for the hiding event or motivation for searching for hidden toys.

Scoring: Scoring was done for both the symbol-based and the subsequent memory-based retrievals. Individual trials were scored as correct if the child first searched in the appropriate hiding location without any prompts. Any perseverative searching was noted; a perseverative search on Trials 2-4 occurred when a child's first search was at the location that had been correct on a previous trial. For this and subsequent tasks, the assistant made a record of children's search behavior during the session on a data sheet; a second coder watched 20% of the videos of the sessions to independently score the children's choices and showed 100% agreement. Disagreements between the live and video coding were discussed and resolved by the video coder and primary investigator.

Pilot Test of Training Tasks

Materials: The materials and procedure closely followed those described by Tomasello et al (1999). The apparatus was a small wooden slide 30.5cm in height with platform at the top where a rectangular container would sit and hold objects arranged in a line, as well as a bucket at its base to catch them (see Figure 2). This setup was similar to the chute used in the original 1999 study. Seeing objects go down the slide was expected to be a highly engaging and motivating activity for children.

Part way through pilot testing, we replaced the slide with a wooden viewing box with a plexiglass window above a rectangular opening through which children would be asked to pass target objects. The viewing box, placed in the doorway between the control room and the search room, served to separate the researcher and the researcher's objects from the child. More details are reported below.

Figure 2

Training Task Apparatuses

Slide	Viewing Box
	

Object sets are shown in Figure 3. A practice set of objects (red block, frog hand puppet, plastic dinosaur, and plastic horse) was used to introduce the child to "the slide game." For symbolic object training, four full-sized target objects and corresponding miniature replicas were a mitten, a brush, a book, and a squirt bottle. Each replica was the same color as the matching larger object. For symbolic transformation training, four target objects were a straw (used as a crayon), a tissue box (used as a shoe), an 8oz measuring cup (used as a hat) and a white ball (used as an apple). The related objects the researcher used to request the transformed object were a crayon, shoe, hat, and plastic apple.

Figure 3

Study 1 Object Sets

Requested Target Objects	Researcher Displayed Symbolic Objects

Note. Object sets used in Study 1, from top to bottom: practice objects, full-sized objects and corresponding miniature replicas, and related objects.

Procedure: The training tasks took place in the middle of the search space used for the object retrieval task. Each child was tested individually, in the presence of their parent. Parents were told they could encourage their child to give the researcher an object but should not label any objects or help their child succeed in any way. All participants began with the practice phase, followed by their randomly assigned training task (see Table 1), described below.

Table 1

Study 1 Training Tasks

Requested Target Objects	Researcher Displayed Symbolic Objects		
	Symbolic Object Training	Symbolic Transformation Training	Scaffolded Training
Mitten, brush, book, bottle	Replicas		Replicas
Straw, tissue box, cup, ball		Related Objects	Related Objects

Note. The symbolic object and symbolic transformation trainings included 4 trials, in order to request each target object once. The Scaffolded training included 8 trials, in order to request each target object once.

The child stood at the top end of the slide, while the researcher sat at the bottom end. An assistant who was present throughout testing helped to manage the various object sets and record the child's object choices. Boxes containing the object sets were kept out of reach of the child. The researcher always introduced the child to the target objects by taking them out of the box one at a time, demonstrating the action associated with it (depending on the condition), and placing it in a rectangular container. Once the child was introduced to all four target objects in a set, the researcher placed the container on top of the slide, accessible to the child, to begin the game. She asked the child to push objects down the slide one at a time, in a different way for each condition (as described below). The child was always tasked with figuring out which one of the four objects on the platform the experimenter wanted and sliding it down into the bucket. After the child selected and slid a target object, it was put back into the container on top of the slide for the next trial, so the child was always selecting from an array of 4 objects. The order in which the 4 objects in a set were held up by the researcher was random and no object was ever in the same position in the child's container more than twice in a row.

Practice phase: The researcher first introduced the child to the "slide game" by demonstrating how the practice objects should be pushed down the slide. Then the researcher placed the set of four practice objects in the container on the platform connected to the top of the slide. She asked the child to push objects down the slide *by name* one at a time. Children only moved on to the testing phase after correctly pushing down three objects in a row without help. The researcher gave the children multiple opportunities to successfully push three objects down the slide in a row. This phase was meant to ensure that children understood the instructions and were given time to practice. The researcher then introduced children to the first set of target objects, depending on the training condition.

Symbolic Object Training: The researcher first introduced the child to the set of four full-sized target objects (mitten, brush, book, squirt bottle). She held each item up, used it in its conventional fashion (e.g., putting on the mitten), and placed it back into a container out of reach of the child. She then placed the container on the platform at the top of the slide. Following Tomasello et al.'s procedure, the researcher indicated which item she wanted pushed down the slide by saying, *"push me the ___" or "give me the ___" and holding up a small replica of the target object (without labeling the object).* Thus, the replica that was displayed represented the full-sized object in the child's container, and displaying the object took the place of its name in the sentence. This phase was meant to present the most straightforward representational relations, between full-sized and miniature replica objects.

Symbolic Transformation Training: The researcher introduced the child to a set of four target objects (drinking straw, tissue box, measuring cup, and ball). She held each item up, used it as something other than itself (symbolically transformed it), and placed it back into a container out of reach of the child. The four target objects and the symbolic actions demonstrated by the researcher were: 1) a straw (used as a crayon by "drawing" on her hand), 2) a tissue box (used as a shoe by putting it on her own foot), a cup (used as a hat by putting it on her own head) and a ball (used as an apple by pretending to "bite" and "eat" it). Following these four symbolic transformations of objects, the researcher placed the container containing the objects on the platform attached to the slide. The crucial change in the transformations phase was that the researcher held up a new object (the related objects) that exemplified *what the target object had been symbolically transformed into*, to request the target object she had acted upon. Thus, she held up a crayon to request the straw, a shoe to request the tissue box, a hat to request the cup, and an apple to request the ball. This phase was more difficult: children were asked to use objects with conventional uses (e.g., a straw) as representations of other objects (a crayon).

Scaffolded Training: The researcher simply combined the two previous training tasks. Following the practice trials, the procedure always began with symbolic objects training, followed by the symbolic transformation training. Part way through pilot testing, more extensive scaffolded training was implemented. This training procedure included simple symbolic relations that might help children to gradually understand more challenging ones. First, the researcher held up a picture of an object she wanted the child to pass through the viewing box (4 trials). Next, the children completed the symbolic object training. For the next set of four trials, the researcher gestured the action appropriate for the object she wanted (also from Tomasello et al., 1999 procedure). For instance, the researcher pretended to use a straw as crayon by "drawing" on her hand. She then demonstrating the "drawing" action during the testing to request the straw. Finally, the children completed the transformation training.

Scoring: Scoring was done in the same manner as reported by Tomasello et al. (1999). The child's object choice on each trial was operationalized as the first object the child sent down the slide, regardless of what other objects the child touched. Sending down the incorrect object or refusing to choose an object for over 1 minute was counted as incorrect for that trial. On trials where multiple objects were sent down the chute, the trial was repeated and only the re-trial was scored. For this and subsequent tasks, the assistant made a record of children's search behavior during the session on a data sheet; a second coder watched 20% of the videos of the sessions to independently score the children's choices and showed 95% agreement. Disagreements between the live and video coding were discussed and resolved by the video coder and primary investigator.

Results and Discussion

Scale model object-retrieval task: The dependent variable on the retrieval task was the number of errorless retrievals, operationalized as trials on which the child searched first in the correct place without a prompt. Percentages are reported along with proportions in both studies to facilitate comparison to previous studies. Mean level of performance on the symbol-based retrieval was 30% (M = .30, SD = .29). The children's level of successful search was not above chance, $t(10)$ =. 516, p = .617 (all tests were two-tailed, chance = .25, based on the four hiding places labeled during the orientation). Memory-based retrieval performance was much higher, with success at 57% (M = .57, SD = .28), and well above chance performance ($t(10)$ = 3.83, p = .003). The result of the symbol-based retrieval was consistent with those from previous studies employing the standard or slightly modified versions of the scale model task of 15 to 25% (see Sharon & DeLoache, 2003). However, the memory-based retrieval was lower than the over 80% success rate reported in other studies (Sharon & DeLoache, 2003). Even so, participants in Study 1 were able to retain the memory of where they saw the smaller toy hidden in the scale model.

However, they struggled to use that information to infer the hiding location of the larger toy in the full-sized room. As expected, children struggled to achieve representational insight into the model-room relation. Poor performance was also not attributed to a lapse in memory, given that children were still quite successful at remembering where the smaller toy was hidden.

Performance patterns over trials were examined to determine if children achieved insight at any point during the scale model task. Because individual trials are categorical in nature (correct or incorrect), I used McNemar's test, a nonparametric measure used for correlated, categorical data. The test determines whether changes between datapoints are equal or not. The change in between trials 1 and 2 on the symbol-based retrievals was not significantly in the direction of correct to incorrect or vice versa ($p = .375$). Nor was there a significant change from trials 2 to 3 ($p = 1.00$) or 3 to 4 ($p = 1.00$). No significant changes between trials were found for the memory-based retrievals. The performance patterns over trials indicate that, in general, children were unable to achieve insight at any point during the scale model task. Successful searching started off low on trial 1 and continued to remain low on each subsequent trial. Only 3 out of 11 participants were right on 3 of the 4 trials.

Training Task: Initial piloting of the training task procedures proved to be challenging. During the practice, the first four participants (one in symbolic object training, one in symbolic transformation training, and two in scaffolded training) successfully demonstrated their understanding of the game (in the practice trials) and of the researcher's intent to have them push requested object down the slide. The three children tasked with using the replicas displayed by the researcher to determine the correct full-sized target object had an overall success rate of 66.7%. However, only one child succeeded on all four trials, while the other two succeeding on only half of the trials. The three children tasked with using the related objects (referents for the transformations) the researcher held up to determine the correct target object struggled (16.7% correct), with the highest score across four trials being one.

Of interest, children demonstrated a similar pattern of behavior in both training tasks: during testing, they consistently attempted to reach for or grab *the object the researcher was holding* rather than the objects in front of them while the assistant and parents tried to keep the children on their side of the slide. Several of the children responded with, “I don’t have that one,” when the researcher asked the children to “push me the __” while holding up the replicas or related objects. Given that Tomasello et al. (1999) reported both 26- and 37-month-olds were above chance in their performance with the replicas, it was not expected that 2.5-year-olds in Study 1 would struggle with the replicas, as shown by the two participants who picked incorrectly on half of their trials. Because the goal was for children to be successful on the training tasks in order to examine their effect on search task performance in Study 2, several changes were implemented.

The practice phase was updated to more closely match the testing procedures in an attempt to make the structure of the game clearer. Children were told that the researcher had her own box with her objects in it and that the child had their own box with identical copies of the practice objects. Then, the researcher held up one of the objects from her box and instructed the child to push down the slide the same object but from his or her box. The experimenters also attempted to focus the children on the objects in front of them by saying, “push me or give me the ___ *from your bucket*.” The expanded practice phase and more elaborate instruction during testing were implemented with three participants (one symbolic transformation, two scaffolded training). The updated instructions did not improve the performance of the two children tasked with using the replicas to determine the correct target object (37.5% correct) or the three children who used the related objects (0% correct); instead, children continued to try to get to the object the researcher displayed, showing that they did not understand her intention to communicate with children about the items in front of them.

The consistent reaching and grasping for the objects in the researcher's hand demonstrated that 2.5-year-olds were struggling to deal with the salience of the objects held up by the researcher and were not understanding them as representations. Recall that DeLoache (2000) successfully reduced the salience of the scale model as an object by placing it behind a window and keeping participants from touching it. Physically distancing 2.5-year-olds from the model redirected their focus away from the concrete nature of the symbolic artifact. For that reason, we replaced the slide with a wooden viewing box with a plexiglass window above a rectangular opening through which children would be asked to pass the target objects. The viewing box, placed in the doorway between the control room and the search room, separated the researcher and the researcher's objects from the child; the rationale was to simultaneously reduce the salience of the objects the researcher held up behind the window, and further emphasize her intent to use the displayed object to represent an object in the child's container.

Additionally, a new version of the scaffolded training procedure was designed to include simple symbolic relations that might help children to gradually understand more challenging ones. First, the researcher held up a *picture* of an object she wanted the child to pass through the viewing box. Next, the children completed the symbolic object training. Third, the researcher *gestured* the action appropriate for the object she wanted (also from Tomasello et al., 1999 procedure). Lastly, the children completed the symbolic transformation training.

The new Scaffolded Training was piloted with five participants. Three children used the pictures to determine the correct target object and were correct on all their trials (100%). All five children were also very successful at using the replicas objects (95% correct). Most children who used the symbolic actions to select the target object were also very successful (81% correct overall), with three children getting all four trials correct (one other child succeeded on only one trial). All five children used the related objects but the success rate overall was 48% correct: three children had great success (lowest score of three) but two still struggled (highest score of one). The new scaffolded training procedure appeared to support many of the children in understanding the researcher's intentions in displaying both iconic (replicas) and non-iconic (related objects) symbols.

When participating in the original procedure used by Tomasello et al. (1999), the 2.5-year-olds in Study 1 (with the exception of one child) struggled to use miniature objects to represent their full-sized counterparts. The small sample size of this pilot study may have been a factor in the low performance with replicas when compared to the success of 26-month-olds in the original study. However, four out of five children who used the replicas with our replication of Tomasello's slide game struggled to understand the task. This would suggest other factors were responsible for the discrepancy between the two studies. Specifically, the results of Study 1 indicate that children under the age of 30 months still have a very difficult time understanding 3D objects as symbols for other objects, including highly iconic objects like replicas.

Only with a number of adaptations were the children successful in Study 1. Several children completed both the symbolic object and symbolic transformation tasks when their understanding was scaffolded in the full training procedures by putting a window between the children and the objects that the researcher displayed, which apparently helped them to disengage their focus from those objects and their desire to touch them. Additionally, giving children more experience using iconic symbols like pictures and the symbolic actions (gestures) appeared to help children understand how to respond to the miniatures and related objects (the referents for the transformed objects). The updated scaffolded training appeared make the researcher's intent to use the symbols to communicate clearer by creating a physical divide between the players of the game. The researcher had to request a target object by communicating to the child using the symbol because she could not reach the target object directly (the window was in the way). In addition, the new procedures incorporated an established finding in the transfer of insight research which indicates that it is easier for children to succeed with a difficult symbolic relation if it is scaffolded with success on an easier one first (e.g., going from pictures to miniatures).

CHAPTER III

STUDY 2 OVERVIEW

In Study 2, I tested the effect of two version of the scaffolded training procedure on search performance in the standard scale model task. The first half of both training tasks were the same. The researcher used pictures followed by replicas to request the target objects. These trials emphasized key factors associated with representational insight, including symbolization experience, symbol-referent iconicity, and intent of the researcher to use the symbolic object for the purpose of communicating some goal. The last 8 trials differed in the two procedures.

One version, the *scaffolded symbolic object training*, emphasized more practice with new sets of iconic symbols (pictures and replicas). One possibility was that the scaffolded symbolic object training would provide better support than symbolic transformations for children achieving representational insight into the model-room relation because it highlights the use of replicas as representations of full-sized objects. To succeed in the first kind of training, children must focus on matching the identity of iconic symbols (pictures and replicas) to their referents (3D or full-sized objects) and attend to the researcher's intent to request the target objects by holding up the symbolic object. Children must realize that in the context of the researcher's request, the picture of the comb or the miniature toy comb "stands for" what the researcher wants (the full-sized comb), which requires that children not become fixated on the toy comb as an enticing object. This possibility is further supported by creating a physical barrier (and psychological distance) between the symbolic objects and the child, which helps children look beyond the concrete nature of the symbol (DeLoache, 2000). Through repeated practice, the 2.5-year-olds in this study may transfer insight about the relation between the displayed pictures and replicas and the full-sized objects, to the model-room relation in the search task, similar to how 2-year-olds were able to transfer their experience with live video at home to the lab setting (Troseth, 2003).

Alternatively, children may learn a low-level strategy of perceptual matching, without gaining awareness of the researcher's symbolic intent in showing the photos and replicas. If so, this training task may not support children in appreciating the higher order model-room relation. Troseth et al. (2007) found that 2.5-year-olds are quite good at identifying correspondences between individual objects in the scale model and in the room, but did not make use of those correspondences in the search task. They failed to understand the meaning of those correspondences as part of the overall symbolic relation: that what happened in the scale model provided information about events in the room.

The other version, *scaffolded symbolic transformation training,* gradually increased the difficulty of the symbolic relations to support children in using non-iconic symbols—objects with established functions that were symbolically transformed into something else by the researcher's pretend actions. In contrast to symbolic object training, the scaffolded transformation training progressively pushes children to contemplate more abstract correspondences, moving from easier to more difficult symbolic relations. Iconicity between the corresponding object pairs was progressively reduced from one symbolic relation to the next, making it less likely that children could succeed through perceptual matching. Instead, success requires appreciation that the symbolic role of the object is determined by the person using it (i.e., the researcher). Children needed to comprehend the intent of the researcher to communicate information using the object she held up, as well as recognize the symbolic correspondence between two dissimilar objects. With the final symbolic relation (transformed objects), children need to understand the researcher's intent for one object to stand for a completely different object (e.g., a measuring cup to stand for a hat), see past the established function of the symbolic object (i.e., as a cup for holding liquid), and recall the transformation upon seeing the referent (i.e., the hat). If children successfully identify the transformed objects, they may gain practice with a more complex symbol-referent relation that is comparable to the model-room relation but outside the context of the object retrieval task. Thus, symbolic sensitivity may increase through multiple experiences interpreting and using a variety of iconic and non-iconic symbolic relations.

Method

Participants

Fifty-two children between 28.7 and 33 months participated in Study 2. Four children were dropped from the study due to experimenter error, failing to complete the study (e.g., non-compliance), or parental interference. Therefore, the final sample included 48 children who were assigned to one of two conditions: *scaffolded symbolic object training* (*n* = 24, 10 females, *M* = 30.68 months, *SD* = 1.13) or *scaffolded symbolic transformation* (*n*= 24, 12 females, *M* = 30.57 months, *SD* = 1.32). After the training task, participants completed the standard model task and a receptive vocabulary assessment. Families were recruited and compensated as in Study 1.

The vast majority of parents identified their children's race as White (90%). Two parents identified their child's race as White and Asian (4%) one as Black or African American (2%), one as Asian (2%), and one parent chose not to disclose their child's race (2%). Only one parent identified their child's ethnicity as Hispanic. The mean and median level of joint education of the participating parents was “some graduate work,” with the sample ranging from “some college/associates degree” to “doctoral degree.” The mean household income bracket was $75,000– $100,000, the median was $100,000– $150,000, and the sample ranged from “$30,000” to “over $150,000.”

Measures

Training Tasks

Materials: A viewing box (74.9 x 63.5 x 30.5 cm) was made of wood with a Plexiglas window (60.9 x 45.7 cm) above a rectangular opening (15.2 x 45.7 cm) through which children would be asked to pass the target objects (see Figure 2). Sets of four target objects that the child would select from were arranged in a line in a rectangular container. The same object sets from Study 1 were used. Additionally, for each target object, a corresponding replicas and color photograph was used (see Figure 4).

Procedure: Lab visits lasted approximately 45 minutes. The procedure for the training task was nearly identical to Study 1, with a few changes to reflect the new apparatus. Specifically, the viewing box was placed in the doorway between the control room and the search room to separate the child and the researcher. The child and the assistant sat on the control room side, with the researcher on the search room side. The researcher now the child to *pass* objects through the opening below the Plexiglas window by saying “give me the ___” or “pass me the ___.” All participants began with the practice phase (same as in Study 1), followed by their assigned training task (see Table 2), described below.

Figure 4

Study 2 Object Sets

Requested Target Objects	Researcher Displayed Symbolic Objects

Note. Object sets used in Study 2, from top to bottom: practice objects, full-sized objects and corresponding miniature replicas, related objects (referents for the transformed objects).

Table 2

Study 2 Training Tasks

Requested Target Objects	Researcher Displayed Symbolic Objects	
	Scaffolded Symbolic Object Training	Scaffolded Symbolic Transformation Training
Mitten, brush, book, bottle	1. Pictures 2. Replicas	1. Pictures 2. Replicas
Straw, tissue box, cup, ball	3. Pictures 4. Replicas	3. Symbolic Actions 4. Related Objects

Note. Each phase included 4 trials, in order to request each target object once.

S*caffolded symbolic object training:* The researcher introduced the child to the first set of four target objects (mitten, brush, book, and bottle). She held each item up, used it in its conventional fashion, and placed it into the rectangular container without ever labeling them. She then passed the container through the opening to the child. The researcher indicated which item she wanted pushed through the opening by holding up a picture of the object, but never labeling it. After requesting all four target objects using pictures, the researcher switched to using the small replicas to request the same four corresponding target objects.

Next, the researcher introduced the child to a second set of four target objects (straw, tissue box, measuring cup, and ball), put them into the rectangular container, and passed the container through the opening to the child. The researcher then indicated which target object she wanted pushed through the opening by holding up the corresponding picture one at a time, followed by the four miniatures.

S*caffolded symbolic transformation training:* This training began exactly like the scaffolded symbolic object training. Children used the first set of target objects (mitten, brush, book, and bottle) and the researcher used the four corresponding pictures, followed by the four miniatures to request the target object.

Next, the researcher introduced the child to the second set of four target objects (straw, tissue box, measuring cup, and ball). She held each item up, used it as something other than itself (symbolically), and placed it into the rectangular box without ever labeling it. The four target objects and the symbolic actions demonstrated by the researcher were: 1) a straw (used as a crayon by "drawing" on her hand), 2) a tissue box (used as a shoe by putting it on her own foot), a cup (used as a hat by putting it on her own head) and a ball (used as an apple by pretending to "bite" and "eat" it). She then passed the box through the slit to the child. The researcher performed the associated symbolic action in order to request the target object. That is, for the straw she pretended to draw on her hand with her finger, for the box she pretended to put a shoe on her foot, for the cup she pretended to put a hat on her head, and for the ball she pretended to bite and eat an apple. After requesting all four target objects, the researcher held up a new object that exemplifies *what the target object symbolically indicated*, in order to request the target object: a crayon to request the straw, a shoe to request the tissue box, a hat to request the cup, and an apple to request the ball.

Scoring: Scoring was the same as in Study 1.

Scale model object-retrieval task

Materials and Procedure: All materials and all aspects of the procedure – including the rooms, toys, the orientation, symbol-based retrieval trials, and memory-based retrieval trials – were the same as in Study 1. The only difference was that the object-retrieval task followed the children's assigned training task.

Receptive Vocabulary

Children's receptive vocabulary was measured to ensure that participants in both conditions had equivalent levels of language comprehension. Because the scale model task contains extensive instructions, vocabulary comprehension could be a predictor of success. The Receptive One-Word Picture Vocabulary Test, fourth edition, was used to measure each child's receptive vocabulary (Martin & Brownell, 2011). The assistant showed one page of the flipbook at a time. Each page contained four pictures on it. She asked the child to point to one of the four pictures that matches the word (e.g., "Can you point to the fish?"). The request was repeated up to three times if the child did not immediately respond. The assistant recorded whether the child produces a correct response by pointing to the corresponding picture. The task was continued until the child gave six incorrect responses on eight consecutive trials. The total raw score was calculated by counting the number of correct items. This raw score was then converted into a standardized score based on established norms for the child's age.

Parent Questionnaire

Parents completed a demographics questionnaire on which they reported information relating to their family's socioeconomic status and race/ethnicity. Demographic information was used to ensure that the two training groups were drawn from equivalent socioeconomic backgrounds.

Table 3

Study 2 Correlations Between Variables of Interest and Errorless Retrievals

Measures	1	2	3	4	5
1. Age	—				
2. Participant Sex	.13	—			
3. EOWPVT raw scores	-.001	.11	—		
4. EOWPVT standard scores	-.01	-.08	.25	—	
5. Errorless Retrievals	.13	.02	.14	-.07	—

Results

Preliminary analysis revealed that age, sex of the participant, and vocabulary scores (raw and standardized) were not correlated with the dependent variable (see Table 3) and were not significantly different across the two conditions, so they were not included in the analyses below.

Training task: Children in the scaffolded symbolic object training were quite good at picking out the target object when shown pictures or replicas (see Table 4). The performance of each group on each of the four phases was compared to chance performance using one-sample t-tests. This analysis revealed that children in the scaffolded symbolic object training were significantly above chance with the first set of pictures and replicas ($p < .0005$) and the second set ($p < .0005$).

Children in the scaffolded symbolic transformation training were also quite good at picking out the target objects with the iconic symbols (see Table 4). Analysis of performance among the scaffolded symbolic transformation training indicated that children were also significantly above chance when using the first set of pictures and replicas ($p < .0005$). Children were also above chance with the symbolic actions ($p < .0005$), but not with the related objects ($p = .245$). While performance on the training tasks was equal with regards to the first half of the procedures, children in the scaffolded symbolic transformation training had a much harder time succeeding with the more abstract symbolic relations presented to them.

Table 4

Study 2 Descriptive Statistics for Training tasks

Phase	Scaffolded Symbolic Objects Training			Scaffolded Symbolic Transformation Training		
	n	*M*	*SD*	*n*	*M*	*SD*
Picture set 1	24	.94	.11	24	.82	.31
Replica set 1	24	.92	.16	24	.88	.22
Picture set 2	24	.97	.15	–	–	–
Replica set 2	24	.98	.10	–	–	–
Symbolic Actions	–	–	–	24	.69	.43
Symbolic Transformations	–	–	–	24	.32	.30

Note. Proportion of correct choices.

Table 5

Study 2 Descriptive Statistics for Object-Retrieval Tasks

Study	Symbol-Based Retrieval			Memory-Based Retrieval		
	n	*M*	*SD*	*n*	*M*	*SD*
Study 1	11	.30	.29	11	.57	.28
Study 2: Scaffolded Symbolic Object Training	24	.34	.28	24	.57	.32
Study 2: Scaffolded Symbolic Transformation Training	24	.30	.26	24	.60	.28

Note. Proportion of errorless retrievals.

Scale model object-retrieval task: Success on the symbol-based retrievals was similar in both conditions and to Study 1 (see Table 5). The percentage of errorless retrievals in the scaffolded symbolic object training was 34%, but this was not above chance performance, $t(23) = 1.62$, $p = .119$. The success rate of 30% ($M = .30$, $SD = .26$) for children in the scaffolded symbolic transformation training was also not above chance, $t(23) = 1.00$, $p = .328$. Memory-based retrieval success was also similar for both conditions. The percentage of errorless retrievals in the scaffolded symbolic object training was 57% ($M = .57$, $SD = .32$) and was above chance performance, $t(23) = 4.99$ $p < .0005$.The success rate of 60% ($M = .60$, $SD = .28$) in the scaffolded symbolic transformation training was also above chance, $t(23) = 6.09$, $p < .0005$. An independent samples t-test confirmed that there was no significant difference between symbol-based retrieval scores in the two conditions, $t(46) = -.54$, $p = .595$, or the memory-based retrieval scores, $t(46) = .36$, $p = .721$.

Unexpectedly, the percentage of errorless retrievals were low in both training conditions. Children struggled to achieve representational insight into the model-room relation. As was the case in Study 1, the memory-based retrieval in both conditions were not consistent with those from previous studies employing the standard or slightly modified versions of the scale model task. Even so, memory-based retrievals were above chance, suggesting that poor performance on the symbol-based retrievals was not due to a lapse in memory.

The performance patterns over trials were examined to determine if children achieved insight at any point during the scale model task. With regards to the symbolic object training, a significant change in between trial 1 and 2 was found, with more children going from correct to incorrect ($p = .035$). The same trend was found between trial 1 and 2 in the memory-based retrieval ($p = .001$). The dip in successful searching from trial 1 to trial 2 has been documented in previous studies with 2.5-year-olds on the scale model task (Sharon & DeLoache, 2003).

An analysis of the change in between trials 1 and 2 on the symbol-based retrievals in the symbolic transformation training did not show a significant change from correct to incorrect or vice versa ($p = .581$). Nor was there a significant change from trials 2 to 3 ($p = .219$) or 3 to 4 ($p = .625$). These results indicate that, in general, children were unable to achieve insight at any point during the scale model task. Successful searching started off low on trial 1 and continued to remain low on each subsequent trial.

At the level of individual performance, the children's success rate differed across condition: only 3 of the 24 children (12.5%) in the symbolic transformation training immediately found the toy on the majority of trials (three or more of the four trials), whereas 6 of the 24 children (25%) in the symbolic object training met this criterion. However, Fisher's exact test indicated that there was no statistically significant difference in individual success rate across the conditions (p = .461).

Discussion

The training tasks were designed to build up young children's symbolic sensitivity to the model-room relation in the scale model task by first giving them experience interpreting and using either a) iconic symbols or b) a variety of symbol-referent relations (both iconic and non-iconic). This was done in a straightforward communication task that presented single 2D and 3D artifacts as symbols of single objects, employed a representational problem without a delay, and emphasized the researcher's intent to use the symbolic artifacts to communicate.

The results of Study 2 demonstrated that following the training tasks, children in both conditions struggled to use the hiding event in the model to infer the location of the full-sized toy in the adjacent room. The rate of successful searching across conditions was similar to the 15-25% correct rate that has been found in the standard scale model task in the past (Sharon & DeLoache, 2003). Therefore, neither training task was able to support the achievement of representational insight into the model-room relation during the scale model task.

One important question pertains to whether or not children succeeding in interpreting the various object sets symbolically. That is, did the training tasks succeed in increasing symbolic sensitivity? One possibility is that children may have been relying on perceptual similarity to succeed with the pictures and replicas. The high success of 2.5-year-olds with the picture portions of the training tasks were expected. The literature regarding very young children's understanding and use of pictures and scale models suggests children this age are quite capable of using picture-mediated information to guide behavior (DeLoache, et al., 1998; Pierroutsakos & DeLoache, 2003; Pierroutsakos & Troseth, 2003; Sharon & DeLoache, 2003).

However, comprehending the referential nature of scale models is a more challenging task. Previous research has shown that children under the age of 3 are at least capable of recognizing the correspondence between a miniature replica and its full-sized counterpart (Troseth et al., 2007). While a strategy that relies on perceptual matching would be useful with the pictures and replicas, it would not help with less iconic and more abstract symbolic relations (i.e., symbolic actions and the related objects). The training tasks may have led children to rely on correspondence detection of individual small and large items, without clarifying the overall symbolic relation between the model and room.

An alternative possibility is that children did achieve some general insight from their experience in the training tasks, which helped them succeed across the majority of the symbolic relations presented in the communication games. The high overall success with pictures, replicas, and symbolic actions suggest that the task similarities between the phases (i.e., same communication game structure) and the repetition of analogous problems aided children in understanding the symbolic intent of the researcher and recognizing the higher-order symbolic relation common to all three tasks. Similarly, in one scale model study, children between the ages of two and four were asked to complete a version of the retrieval task using different pairs of model sets like doll houses or train sets, one small and one large (Chen, 2007). The correspondences between the pairs of models was not pointed out; instead, participants were simply shown the hiding event and told to find the toy in the corresponding location in the larger model. Older children (over 40 months) progressively got better from one set of models to the next. The experience with the highly analogous problems (i.e., different sets of models) supported children in understanding the basic structure of the search task and in achieving insight into the relation between the different sized models in the absence of detailed instructions to highlight object correspondences. However, younger children had difficulty transferring across analogous sets .Younger children struggled to recognize the connection when the surface similarity between the problem sets (model pairs) changed. Similarly, in Study 2, transfer only seemed to go so far—it helped in the communication game, but not in the object retrieval task.

In the current research, it is possible that children came to appreciate the relations between the various symbolic objects and their referents (with the exception of the transformed objects), but could not transfer this general symbolic awareness to a different situation. The lack of surface similarity between the training tasks and scale model task could have impeded transfer. Both kinds of training tasks employed the same communication game structure to give children experience interpreting and using various symbolic relations. The major change was that the structure of the training task now differed from the structure of the search task. For transfer to occur from an easier to more difficult version of the search task, children may need to represent the easier retrieval task in terms of the basic structure and the higher-level relations involved in it. For instance, children need to appreciate that the picture or video gives information about the hiding event in the room and then generally apply the same relational structure to another version of the task in which the sale model now gives information about the hiding event in the room (DeLoache et al., 2004). Presumably, the change in context (i.e., game structure) between training and retrieval tasks made it too difficult for children to transfer any understanding of the general higher-order relation between the symbolic artifacts and their referents that might have been achieved by the children. The similarity in the basic structure of the training and retrieval tasks appears to play a critical role in transfer.

A clearer connection between the training and search task might be needed to help children transfer across dissimilar tasks. Marzolf and DeLoache (1994) have described symbolic sensitivity as having to do with "initial awareness of the symbol referent-relation, not mapping a relation of which one is fully aware" (p. 12). Even when children were given experience using a variety of symbolic relations to solve a problem, this more general experience did not appear to increase symbolic sensitivity and thus the initial awareness of the model-room relation. The lack of similarity between the training tasks and scale model task made it difficult for children to apply their appreciation for how symbolic artifacts can relate to reality towards the model-room relation. A clearer bridge between the training tasks and the scale model task may be necessary.

To test this hypothesis, a follow up study should seek to create a clearer connection between the training task and the scale model task. For example, incorporating the scale model furniture into the training procedure may enable children to more readily transfer learning across tasks. Children could be asked to push through the replica furniture when the researcher points to its corresponding full-sized counterpart. This way, children would receive practice contemplating the model furniture in a symbolic relation. On its own, this correspondence detection would not improve success on the search task (see Troseth, et al., 2007). However, incorporating the model furniture, and photos of the furniture, into the context of the communication game of identifying the researcher's intent and pushing the matching item to her may serve as this bridge, helping children to transfer symbolic insight from the training task to the scale model task.

CHAPTER IV

GENERAL DISCUSSION

The results presented in this research lend further evidence that children under the age of 3 have a difficult time understanding the abstract "stands for" nature of symbolic 3D artifacts (see Sharon & DeLoache, 2003). Even when symbolic relations between 3D objects are presented in a straightforward way, children require extensive support to use the symbolic artifacts as sources of information. Consider that children in Study 1 frequently reached for the replicas when the researcher held them up to show the child which corresponding full-sized object to send down the slide. Similarly, children often responded with "I don't have that one" when the researcher held up the referent (e.g., a hat) to request the corresponding object that had been previously transformed through a pretend action (a measuring cup put on the head). A physical barrier (a Plexiglas window) helped children to succeed with the replicas and, to a lesser extent, with the related objects. The need for psychological distancing in both of these phases suggests that the concrete nature of the 3D artifacts is very salient and that this initial representation of the objects distracted children from the abstract role that the researcher was intending to highlight—that the object was being used to communicate about one of the items in the child's container.

The difficulty participants demonstrated with the replicas in Study 1 was especially interesting. Tomasello and colleagues (1999) reported that the choices of 26-month-olds (23.6 to 29 months of age) were correct at above chance levels (around 60% correct) when the children were asked to use a replica to pick out the correct full-sized object (i.e., a miniature brush represented a full-sized one). The children in Study 1 were on average 4 months older than Tomasello et al's participants, but clearly struggled much more with the replicas. Despite following the procedure from the 1999 study closely, these older children struggled to demonstrate similar proficiency with the replica objects. Recall that only one of the five children in the original slide game were highly successful at using the replicas to select the correct target object. Tomasello and colleagues did report that the 26-month-olds often reached for the replicas (45% of the time) and were quite slow to pick a target object (on average, taking between 15 and 20 seconds). Participants in Study 1 also reached for the replicas often but appeared to be guessing when they finally did select a target object. The reason for the difference in performance between the 26-month-olds in the original research and the older children in Study 1 with the replicas is unclear. The small sample size in Study 1 certainly limits our ability to directly compare performance across studies. A larger sample size may better serve to replicate the results reported by Tomasello et al. with the replicas.

The symbol- and memory-based retrieval performances in the scale model task were also somewhat unexpected. Children in both Study 1 and Study 2 found the hidden toy in the room 30-34% of the time, which was slightly higher than the 15 to 25% correct rate reported in the past. In contrast, memory-based retrieval performance was rather low (57-60%) when compared to the 75 to 85% rate reported in the past (Sharon & DeLoache, 2003). One possibility is that the sample size of Study 2 could have accounted for the slightly higher symbol-based retrieval scores when compared to previous studies. A meta-analysis of previous scale model task studies by Sharon and DeLoache (2003) indicated that a sample size of 12 participants was most commonly used in various version of the scale model task. Recall that at the level of individual performance, the children's success rate differed across condition. Only 3 of the 24 children (12.5%) in the scaffolded symbolic transformation training immediately found the toy on the majority of trials (three or more of the four trials), compared to 6 of the 24 children (25%) in the scaffolded symbolic object training. The larger sample size of 24 children per condition in Study 2 could have highlight individual differences among participants.

DeLoache (1995a) has noted that symbolic experience alone cannot account for improved performance with age. The development of other domains such as language, memory, Executive Functions, and attention play an important role in how children come to understand and use symbolic artifacts. While this study did not find language comprehension (i.e., ROWPVT scores) to be correlated with search performance, this could be due to the fact that all of the participants scored fairly high on the vocabulary measure. Future work should seek to determine what impact a wide range of individual predictors. For instance, in a recent study, 33- to 39-month-olds were tested on measures of working memory, inhibitory control, and cognitive flexibility, as well as on 8 trials of the scale model version of the object-retrieval task (Hartstein & Berthier, 2018). Of the three measures tested, only working memory was found to be a significant predictor of search performance. Specifically, children with high working memory were far more successful on the search task than those with low working memory. Working memory is likely employed to represent 1) the initial hiding event in the scale model, 2) the higher-order model-room relation, and 3) to update the hiding event on each trial.

An alternative possibility is that children today have far more varied experience with replica toys like those found in doll house, compared to children 30 years ago. Parents may be engaging their children with these objects in different ways than past generations. Individual differences in the manner in which families use replica toys could be responsible for the slightly higher performance by some of the children across the two studies. Are parents using more referential language when talking about replica toys with their children? Unfortunately, examining in-home experiences with toys was not something this research address. But there is evidence for the importance of such experiences. For example, DeLoache (1995a) reported some initial findings suggesting that a lack of exposure to symbolic artifacts can be detrimental to general symbolic understanding and use. In one study she described, children from a lower SES group struggled to succeed on the similar sized model task when compared to children from a middle SES background. Children from the lower SES were not successful until the age of 3.5 years. DeLoache hypothesized that the main culprit was a lack of experience with early symbols like picture books and representational toys. A comparable study she conducted in Argentina seemed to confirm this suspicion. Children tested also struggled with the similar sized model task. But this time, the teachers at the childcare centers reported that the children received relatively little exposure to picture books and representational toys. The lack of experience interpreting and using early common symbolic objects presumably made the task of comprehending the scale models as symbols more challenging.

One key limitation of the research reported pertains to the homogenous sample of participants. Past studies exploring transfer in the object retrieval task have often been conducted with predominately White and middle-class families. While the vast majority of families in this study identifies as White, parents were also highly educated. This makes it difficult to compare our findings to those of previous studies with middle-income families. These results are also not easily generalizable because of the limited scope of our sample. As noted earlier, symbolic experiences are likely influenced by access to resources that are constrained by parental income and education. Future work should seek to include more representative samples of children and to determine how much time children spend interacting with toy replicas, to what extent parents use these replicas to refer to real-world entities, and if so, at what age do they begin to do so.

This research serves to address important questions in the transfer literature: how similar does the learning context have to be to the transfer context? Can we transfer learning even through substantial differences in content and context? Barnett and Ceci (2002) have argued that most transfer research has predominately addressed *near* transfer, with similar context and content between the learning and transfer situations. This study is unique within the scale model task literature because it examines far transfer (different content and context). Children were tasked with learning the higher-order symbol-referent relations and transferring that appreciation across tasks that did not share a basic structure. Instead, the training task sought to teach children a general rule, that the researcher was using the symbolic artifacts to communicate with them. Young children struggled to transfer their appreciation for symbolic relations from one situation to another when there were extensive differences in content and context.

Studying young children's transfer in the model task in more challenging situations also gives us a better understanding of the role transfer plays in symbolic development in general (DeLoache, Simcock, & Marzolf, 2004). Symbolization experience can lead children to become more sensitive to novel symbol-referent relations. However, the research reported here provides evidence that in order for young children to transfer representational insight from one symbolic relation to another, they need to have the symbolic relations presented in a highly similar context. They also suggest that building up symbolic sensitivity requires extensive support. However, future work is needed to determine if young children can benefit from tasks meant to increase symbolic sensitivity in order to support the achievement of representational insight into symbolic relations that children do not typically appreciate.

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