CHAPTER FIFTEEN

Maps, Globes, and Videos: Parent–Child Conversations about Representational Objects

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Manipulation of three-dimensional objects affords children learning opportunities that are less available in situations that involve purely verbal or written communication (Rogoff, 1990). As discussed in other chapters in this volume, and in the education literature more broadly, the opportunity to touch and interact with objects is often very helpful for young children as they attempt to understand abstract concepts or processes. Inspired by Piaget's theory (cf. Piaget & Inhelder, 1969), psychologists and education researchers have posited various concrete-to-abstract shifts in children's thinking. For example, whereas preschool-aged children understand perceptually based analogies, older children understand analogies based on more abstract relational features (Kotovsky & Gentner, 1996). Educational methods have often been developed with such concrete–abstract shifts in mind. The manipulative materials used in early mathematics classrooms, for example, have long been considered essential aids in communicating abstract principles to young children. The usefulness of concrete objects as tools for abstract thought is not surprising, given young children's connection to the sensory reality of the here-and-now. In this chapter, however, we focus on a growing view that concrete objects do not always improve children's understanding of abstract ideas, and, in fact, that the sensory properties of certain objects, "representational objects," can even pose an obstacle to learning (Uttal, Liu, & DeLoache, 1999).

A *representational object* is an object in its own right, but it is also intended to be used as a symbol for some other entity (what we call the *referent*

object). For adults, some representational objects, such as maps and scale models, are easy to think of in that way because they are clearly concrete objects, and their function as representations is also clearly understood by most people who use them. There are other representational objects, however, that may be less obviously thought of as both objects and representations. Photographs and videotapes, for example, are not usually thought of as objects in themselves. Instead, they are extremely transparent representations and immediately bring to mind the objects, people, and scenes that they depict. In this chapter we later consider three features of representational objects that may help to characterize the range of variation in this class of objects: representational objects can vary in their *salience* as objects, in their *similarity* to the referent object, and in their *familiarity* to the user.

Although some representational objects, such as maps and globes, are very commonly seen in children's homes and classrooms, several areas of research suggest that children may not understand that these objects are meant to be symbols. Without seeing them as symbols, children cannot possibly use these objects to improve their understanding of the objects that they represent. DeLoache and her colleagues (DeLoache, 1995; DeLoache & Marzolf, 1992) have shown, in a comprehensive program of research, that representational objects can often hinder young children's ability to solve problems concerning the objects that they represent. In her most famous work, DeLoache (1987, 1991) asked whether young children can use a scale model of a room (akin to a dollhouse) to reason about the hiding place of an object in a full-size (but otherwise identical) room. Children see a small Snoopy dog hidden in the scale model, and they are then asked to find the large Snoopy in the same place in the full-scale room. It is not until 3 years of age that children are consistently successful in using the information provided in the scale model to reason about the location of the referent object (DeLoache, 1991). Beyond the preschool years, Liben and her colleagues (e.g., Liben & Yekel, 1996) have shown that once children understand the symbolic nature of representational objects, such as maps, there is still a great deal of development needed before they fully understand the meaning of various components of the representations.

DeLoache's and Liben's findings raise questions about why young children find representational objects so challenging to understand. DeLoache (2000) suggests that children may have trouble achieving "dual representation," in other words, they may not initially be able to think of objects simultaneously as both objects in their own right and as representations for something else. Because the physical reality of these objects is so salient to young children, it may be difficult for them to get past that physical reality to reason about the thing that the object represents. Thus, DeLoache's work documents a striking developmental shift in children's understanding of representational objects; however, the source of that developmental change is less clear.

To investigate the mechanisms underlying the developmental transition that DeLoache has uncovered, it is important to consider the social contexts in which children experience representational objects. The importance of the social context is suggested by Tomasello (1999), who argues that because representational objects are a kind of cultural tool, observations of or interactions with other people may be needed for children to learn the functions intended for these objects.

The focus of this chapter is on exploring the role of children's everyday social interactions in their developing understanding of representational objects. In particular, the project focused on three types of representational objects often found in museums and other settings: maps, globes, and video. Representational objects are commonly used in museum exhibits, presumably because they allow visitors to explore objects that could not be literally brought into the museum. For example, a globe encourages one to think about the earth's properties and its place in the solar system. Various photographic and videographic media bring the visitor information about objects and events that would be difficult to view firsthand. Parent–child conversations around these objects were investigated as families interacted with them in the context of a hands-on children's museum. We were particularly interested in gaining information about the everyday contexts within which children may come to understand the links between these object-like representations and their referents.

The following review of the literature focuses first on the possible role of the social context in the development of dual representation, and then on aspects of representational objects that seem to affect the likelihood that they will be understandable to children. In the subsequent sections, we discuss previous research on three different types of representational objects relevant to the museum exhibits we observed: maps and aerial photographs, globes, and live video. Next we discuss our own research on three exhibits, each presenting children with one of these types of representational object. Finally, we consider implications and conclusions from this research.

SOCIAL CONTEXT OF CHILDREN'S EXPERIENCE WITH REPRESENTATIONAL OBJECTS

How might parents guide children in coming to understand the complex and abstract symbolic nature of representational objects? To answer this question it is important to investigate how parents and children talk about representational objects in museums as well as other informal settings. DeLoache (2000) points out that because of their limited experience with symbolic artifacts, children may need guidance from adults in order to even think of the possibility that something is meant as a symbolic object rather than an object in

itself. As their experience with symbols increases, children are likely to develop more "symbolic sensitivity" and have a greater ability to recognize the symbolic nature of previously unencountered representational objects (DeLoache, 1995; DeLoache & Marzolf, 1992).

Because children's first reaction may be to deal with representational objects only as objects, parents may play an important role in helping children to see the representational nature of these objects. To date, however, most research on children's understanding of representational objects has focused on when children gain symbolic understandings, and not on how this understanding emerges. Two recent studies have begun to uncover evidence regarding the potential influence of social interaction on children's developing understanding. First, Troseth, Rozak, and Spry (1999) asked parents of 2-year-olds to encourage their children's understanding that video images can represent reality. They sent parents home with a camcorder for 2 weeks and suggested that they use real-time recordings of children's behavior to encourage children to see links from their own behavior to the video image. After the 2-week period, Troseth et al. found that children who had this experience were more successful than the control group on a task where they saw an object being hidden on video and then were asked to find the object. This finding suggests that familiarity with this particular use of video improved children's ability to use video as a symbolic medium. This research provides a first step toward understanding the role of social interaction in the development of representational insight. The next step is to ask more directly about the process by which these experiences may influence children's understanding. In another study, we have some preliminary evidence that adults' talk about representational objects may contribute to children's understanding of video as a representational medium (Soennichsen & Callanan, 2001). Two-year-olds who heard labels for the video images of objects and for their actual object referents were more successful later at using the video to find a hidden object than were those who saw the same video but did not hear object labels. From these two studies, we have some preliminary evidence that, at least with video, adult–child conversations may be helpful to children who are learning about dual representation. The research reported in this chapter extends this work by providing information about the dynamics of situations in which parents and children discuss a variety of representational objects.

This project is influenced by Tomasello's (1999) analysis of the reasons representational objects may be very difficult for children to understand. Tomasello points out that representational objects are cultural tools and that their intended symbolic nature may not be apparent to young children. In making this point, Tomasello extends DeLoache's dual representation argument, claiming that children may not only have difficulty decoupling the material and symbolic aspects of representational objects, but may also need guidance in understanding the intentionally communicative affordances of

such objects. Our hypothesis is that parents are not likely to directly teach children about abstract concepts such as dual representation. Instead, parents may talk with children about the meaning of specific representational objects, treating the children *as if* they understand the bigger concept of symbolic representation. By helping children see that individual objects in specific situations are symbolic objects, parents could be teaching children an instance of the deeper notion of dual representation. We next consider three features of representational objects that have been elaborated in previous work: salience, similarity, and familiarity. With those features as a framework, we evaluate this approach using family conversations about maps, globes, and video.

THREE IMPORTANT FEATURES OF REPRESENTATIONAL OBJECTS: SALIENCE, SIMILARITY AND FAMILIARITY

As mentioned earlier, three aspects of the representation-referent relation seem especially influential in terms of children's appreciation of the symbolic nature of representational objects. They vary in their salience as objects, which can also be thought about as their "transparency" as representations. Photographs are transparent, that is, they bring to mind the referent object and are not salient as objects in and of themselves. Representational objects also vary in similarity to the referent object, which may have impact on their recognizability as symbols. They also vary in their typical familiarity to young children.

In a series of studies, DeLoache (1987, 1991) found that whereas 3-year-old children performed well in tasks requiring representational understanding, children only 6 months younger were not as successful. In subsequent studies, DeLoache and her colleagues turned their focus toward systematically identifying task variations that influence the age at which children demonstrate achievement of dual representation. Although DeLoache's findings show that scale models are generally understood as representations by the end of the preschool years, related work on globes (Vosniadou & Brewer, 1992) and maps (Liben, 1999) suggest that the developmental trajectory for understanding representational objects continues well into the elementary school years. Using DeLoache's research as a guide, Table 15.1 illustrates the impact of the three features of salience, similarity, and familiarity, in relation to children's understanding of different types of representational objects.

Salience of Representational Object

First, DeLoache argued that the salience of the model as an object itself can impede young children's ability to hold the dual mental images of object and

TABLE 15.1
Summary of DeLoache Findings as Relevant to Salience, Similarity, and Familiarity

	Salient as an Object?	*Similar to Referent?**	*Familiar as a Representation?*
Photographs	no	yes	yes
Video	no	yes	no (but familiar in other form)
Scale Models	yes	yes	no

Note. *Varies across studies.

symbol in mind. In one study, increasing a model's salience as a concrete object (rather than a representation) by allowing children to play with it in a nonsymbolic manner decreased the chances that 3-year-old children would reason with it as a symbolic object (DeLoache, 2000). Conversely, placing the model behind a glass window, and thus eliminating the possibility of playing with it as an object, led to improved performance in finding hidden toys (DeLoache, 2000).

In further support of the importance of object salience, DeLoache found that pictures are understood as representational objects at an earlier age than other symbols. Salience of a representational object can also be thought of in terms of how "transparent" the object is as a symbol. Pictures are quite transparent as representations; when parents point to a picture, for example, they are likely to talk with children about the object depicted rather than about the picture itself. As DeLoache's work with photographs suggests, to the degree that a representational object is transparent (and not salient as an object) it may be easier for children to "see through" the symbol to the referent (cf. Ittelson, 1996). Two-and-half-year-olds are able to use pictures as representations of objects, yet are unable to use scale models in the same manner (DeLoache, 1991, 2000).

Similarity Between Representational Object and Referent

Another important feature of representational objects is the degree to which they are similar to their referents. DeLoache varied the similarity of representation and referent and found important effects (DeLoache, Kolstad, & Anderson, 1991). For example, when physical similarity between a scale model of a room and the actual room was increased by making the rooms similar in size, even 2-year-old children were able to successfully understand the model-room relationship. Liben (1999) also discusses the idea that representations that closely resemble their referents come close to "re-presenting" the referent, therefore the connection may not be as difficult to comprehend as that

between a referent and a representation that are less similar. Liben and Yekel (1996) found that children were better able to make map-room connections with maps in which the depicted objects more closely represent their referents (oblique maps), than with more abstract "plan" maps (with overhead or aerial perspective). Thus, children have an easier time understanding representational objects that have a high degree of similarity to their referents.

Similarity of a representational object to its referent is only helpful, however, if comparisons between the two can be made. Some representational objects that are commonly used by adults have referents that are not easily compared to the representation. Both maps and globes, for example, have referents that are not easily examined in their own right, namely specific geographical regions in the case of maps and the entire earth in the case of the globe. In these cases, children are likely to have a harder time considering the similarity between representation and referent. Extrapolating from DeLoache's work, when the referent is not available for comparison, it should be even more difficult for children to understand these representational objects.

Familiarity With Representational Objects and Symbolic Experience

The third feature of representational objects that may affect how likely children are to understand them is their familiarity to children. Research has demonstrated that children's ability to engage in spatial reasoning tasks is influenced by their familiarity and comfort with the testing space (Acredolo, 1982). Troseth, Rozak, and Spry (1999) have also reported evidence that preschoolers' experience with video predicts their understanding of video as a representation. Interestingly, however, just because representational objects are familiar to children does not ensure that they are understood. Globes are common in middle-income U.S. homes, yet Vosniadou and Brewer's (1992) research suggests that children well into their school years have difficulty with the notion that the earth is globe-shaped.

In addition to considering children's familiarity with particular representational objects, it is important to also consider their familiarity with those objects as symbols. Troseth and DeLoache (1998) discussed children's symbolic experience as part of the explanation for why pictures become easier to use as symbols between ages 2 and 2½ years. Children's typical experience with video may actually act against their understanding of video as symbolic. Because they see video mostly as a medium through which to view movies or previously recorded events, it may be difficult for children to interpret video as a representation of an actual ongoing event. As mentioned earlier, Troseth et al. (1999) found that parents were able to provide their 2-year-olds with experience that helped them understand video as a representation. Further, there is evidence from both DeLoache's (e.g., Marzolf & DeLoache, 1994) and

Liben's (e.g., Liben & Yekel, 1996) laboratories that children's experience with a simpler form of representation can transfer to more complex sorts of representations. This suggests that familiarity or experience seems to be an important factor in children's symbolic understanding.

In our research, we explored parent-child conversations about three museum exhibits that centered around representational objects varying in their salience, similarity, and familiarity. In the following sections, we consider research on children's understanding of each of the three types of representational objects explored in these exhibits: maps, globes, and video. We then present our findings on how parents talk with their children about each of these representational objects.

MAPS AND AERIAL PHOTOGRAPHS AS REPRESENTATIONAL OBJECTS

DeLoache's work with scale models points to the difficulty that children have in conceptualizing something as an object (e.g., a dollhouse) and a symbol at the same time. Dual representation applies to maps and photographs as well. The first exhibit we examined was a set of aerial photographs and matching maps of several neighboring towns surrounding the museum. In this exhibit the representational objects are the photographs and maps, with the referent being the streets, buildings, and parks depicted. The maps and photographs were arranged along a wall with the maps mounted vertically on the wall and the matching aerial photographs mounted below them on an angled counter-like table. Each photograph was covered in plexiglas with a movable dome-shaped magnifying glass attached.

With regard to the three features of representational objects, the maps and aerial photographs were considered to be relatively low in salience. Table 15.2 presents an analysis of how the exhibits we studied compare to DeLoache's exhibits on these three dimensions. Although in other settings maps may be salient objects in their own right, the particular exhibit under investigation

TABLE 15.2
Summary of Observed Exhibits as Relevant to Salience, Similarity, and Familiarity

	Salient as an Object?	*Similar to Referent?*	*Familiar as a Representation?*
Ideal (based on DeLoache)	no	yes	yes
Maps & Aerial Photos	no	difficult to assess	no
Globes	yes	difficult to assess	yes? (confusing?)
Video	no	yes	no

here was arranged such that paper maps were placed on a wall over a counter and were, therefore, inaccessible for children to physically manipulate. The aerial photographs were similarly unavailable as they were placed under Plexiglas. Thus, museum visitors were not likely to find these particular maps and aerial photographs to be salient as objects. The decreased salience of these representational objects should, according to DeLoache (2000), enhance their symbolic attributes.

Consideration of how similar maps are to the spaces that they represent suggests that despite surface similarities, the relationship is quite abstract. Although the aerial photographs in the exhibit directly represent actual geographical spaces, they are novel types of photographs and the perspective taken is one that tends to be unfamiliar to children. In a study of children' s interpretations of aerial photographs, for example, children identified tennis courts as "doors," refused to accept a rectangle as an office building because buildings are bigger, and failed to find grass on the black-and-white image because "grass is green" (Liben & Downs, 1989). Thus, the buildings and streets that are represented in the aerial photographs are difficult to recognize from overhead views, making these photographs more like maps and less like photographs of canonical objects. In addition, the size differences between the representations and the spaces they depict is considerable, thus decreasing the similarity between the two and making it impossible for children to compare the map to its referent space except by using their memory for the space.

Finally, regarding the familiarity of maps and aerial photographs, different families were likely to have had varying experience with these kinds of representational objects. In general, it was anticipated that most parents would be very familiar with maps and relatively unfamiliar with the aerial photographs. In addition, because the museum in which this study was conducted attracts families visiting from other parts of the country and other parts of the world, families were expected to vary in the extent to which they found the depicted spaces to be familiar. Thus, the aerial photography exhibit, in particular, is unique in that parents may not be very familiar with either the medium of symbolic representation or the referents.

Children's understanding of representations of space (e.g., maps, aerial photographs, scale models) has received a great deal of research attention, particularly by Liben and her colleagues. In general, studies in this area suggest that by the time children enter preschool, they demonstrate an appreciation of the symbolic nature of maps. This understanding is remarkable in that preschoolers must come to think about a physical object (e.g., a map) as also having a symbolic function, what DeLoache (1995) referred to as attaining representational insight. Liben (1999), however, made the point that understanding maps as representing physical spaces is but the first step in gaining competence in map use. Many children who have made this step go on to reveal misunderstandings in map interpretation. For example, Liben & Downs

(1989) reported that several preschool children in their studies overextended the physical properties of maps to the referent (and vice versa), as in the case of one child who inferred that a road shown in red on a map meant that the actual road would be red.

Despite these misunderstandings, preschool children have been shown to successfully use maps in a variety of ways. In some situations, for example, they are able to use maps as sources of information as to the location of hidden objects (Uttal, Lio, & Taxy, 1995), and as tools to accelerate their learning of a route through a playhouse (Uttal & Wellman, 1989). Further, Liben and Yekel (1996) found that 4½- to 5½-year-olds were able to reverse their representational understanding and use their knowledge of a familiar room to interpret a map of the room. Interestingly, this last study revealed that all maps are not created equal. Children had an easier time making the room–map connection when presented with an oblique map (in which depicted objects resemble their referents) than when shown an overhead map. This finding reinforces DeLoache's argument that the use of symbolic information is facilitated when representation and referent are physically similar (DeLoache, Uttal, & Pierroutsakos, 1998).

GLOBES AS REPRESENTATIONAL OBJECTS FOR THE EARTH

Globes are another type of representational object for which children must use dual representation to understand the link from the globe to the earth. Because globes are very common cultural artifacts, one might think that children understand their function from an early age. Research on children's understanding of the shape of the earth, however, suggests that the dual representation problem is very difficult in this case as well (Vosniadou & Brewer, 1992). The second museum exhibit we investigated was called "Digging to China." The exhibit consists of a large globe (representing the earth) equipped with two small video cameras that display opposite sides of the earth. An accompanying video monitor presents the images from both cameras. Visitors use controls to find a spot on the globe, look at that image on the monitor, and then look at the other image to see what spot on the globe is at the exact opposite point. The idea is that you can find out where you would end up if you could dig through the earth (as in the phrase "digging to China.")

Compared with the scale models in DeLoache's research, globes are perhaps equally salient as objects and considerably more familiar as cultural artifacts. They are also regarded by adults as quite similar to their referents. This similarity may be lost on children, however, as suggested by a large body of research in developmental psychology and education that shows that even children as old as 7 years of age have difficulty truly understanding that the

earth is a sphere (e.g., Nussbaum & Novak, 1976; Vosniadou & Brewer, 1992). This research suggests that, despite their exposure to globes as artifacts, children may not understand globes as symbols. Direct evidence on this point is not available, however.

In contrast to the research attention given to children's understanding of maps of physical space, children's understanding of globes per se has received little attention from researchers. One reason for this oversight may be that the symbolic relationship between a globe and the planet Earth is so obvious to researchers that the question of whether children appreciate the connection has been overlooked. Educators of young children may also overestimate their understanding of the globe as a symbol for the earth. In this section, we discuss prior research that suggests that an appreciation of the symbolic relationship between globes and the earth may be quite difficult to attain. We first present findings that suggest that young children may encounter difficulties in considering globes to be representational objects in addition to being interesting objects themselves. We then discuss research indicating that children's limited understanding of the earth itself may impede successful mapping of the globe-to-earth relationship. Thus, making the symbolic connection between globes and the earth may be challenging for any of three reasons: ability to achieve representational insight; ability to interpret the representational object (globe) as symbolic; and understanding of the referent (earth).

The work of DeLoache and her colleagues offers valuable information regarding the emergence of representational insight, as discussed earlier. In her work with scale models, photographs, and videos, DeLoache (1995) generally found that children's understanding of the symbolic link is available by 3 years of age. Children's confusion about the shape of the earth continues much later, however. Therefore, it is interesting to consider whether the globe as a symbolic object may be very challenging for children to use to gain information about the earth's shape. In everyday life, children may be likely to treat globes as objects in and of themselves and interact with them nonsymbolically. Unlike maps or photographs, which tend to be treated by parents and children primarily as representational objects (Liben, 1999), globes are particularly salient and interesting in their own right (e.g., they are colorful, fun to spin). Thus, depending on individual experiences, globes may first be considered to be amusing playthings and the insight that they are representational may be delayed.

Another possible obstacle to appreciating globes as models of the earth may lie in children's incomplete knowledge of the earth itself. Liben (1999) suggested that understanding the referent is essential to understanding representations. For example, she suggested that a child's difficulty interpreting a clover-leaf intersection on an aerial photograph is likely to be due to limited knowledge of clover-leaf intersections, rather than an inability to interpret the representation. We know that the degree of similarity between a symbolic

object and its referent influences the success with which children are able to demonstrate representational insight (DeLoache et al., 1991). However, if children do not understand enough about the earth's shape to appreciate the physical similarities between a globe and the earth, it will be extremely difficult to make a representational link between the two.

Research examining children's mental models of the earth suggests that many children do not, in fact, initially consider the earth to be a sphere. Instead, studies in this area converge to show that children initially construct ideas about the earth based on information gained through perceptual experiences (e.g., the earth is flat). With time, however, children demonstrate attempts to merge their initial understandings with the scientific idea of a spherical earth and develop a variety of alternative models of the earth (e.g., flat disc, hollow earth, dual earth theory, flattened sphere; for a description of these alternative models see Vosniadou & Brewer, 1992). These "synthetic models" reflect children's attempts to resolve inconsistencies between their own perceptual experiences and information given to them by others (e.g., teachers, parents, other children). It is not until children are 10 or 11 years of age that they seem to have fully accepted the scientific model of a spherical earth (e.g., Nussbaum & Novak, 1976; Sneider & Pulos, 1983; Vosniadou & Brewer, 1992). This research is crucial in that children who do not understand the earth to be a sphere may find it more difficult to understand the relationship between a globe and the earth, regardless of their representational skills.

VIDEO AS A REPRESENTATIONAL OBJECT

The third exhibit we investigated as part of this project uses video as its symbolic medium. In this exhibit, while a model train goes around a track, a camera mounted on the train's engine sends a video image to a monitor. The video monitor is in a booth that looks like a stylized train engine. Children watch the monitor while controlling the movement of the small model train. Dual representation is embedded in this exhibit because children can respond to the video as an entity of its own or as a representation of the objects that the train "sees" as it goes around the track.

Real-time video is clearly not very salient as an object, hence it should be easier for children to achieve dual representation with video than with three-dimensional objects. In fact, Troseth and DeLoache's (1998) work has shown that 2-year-olds find it quite difficult to use information conveyed via video in their Snoopy hiding task, but that, similar to their performance with pictures, children begin to use video in a symbolic fashion between 24 and 30 months. Similarity between representation and referent is very high with video. In the case of the train exhibit, the similarity between the objects on the monitor and the three-dimensional objects that they represent is extremely high.

Further, the similarity is there for children to perceive firsthand. This contrasts with both the map and globe exhibits, where the referents are not available in the exhibits themselves.

The role of familiarity is also evident in children's developing understanding of the representational nature of video. It is likely that between the ages of 24 and 30 months children gain experience with video as a symbolic medium. Troseth and DeLoache (1998) pointed out that although many 2-year-olds have certainly been exposed to video, it is usually in the context of entertainment and make-believe. This may make it difficult for young children to consider video as something that can represent reality. As mentioned earlier, Troseth et al.'s (1999) study, as well as our own preliminary findings (Soennichsen & Callanan, 2001) suggest that children's conversations with parents may provide experience that contributes to children's ability to use video as a symbolic medium.

RESEARCH FINDINGS— MAPS, GLOBES, AND VIDEO

The main goal of this study was to explore parents' talk with children about representational objects to gain information on the process by which children might learn about symbolic relationships. In addition, we asked about whether children were jointly engaged with parents during these interactions. To do so, we examined 126 interactions between children and parents at the Children's Discovery Museum in San Jose, California, a hands-on children's museum (see Crowley & Callanan, 1998). Forty-two parent–child interactions were coded at each of the three exhibits. At each exhibit, half of the target children were aged 4 years or younger, and the other half were aged 5 and older. These age groups were selected due to our desire to compare the conversations parents have with children who are not yet in school to those of parents with school-aged children. These data were collected as part of a larger study of children's learning in museum settings (see Crowley, Callanan, Jipson, Galco, Topping, & Shrager, in press; Crowley, Callanan, Tenenbaum, & Allen, 2001). Families were approached as they entered the museum, informed about the research, and invited to participate. Families who agreed to participate were given age-coded stickers for their children to wear. When children with stickers approached targeted exhibits, video cameras were turned on. This project included only children who visited with one or both parents.

Coding of Interactions

In our analysis of these conversations, we first asked whether parents discussed representational objects in ways that might reveal the link between representation and referent. One strategy that parents might use to explain

the representational nature of maps, globes, and video is to explicitly point out the representational link. We therefore identified cases where parents explained the *explicit link* between the representational object and its referent. For example, a parent at the train exhibit might say, "See the picture of the tree on the TV? And there's the real tree over there!" This strategy might be particularly helpful in those cases where the similarity between a representational object and its referent is not obvious or is not accessible, as in the case of the link between the globe and the earth. Furthermore, if familiar representational objects are used in unfamiliar ways, parents' discussions of explicit links could help to clarify the situation. Knowing that their child is familiar with video that is not "live," for example, a parent might make a point of indicating that this video is being shot at the present moment.

Even if parents do not explicitly explain the link between a representational object and its referent, there are more subtle ways that they might guide their children's understanding. In particular, parents might talk about a representational object as if it were its referent. This kind of talk is very common, for example, in conversations about photographs; parents often point to a photograph saying, "There's Daddy!" even though literally speaking they are pointing to a piece of paper rather than to the person depicted. We coded this sort of "transparent" talk about the referent, differentiating it into two subcategories. Parents might use *specific labels* for aspects of the referent with which children are familiar. For example a parent might point to an aerial photograph and say, "Look, there's your school!" Or they might use *generic labels*, naming aspects of the referent that are less familiar to the child, for example saying something like, "There's a river." Notice that if children do not understand the representational nature of the object, these sentences could seem nonsensical. Such a child might think, for example, "How could a piece of paper on the wall be my school?" Children who notice this contradiction, but who are trying to make sense of what their parents are saying, might begin to understand that the map, globe, or video is a representation for something else. We predicted that the specific label strategy might be more helpful than the generic label strategy in guiding the child to see that the object being discussed is a representational object. This is because children may be more motivated to figure out why their parent is labeling a familiar object while pointing to something else.

Finally, if none of these strategies were used, we coded the parents' speech as *not relevant* to the symbolic relation between representation and referent. This category also included interactions in which parents did not talk about the exhibit. In addition to coding parents' talk about the representational objects, we also asked about how children were engaging with their parents and the objects during these interactions. We were particularly interested in whether children seemed to be engaged in joint attention with their parents as the representational objects were being discussed.

TABLE 15.3
Percent of Parents at Each Exhibit Demonstrating Strategies

	Explicit link	*Specific*	*Generic*	*Not relevant*
Maps	17	52	9	22
Globe	5	67	5	23
Video	19	52	7	22

Frequencies of Categories of Talk

The frequencies with which parents used these different strategies are presented in Table 15.3. A chi-square goodness-of-fit test was conducted to explore whether parents used all strategies equally. This analysis revealed that parents did not demonstrate equal use of the four strategies ($\chi^2(3) = 75.21$, $p < .001$). Examination of these frequencies suggested that parents used more *specific-label* strategies than other strategies. Further, when reanalyzing parents' strategy use by exhibit, we found that a similar pattern was true across all three exhibits and that this pattern did not vary by children's age.

These results indicate that parents tended to talk about specific aspects of the referent while interacting with the representational objects. Further, parents rarely offered explicit explanations of the relationship between the representational object and its referent. This pattern of results is consistent with the prediction that although parents may not explain the abstract concepts of dual representation to their children, they may guide children in achieving particular instances of dual representation.

Although they were rare, the conversations in which parents explained the explicit link between representation and referent suggested that parents may sometimes provide children with explicit information about representational objects. For example, one parent pointed to the video image, saying, "You see that? That's the picture that the train takes." He then pointed to the real train and said, "And see, there's the real train right there." Another parent pointed to an aerial photograph saying, "This is what it looks like when you're in an airplane and you look down."

Salience, Similarity, and Familiarity

To further elaborate on patterns in parents' guidance, we return to the three important features of representational objects discussed earlier — salience, similarity, and familiarity — especially as they relate to these three museum exhibits (see Table 15.2). First, the maps and aerial photographs exhibit presents representational objects that are not particularly salient, so parent guidance is not likely to be needed on that dimension. As might be expected, then, parents rarely labeled the map or photo as an object itself. One exception was

where a mother said, "This is a map of where Aunt Jenny lives." Much more common, however, was the kind of "transparent" talk where parents pointed to the image and labeled things as if the actual things were present, for example: "This is Hwy 101, the big road we drove down to get here," and "See, there's our house."

The depictions on maps and aerial photographs are somewhat similar to the objects they represent, but this similarity is difficult for children to assess, partly because the referent objects are not available for inspection. Further, the maps and aerial photographs are not likely to be familiar to children, or at least they present an unfamiliar perspective. Therefore, parents' guidance on the similarity and familiarity dimensions seem potentially informative, as in the following example:

> **Parent** (pointing to aerial photograph): "Can you find our house? We're on here. Right here."
> **Child:** "Where?"
> **Parent:** "This is where we are. Somewhere on here. Can you find our house? Where's your school? This is a picture from the air.... There's the middle school that you went to and right there is your house."
> **Child:** "Oh cool!"

The parent's explanation that a map is, in a sense, "a picture from the air" may help the child make the representation–referent connection by addressing the unfamiliarity of the perspective for the child.

A map is less similar to its referent than a picture or even a video image of an object, and this disparity was evident in another parent's directive to her child to see that "white dots" represent ponds at the map exhibit. The parent pointed to the aerial photograph and explained, "See, those are where our house is. See the pond? See our house is right there and see, those white dots, those are the ponds."

In contrast to the map exhibit, the salience of the representational object as an object is particularly a problem for the globe exhibit. The globe is a compelling object and parents could potentially guide children in seeing it instead as a representation for the earth. In our observations, however, we found that parents tended to treat the globe as an object, and rarely seemed to help children see that it could also be thought of as a symbol for the earth. By treating the globe not as a representation of the earth, but as an object in its own right, a parent's behavior reflects an assumption of the child's understanding of the earth–globe relationship, as in "See the globe that is showing where you are?" Examining the data in Table 15.3 reveals that explicit links were particularly rare in conversations about the globe exhibit. Parents may think that children already understand globes as representations for the earth and that they are not in need of further explanation. As discussed earlier, Vosniadou and Brewer's (1992) research suggests that this assumption on the part of parents may not

be warranted. In a related study, Jipson (2000) explored parent-child conversations about the shape of the earth. Some of these conversations suggest that parents assume that children understand the globe as a model of the earth, and children's comments in those conversations also suggest that the assumption may be invalid. The following example from that study is from a 7-year-old's conversation with his parent during a part of the procedure where parent and child were asked to draw the earth:

Child: Can you draw what ever however you want?
Mother: Yeah, you can do whatever you want.
Child: What color is it?
Mother: What? The earth? What color is the water?
Child: Blue. Where should I leave the house? Should I do it on this side?
Mother: Remember when we saw the globe and then there are some parts that are green and some that are blue? And the green parts are land.
Child: Oh the globe doesn't live on the earth.
Mother: Who?
Child: The globe.
Mother: The globe?

Later, the conversation continued when they were asked to show where two children would live if one (John) lived in Australia and the other (Sally) lived in California:

Mother: OK you want to show me on there on the globe?
Child: (points at quilt on wall) That's a globe?
Mother: No sweetie, right on the globe right there (points to globe on table).
Child: That's a globe?
Mother: Yeah, so show me on that where Sally and John live.
Child: Right here, see right there. (pointing to drawing)
Mother: No, but on that one. Where's Australia?
Child: (looking at globe) Australia, Australia, Australia, Australia, Australia, Australia, Australia, Australia.
Mother: So where does John live?
Child: John lives in Australia.
Mother: OK so put him there and put Sally in California.
Child: Can I see where California is? California is that big.
Mother: Yeah, so show me on the globe.
Child: (looks on globe) This?
Mother: Mm hmm.
Child: This?

This conversation suggests that the mother is assuming some familiarity with the globe on the part of her child, but the child seems somewhat confused. If parents generally assume understanding that is not there, then familiar

representational objects could elicit less explanation from parents and could take longer for children to begin to understand.

Finally, the video exhibit presents children with a representational object that is not at all salient (and arguably not even an object) and that is very similar to the referent. Consistent with our predictions, parents' talk about the objects in the video rarely mentioned the video image itself. Instead the same kind of transparent labeling seen in the map exhibit was apparent here. Parents often pointed to the video image saying things like, "Look at the coins," or "There's Daddy!"

Unlike the other two exhibits, the referent objects in the video exhibit are present and available for comparison to the representation. This allowed parents to point out the similarity between the referent and the representation. Parents talked about the video exhibit in ways that emphasized the link between the representation and the referent, as in the following example:

> **Parent:** "That's the train you're moving (pointing to the object). See that one right there?"
> **Child:** (standing on his tip-toes to look at the object) "uh huh."
> **Parent:** "And this is what it looks like if you were the train conductor (pointing to the object representation)."

Parents also often used the same term to refer to the object representation (video image) and the object itself, perhaps helping children to recognize the similarity between the two.

> **Mother:** (pointing to the video image) "See, the train?" (then lifting the child up so that she could look at the real train) "There, going around the track, right there. See the train? Look down there.... See the train? It's coming out the other side."

Children's Engagement

In addition to coding parental strategies, we also coded whether children were engaged in joint attention with their parents as the representational objects were being discussed. Each parent–child dyad was coded as either being jointly engaged or not at the time of each coded statement, and reliability was assessed. The data on joint attention are presented in Table 15.4. Chi-square analysis of the relationship between joint attention and parental strategy revealed that children's likelihood of being in joint attention with their parents varied as a function of the strategies parents used ($\chi^2(3) = 15.44, p < .001$). Of children whose parent discussed a specific aspect of the referent, 90% (65 out of 72) were in joint attention with the parent. There were fewer children whose parents talked about an explicit link, but they were also quite likely to be in joint attention (88%, 15 out of 17). In addition, all of the

TABLE 15.4
Number of Children in Joint Attention as a Function of Parental Strategies

	Explicit link	*Specific*	*Generic*	*Not relevant*
Joint attention	15	65	9	17
No Joint attention	2	7	0	11

children whose parents talked about a generic aspect of the referent were in joint attention (9 out of 9), but 60% of the children whose parents talked about nothing relevant were in joint attention (17 out of 28).

Joint attention is not an assessment of children's understanding, and future work on this topic is needed before we can understand the potential impact of parents' strategies on children's understanding. Further, it is not clear whether the strategies used by parents differentially encouraged joint attention or whether children's attentiveness motivated parents' use of certain strategies. This research does begin to suggest, however, that parents may be providing information that is potentially helpful as children begin to understand that these objects are not just objects in their own right, but also representations.

CONCLUSIONS AND IMPLICATIONS FOR MUSEUM EXHIBIT DESIGN

The findings of this study are consistent with results from several related projects (Callanan & Jipson, 2001) where we observed parents conversing with their children about science in ways that focused on particular events rather than on deeper abstract principles. These findings are also in line with the work of Gelman, Coley, Rosengren, Hartman, and Pappas (1998) on parents' talk with children about category membership of various natural and human-made objects. Gelman et al. found that parents used subtle cues such as gestures to indicate shared category membership, but that they rarely gave explicit explanations about underlying category structure. In his commentary on that work, Keil (1998) argued that it would perhaps be unproductive for parents to give children too much detail about underlying scientific principles, and that it might be more appropriate to introduce children to the general domain and then let them explore the details on their own. We are beginning to formulate a model of how these fragmentary explanatory conversations may impact children's learning. We argue that by focusing on particular events of interest in the moment, and providing fragments of information, parents may be laying the groundwork for children to eventually build up coherent understanding of deeper principles.

In the conversations analyzed here, parents talked to young children as if the children understood representational objects for what they are. Although deep explanations did not abound, we argue that there was some guidance given that could help children to begin to attain dual representation. When parents name the referent while pointing at a representational object, for example, we argue that children are being presented with a puzzle to be solved. To make sense of what their parents are saying, they must come up with a nonliteral way to interpret the label. This conflict may lead children to begin to search for another way to think about the objects with which they are interacting. These sorts of conversations could perhaps be important motivation for the emergence of dual representation ability.

It seems possible that in some situations it could be unhelpful to children to have adults treat objects as if they are already understood. A speculative example is that the parents in our observations seemed to assume that their children understand that globes are models of the earth. Given parents' assumption that this must be obvious, they do little to clear up the confusion that results from the fact that the globe is a compelling object in its own right. It is possible, then, that children's confusion about the shape of the earth may not be helped by their exposure to globes, partly because globes may not be recognized as representations for the earth. Further research on this point should help to shed light on this issue.

Consistent with this point of view, and as mentioned at the beginning of the chapter, DeLoache's original work is sometimes taken as evidence that representational objects can hinder children's learning. Uttal, Liu, and DeLoache (1999) argued that the use of interesting manipulative materials in mathematics classrooms (e.g., Cheerios, marbles) may actually obscure the representational quality of those objects and make it more difficult for children to learn the abstract concept that is being represented. They cited Stevenson and Stigler's (1992) research reporting on the use of manipulative materials in Japanese math classrooms. Interestingly, a common practice in Japanese classrooms is to use the same manipulatives — simple tiles — throughout the early school years; this consistency may help children to develop an understanding of the representational nature of the objects. Uttal, Scudder, and DeLoache (1997) suggested that the most effective concrete object for encouraging learning is one that is interesting enough to hold a child's interest, but not so appealing that it ceases to have representational qualities for the child.

One contribution of the work presented here is to bring into focus not just the nature of various representational objects, but also the nature of the social interaction within which children experience these objects. The previous research reviewed here suggests that children are likely to appreciate the representational nature of photographs and videotapes by the time they reach the preschool years. Representational objects that are more salient as objects,

such as globes and maps, are likely to take several more years to be fully understood. Our research suggests that parents and others may be able to help children understand the dual nature of these objects by talking about them both as objects and as symbols for other (more abstract) objects.

Children's museums often contain many representational objects. These exhibits may be designed without much background information regarding children's understanding of the dual nature of such objects. Also, the philosophy of museum design may not distinguish these objects from other sorts of objects. Constructivist theories in museum settings, for example, may lead exhibit designers to hide their intentions for exhibits, with the goal of encouraging open-ended exploration so that children can discover new affordances of objects. Tomasello (1999) argued that children (and adults) respond to human-made objects in terms of their "intentional affordances" as well as their physical affordances. The idea is that we have expectations that human-made objects have intended functions, and if they are not apparent to us, we may be confused about how to approach the object. Tomasello's approach raises intriguing questions regarding the interface of museum visitors' expectations and designers' intentions (hidden or otherwise). Further, our findings suggest that it may be beneficial to create opportunities for social interactions around museum exhibits containing representational objects.

Although our studies took place in the context of a hands-on children's museum, children's everyday lives are full of opportunities to explore and discuss representational objects with their parents. For example, when planning a trip, parents and children may look at road maps together to discuss their route. Or, when watching a video of a family gathering, parents and children may talk about the people seen on the tape. Of course, the most common instance of conversation around representational objects may be when parents and children together look at picture books, labeling the objects they see represented on the pages. Given the numerous representational materials of use in day-to-day living, our research easily extends to settings beyond children's museums. Children's conversations with parents serve as a setting for children to figure out the notion of an object that serves as both object and symbol.

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