Early Development of the Understanding and Use of Symbolic Artifacts

Judy S. DeLoache

"a rose is a rose is a rose"

In this famous statement, Gertrude Stein emphasizes that any given rose is incontrovertibly a singular object. Ironically, this oft-quoted line also draws our attention to the fact that a rose can also be something other than a rose. For example, these flowers have traditionally served as symbols of love, death, and success. Roses are not alone; virtually any natural object can be used to stand for something other than itself. Consider the meanings we project onto rainbows, majestic peaks, and dark, dank swamps.

Artifacts can also serve as symbols; indeed, our world is replete with objects that have been specifically designed to fulfill a symbolic function. Symbolic artifacts are a ubiquitous and vital feature of modern life. This fact is well illustrated by William Ittelson’s (1996) description of the wealth of pictorial media present in his breakfast room one morning:

As I sit here at my breakfast table, my morning newspaper has printing on it; it has a graph telling me how the national budget will be spent, a map trying to tell me something about the weather; a table of baseball statistics, an engineering drawing with which I can build a garden chair, photographs of distant places and people, a caricature expressing what the editor thinks of a political figure . . . On the wall in front of me hangs . . . a calendar [and above it] is a clock. All this and more, and I haven’t even turned on the TV or the computer . . . (p. 171)

Before proceeding further, we should note that the term “symbol” has been used in many different ways in psychology, as well as in other disciplines. The word has also been used

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for language and certain gestures. Most of the scholars who have written about symbolization – from Peirce (1903) to Langer (1942) to Deacon (1997) – have been primarily interested in language. In addition, “symbol” is used to refer to purely internal, mental representations – the coding of experience in memory (e.g., Newell & Simon, 1972). A third use – the one of primary relevance to this chapter – is to refer to a variety of artifacts created to serve a referential function. Unlike mental representations or words, many symbolic artifacts are iconic representations: They bear some physical resemblance to what they stand for, whereas others have only an abstract relation to what they represent. Although some theorists prefer to reserve the term “symbol” for arbitrary, non-iconic representations (e.g., Peirce, 1903; Bruner, Olver, & Greenfield, 1966), others argue persuasively that iconicity per se is irrelevant to whether something serves a symbolic function (e.g., Goodman, 1976; Huttonlocher & Higgins, 1978).

I have offered this definition: A symbol is something that someone intends to stand for or represent something other than itself (DeLoache, 1995a). The first and foremost of the four components of the definition is someone. Humans are the “symbolic species” (Deacon, 1997); symbolization is the “most characteristic mental trait of mankind” that “makes [us] lords of the earth” (Langer, 1942, pp. 72 and 26). The second element – the very indefinite term something – is used quite deliberately in this definition to signify both that almost anything can serve as a symbol for almost anything else. The third element is representation. A symbol represents, refers to, denotes, something other than itself. As a consequence, symbols are inherently asymmetrical, even when symbol and referent resemble one another. A scale model of the Tower of London represents that structure, but the tower does not represent the model. One important source of this asymmetry is that symbol and referent typically have different action affordances: one can, for example, climb the steps of the real tower, but not the model of it.

The last, but certainly not the least, element of the definition is intention: one entity stands for another only if some person intends for it to do so. Intention is both necessary and sufficient to establish a symbolic relation (see also Lillard, ch. 9 this volume). Thus, nothing is inherently a symbol; only as a result of someone using it with the goal of denoting or referring does it become a symbol. A dozen long-stemmed red roses can simply be a beautiful sight. Or, presented by a lover to his beloved, the same roses serve as a symbol of love and devotion.

A unique aspect of symbolic objects is that they have an inherently dual or double nature (Kennedy, 1974; Potter, 1979; Sigel, 1978; Werner & Kaplan, 1963). An object, such as a picture, that is created and/or used to serve a symbolic function, is seen both as itself and something entirely different (Gregory, 1970).

A picture, no matter how “realistic” or “representational,” always presents two broad classes of visual information: (1) information that would be provided by viewing the pictured real-world scene . . . and (2) information that is unrelated to the pictured scene but comes from the real-world surface on which the picture appears . . . These two types of information can be analyzed separately by the psychologist, and they can be decoupled by the observer, but they are always encountered together. (Itelson, 1996, pp. 175–176)

Because of the dual nature of symbolic objects, both aspects of their reality must be represented to use them. Dual representation must be achieved; one must think about both
the concrete object itself and its abstract relation to what it stands for. As we shall see, the need for dual representation presents a substantial challenge to young children's understanding and use of symbolic objects. They tend to focus on either the conceptual referent or on the symbolic object itself, missing the relation between them (DeLoache, 1995a; Potter, 1979).

A crucial role that symbolic artifacts play in our everyday lives is as a source of information. Interaction with symbols expands our intellectual horizons in both time and space. Because of our access to books, pictures, models, maps, and other media, we can indirectly experience and learn about events, objects, and people we have never directly encountered. From an infant on her father's lap looking at a picture book of zoo animals she has never seen to an adult studying the diagrams in an instruction manual on car repair, new and useful information about the world can be acquired from a variety of symbolic artifacts. A weather map seen on television can be an excellent source of information for making travel plans. A scale model of the Rotunda designed by Thomas Jefferson can provide useful clues for understanding Palladian architecture.

Given the important informational role of symbolic artifacts and the degree to which our world knowledge is symbolically mediated rather than acquired through direct experience, the process of coming to understand and use symbols as a source of information is a vital part of early cognitive development. All children, everywhere in the world, must master the symbols and symbol systems that are important in their society. In spite of the importance of learning from symbols, we know relatively little about how children develop the ability to do so.

There is, of course, an enormous body of research on symbolic development, with by far the most work on language development. With respect to symbolic artifacts, researchers have investigated children's developing abilities to interpret and produce instances of various media. Substantial attention has been paid to pictures, both with respect to children's ability to interpret pictures and to produce them through drawing (Freeman, 1993; Robinson, Nye, & Thomas, 1994; Thomas, Nye, & Robinson, 1994), as well as children's interpretation of television (Huston & Wright, 1998). Pretend play has also been the focus of a substantial amount of research (see Lillard, ch. 9 this volume). However, other than research on maps (Liben, 1999, ch. 15 this volume; Uttal, 2000a), little attention has been paid to young children's ability to acquire information via symbols. And virtually no research has examined the emergence and very early development of children's use of symbol-mediated information. The research that is the focus of this chapter concerns very young children's ability to appreciate and exploit the relation between a symbolic artifact and some aspect of reality that it represents. Most of the research discussed concerns children's use of information from three types of symbols—scale models, pictures, and video.

Symbol-Mediated Problem-Solving

In the program of research discussed here, young children's understanding of symbolic artifacts is studied by using symbols to provide them with information to solve a problem.
If the children appreciate the relevance of the symbol, it is relatively easy to solve the problem using the symbol-mediated information. If they do not understand the relevance of the symbol to the problem at hand, they have no means of solving it.

The basic problem is retrieving a hidden object. Finding an object that they have observed being hidden is well within the competence of very young children: After watching as an attractive toy is hidden somewhere in a natural environment, children as young as 18 months of age are very successful at retrieving it, even after relatively long delays (e.g., DeLoache & Brown, 1979, 1983). In other words, even children younger than 2 years of age remember the information they receive by directly observing a hiding event and are able to use that information to guide their search for a hidden toy. The question addressed in the research described here is whether children can remember and use information that they experience indirectly, that is, information presented to them via a symbolic medium. The underlying question is whether children understand the relevant symbol-referent relation.

Scale model task

The majority of the research that I and my colleagues have conducted investigating this question has employed a scale model as the source of information about the current state of reality, that is, about the current location of a hidden object (see DeLoache, 1995a, and DeLoache, Miller, & Pierrotsaksos, 1998, for reviews of this work). Typically, the model is a realistic scale model of a regular room containing miniature items of furniture corresponding to the items of furniture in the room itself. The miniature items are highly similar in surface appearance to their larger counterparts in the room, and they are in the same spatial arrangement. The children in these studies typically receive an extensive orientation in which the relation between the model and room and all the individual items contained in them is described in detail and demonstrated by the experimenter. A crucial part of the orientation is that the experimenter takes each of the miniature items of model furniture into the room and directly compares it to its larger counterpart.

On each of the retrieval trials, children watch as the experimenter hides a miniature toy ("Little Snoopy" — a toy dog — or "Little Terry" — a troll doll) somewhere in the model (behind the couch, under a chair, etc.). They are told that a larger toy ("Big Snoopy," "Big Terry") will be hidden in the corresponding place in the room itself, and they are instructed to remember where the smaller one is hidden in the model so they will know where to find the larger one in the room. After the experimenter hides the larger toy, the children are invited to find it. The only way they know where to search for the large toy in the room is if (1) they remember where the small one is in the model, and (2) they understand the relation between the model and room and between the hiding events in the two spaces.

After searching in the room, the children return to the model to find the miniature toy they had originally observed being hidden. This serves as a memory and motivation check. If the children can find the toy in the model, it indicates they remember the hiding event they observed earlier and they are motivated to find it. Thus, if they fail to retrieve the larger toy in the room, it must be for some other reason than memory or motivational problems.
Picture and video tasks

The same symbolic object-retrieval task has also been used with pictures and video. Various types of pictures have been used, ranging from highly realistic photographs of single items of furniture in the room to colored line drawings of the entire room. In the picture task, children again receive an extensive orientation to the relation between the picture or pictures and the room. On each trial, the experimenter points to the appropriate picture or to a location on a picture to communicate to the children the location of the toy in the room. In the case of video, children again receive an extensive orientation, designed to demonstrate to the child that what they see on a monitor is being filmed at the same time. They see themselves, their parent, and the room on the monitor as the experimenter talks about what they are looking at and how it is being filmed by the camera. On the retrieval trials, the child watches on the video monitor as the experimenter goes into the room and hides the toy. The child is then invited to search for it. Again, the question is whether children are able to use the relevant symbol-referent relation to solve the problem, with successful retrieval taken as evidence that the children appreciate something about the nature of that relation.

Our symbol-mediated object-retrieval tasks are thus essentially analogical reasoning problems, in which children must reason from a base to a target problem (Goswami, 1992, and ch. 13 this volume). The target problem is finding the toy that is hidden in the room. To solve it, the child has to use the base information he or she has been given via a symbol to construct a mental model of the location of the toy. The unique element is that the base information is provided via a symbolic artifact (DeLoache, Miller, & Pirrouutsakis, 1998).

Advantages of the symbolic object-retrieval task

There are several advantages to this format for investigating the early development of symbolic understanding (Marzolf & DeLoache, 1997). An important one has to do with the relatively low verbal demands made by this task. Children do, of course, have to understand the simple instructions they are given, but they are not required to respond verbally. Therefore, performance in these search tasks is much less likely to be confounded with limited verbal ability, a perennial problem in research with young children.

A related advantage is that we can be reasonably confident that even very young children will encode and remember the base information. Young children generally perform more competently on memory tests that require them to retrieve a hidden object than they do in standard verbal memory tasks (Myers & Perlmutter, 1978), and their memory-based retrieval performance is very good. For example, after observing a toy being hidden somewhere in a room, 18- to 24-month-old children retrieve it over 80 percent of the time (DeLoache & Brown, 1983).

Furthermore, since the dependent variable is searching for a hidden object, children's performance is unambiguous: Either they find the toy in the first location they search, or they do not. (Our results are typically reported only in terms of children's first
search.) Because very young children’s behavior is often difficult to interpret, the relatively straightforward nature of the relevant response is another benefit of object-retrieval tasks.

Another beneficial feature of search tasks for studying toddlers is that these tasks are highly motivating. One of the major challenges in doing research with young children is designing tasks that will engage and hold their attention. By capitalizing on young children’s natural enjoyment of searching for hidden objects, we can obtain reliable and consistent data, even from such a notoriously uncooperative age group.

Finally, object-retrieval tasks have relatively high ecological validity. Searching for objects is ubiquitous in everyday life, and children are frequently faced with the need to retrieve misplaced shoes and mittens and to locate items needed for play. Thus, this part of the task is highly familiar to young children. The only unfamiliar part is receiving the information about where to search from a symbol. The set of advantages of search tasks means that we do not have to worry that our results will be caused by something other than what we wish to study – children’s understanding of symbol-referent relations. As it turns out, the simplicity of our task has revealed a wealth of complexity in young children’s developing symbolic abilities.

Young Children’s Performance in Symbolic Object-Retrieval Tasks

The original scale model study resulted in the pattern of results shown in figure 10.1 (DeLoache, 1987). This study was based on the standard model task, in which the room was a large room with basic living-room furniture, and the model contained miniature items of furniture that were in the same spatial positions and that were highly similar in...
appearance to those in the room. The older children in this study were 3-year-olds, and the younger ones were 2.5-year-olds. Retrieval 1 refers to finding the larger toy in the room, based on the hiding event the children had seen in the model; hence, this search is symbol-mediated. Retrieval 2 is finding the miniature toy in the model; hence, this search is based on direct experience.

As is apparent in the figure, both the older and younger children were highly successful at retrieving the miniature toy in the model. Having directly observed a hiding event, they remembered the location of the toy and successfully retrieved it. The older children, the 3-year-olds, were equally successful in the symbol-mediated retrieval. They used their memory representation of the location of the miniature toy in the model to figure out where to search for the larger toy in the room. There was no difference between their success in the retrievals based on direct versus symbol-mediated experience. In contrast, the younger children, the 2.5-year-olds, had virtually no idea where to search in the room. They failed to use their memory for where the miniature toy was in the model to infer where to find the larger toy in the room.

This pattern of results reveals a large difference in the understanding of the two age groups of the relation between the model and the room, that is, the symbol–referent relation. The difference apparent in the mean levels of performance shown in figure 10.1 is equally evident in the performance of the individual children: The great majority of 3-year-olds are successful in the retrieval task (over 75 percent correct on Retrieval 1), and the great majority of 2.5-year-olds are markedly unsuccessful. Thus, the older children clearly appreciated the symbol–referent relation and used it to succeed in the task. The younger children gave no evidence of understanding anything about the model–room relation.

This basic pattern of performance has been replicated many times, both in our lab and others (O'Sullivan, Mitchell, & Daehler, 1999; Dow & Pick, 1992; Sharon, 1999; Solomon, 1999). Across a large number of studies that have been performed using various versions of the standard scale model task, as well as other symbolic object-retrieval tasks, the performance of children of 2.0, 2.5, 3.0, and 3.5 years of age has been shown to vary dramatically as a function of age and several task factors. A consistent but complex pattern of results has emerged. Accounting for this complex pattern of performance requires consideration of the interaction of several different variables.

A Model of Young Children's Symbol Use and Understanding

A substantial amount of research using the scale model and other symbolic-retrieval tasks led to the formulation of a conceptual Model of Symbol Understanding and Use. The model shown in figure 10.2 is a revision of one published earlier (DeLoache, 1995a, 1995b). Note that this is not a formal path model; rather it is a heuristic representation of several factors known or hypothesized to affect young children's ability to understand and use a symbolic artifact as a source of information. Note also that the pivotal element in the model is representational insight. This component concerns children's insight into the existence of a symbol–referent relation in a particular task. Thus, the model represents the
Figure 10.2  A model of young children’s understanding and use of symbols (an earlier version appeared in DeLoache, 1995a, 1995b)
factors that combine to determine the likelihood that young children will achieve representational insight and hence be successful in a specific situation. Representational insight does not refer to children’s ability to understand and use symbols in general. Their general symbolic ability does, as will be discussed later, influence the likelihood of achieving representational insight in any specific task. We will briefly describe the components of the model and then focus in detail on some of the evidence for each of them. We will particularly highlight some relatively recent results regarding intentionality that motivated revision of the original model.

Behavior and mapping

Starting at the end point, the behavior in question in this research is, of course, retrieving a hidden object, based on a mental representation of the correct location. Mapping is the process of constructing and using a mental representation of the current location of the toy in the room based on what was observed via the symbolic artifact (model, picture, or video image). To map from symbol to referent, children must draw on their memory representation of the location of the small toy in the model, and based on insight into the general model–room relation, infer the location of the large toy in the room. Their mental representation of that inferred location must then serve as the guide for their search behavior in the room.

The perception of similarity

Physical similarity always makes it easier to detect the relation between two entities, and it plays an important role in relational reasoning of various sorts (DeLoache, Miller, & Pierroutsakos, 1998). The more two things resemble one another, the more likely it is that one will believe they belong to the same conceptual category. In analogical reasoning problems, higher levels of surface similarity between base and target increase the likelihood that the relation between them will be detected.

The same is true for symbolic retrieval tasks. A high level of iconicity between symbol and referent facilitates reasoning between them. In the standard model task, described briefly above, there is a high level of surface similarity between model and room, including similar surface appearance (color, fabric, material) of the miniature and full-sized items of furniture. The importance of this similarity is shown by the fact that the high level of performance achieved by 3-year-olds in this task (see figure 10.1) can be seriously disrupted by decreasing the level of physical similarity between the scale model and the room. When the items of furniture in the two spaces do not look so similar, 3-year-olds perform at the same low level as 2.5-year-olds do with high similarity. With age, children become able to cope with this lower level of similarity: 3.5-year-olds are highly successful in the low-similarity task that is so difficult for 3-year-olds.

Increasing similarity has an equally strong effect in the opposite direction for 2.5-year-olds. If the larger space is only twice as large as the scale model (rather than 16 times as large as in the standard model task), 2.5-year-olds are reasonably successful, achieving a
retrieval rate of around 70 percent (DeLoache, Kolstad, & Anderson, 1991; Marzolf & DeLoache, 1994).

Although iconicity has a strong effect on young children's performance in symbolic retrieval tasks, the perception of similarity between symbol and referent is not enough for success. For example, in one study, the experimenter pointed to one of the items in the model and asked 2.5-year-old children to show her one just like it in the room. The children readily matched the individual items of furniture in the model and room. However, when tested in the standard model task minutes later, they failed. Although they knew that the little couch was like the big couch, they still failed to realize that the fact that the miniature toy was hidden behind the small couch meant that the larger toy was hidden behind the large couch. Thus, appreciating the correspondence between the individual items of furniture in the two spaces is necessary, but not sufficient for success in the task.

**Dual representation**

Representational insight — and successful symbol use — requires *dual representation*. To use a symbolic artifact as a source of information, children must mentally represent both the concrete entity itself and, at the same time, its abstract relation to its referent. Achieving dual representation is a major challenge to young children's symbolic understanding and use. One reason, which is not at all specific to symbols, is that it is generally difficult for young children to have two active representations of a single entity (Zelazo & Frye, 1996). Specifically with respect to symbol use, the concrete features of a symbolic artifact can interfere with young children's ability to notice its relation to what it stands for. A realistic scale model like those used in our research is a highly salient, attractive, interesting object in and of itself. It affords and even invites direct physical activity — playing with the items of furniture contained in it, for example. This makes it hard for young children to treat it as standing for something other than itself. The younger the child, the more difficult it is to notice and think about both the concrete model itself and its relation to the room it stands for.

A picture or video image is much less physically salient than a model, and it has no competing affordances; there is little one can do with a two-dimensional representation other than look at it, talk about it, or think about its relation to what it represents. Thus, it should be easier to achieve dual representation with pictorial images than with real objects. This hypothesis was confirmed in a series of studies in which the experimenter pointed to a photograph of the room while telling the child, “This is where Snoopy’s hiding.” In every comparison, 2.5-year-olds succeeded in the various picture tasks but not in the model task (DeLoache, 1987, 1991; Marzolf & DeLoache, 1994). The superior performance by 2.5-year-old children with pictures versus real objects is strong evidence for the concept of dual representation, because such a result is counterintuitive on any other basis. Children typically perform better when real objects are used in a wide variety of cognitive tasks (such as memory or categorization tasks) than when pictures serve as stimuli.

The importance of dual representation in young children's use of symbols has received substantial empirical support from the confirmation of a series of other theoretically
motivated, but similarly counterintuitive predictions. Decreasing the salience of a model by placing it behind a window enables 2.5-year-olds to succeed in the model task, whereas increasing the physical salience of a model by letting 3-year-olds play with it for several minutes before the retrieval task leads to significantly poorer performance (DeLoache, 2000). Eliminating the need for dual representation altogether also enhances performance: 2.5-year-olds who were led to believe that a scale model was actually a room that had been shrunk by a "shrinking machine" successfully retrieved the miniature toy based on where they had seen the larger toy being hidden in the room (DeLoache, Miller, & Rosengren, 1997).

The challenge that achieving dual representation presents for young children is not limited to symbolic retrieval tasks. For example, Tomasello and his colleagues have shown that young children can interpret gestural symbols earlier than object symbols (Tomasello, Striano, & Rochat, 1999). When an experimenter used either a symbolic gesture or a replica object to communicate which of a set of objects was the correct one, children below 2 years of age more often selected the object indicated by a gesture than the one the experimenter denoted by holding up a replica of it. Thus, the replica objects, which require dual representation were more difficult for these young children to interpret symbolically than were gestures, which do not require dual representation.

Other examples of dual representation problems come from the work of Liben and Downs (1992; Liben, ch. 15 this volume), who have documented a number of cases in which young children misinterpret the relation between a map and the space it represents. For example, when told that a red line on a highway map was a road, one child argued that it could not be because roads are not red, and another rejected the line on the basis that it was too narrow for a car. These children are responding in an overly literal way to the map, confusing its concrete and abstract nature.

**Symbolic sensitivity**

The only specific element in the model having to do with why children exploit symbolic artifacts more successfully with age is symbolic sensitivity. Adults readily assume that any novel entity they encounter may have a symbolic function, but children do not make this assumption so easily. As they gain experience with symbols, children develop a general expectation or readiness to look for and detect symbolic relations among entities. Thus, symbolization experience generally increases their readiness to respond to novel entities in an abstract rather than concrete mode. This view is consistent with Sigel's (1970) concept of distancing: In common is the notion that children become increasingly able to achieve psychological distance from concrete entities, enabling them to think about those entities more abstractly. Young children who are able to inspect a scale model with calm detachment rather than an overwhelming desire to get their hands on it are more likely to appreciate its relation to the room it stands for.

Support for the importance of experience in performance in the symbolic-retrieval task comes from a series of transfer studies in which children of a given age are first given experience with a task on which they can succeed — and in which they presumably achieve representational insight. When subsequently presented with a task their age group
normally fails, they are now successful. For example, in one study, 3.0-year-olds successfully transferred from a high-similarity (standard) model task to a low-similarity one. In another study, 2.5-year-olds who had first performed well in a similar-scale model task later did equally well in the more difficult different-scale (standard) task (Marzolf & DeLoache, 1994). Similarly, 2.5-year-olds show substantial transfer from a picture or video to the scale model task (DeLoache, 1991; Troseth & DeLoache, 1998). (Additional transfer studies will be discussed later.)

The social context

The social context of the symbolic-retrieval task is of great importance. The nature and extent of the instructions that children receive about the symbol–referent relation profoundly affect their performance (DeLoache, 1989). The success of 3-year-olds depends critically on receiving very extensive instructions and demonstrations of the model–room relation. Their performance, and even that of 3.5-year-olds, is dramatically disrupted by slightly less complete instructions (such as leaving out the explicit comparison of all the individual items of furniture in the two spaces). Not until 4 years of age can children detect the model–room relation with less than the standard extensive orientation to the task, and not until 5 to 6 years are they able to figure it out with no instructions about the relation at all (DeLoache, DeMendoza, & Anderson, 1999).

Another aspect of the social context of the task is intentionality (a new element in the model). As discussed above, an inherent aspect of any symbol–referent relation is the intention of the creator and/or user of that relation. A hiding event in a scale model is informative about a hiding event in a different space only because someone makes it so. There is no direct causal link; it is only by virtue of the adult’s intention to hide the toys in corresponding locations that the hiding event in the model has significance for the unseen event in the room. Presumably, a mature understanding of the symbol–referent relation in our symbolic object-retrieval tasks includes some recognition of the intention that establishes it.

Very young children are clearly sensitive to adult intention and use it as a guide in many ways. One clear demonstration of this is research by Melzoff (1995a; ch. 1 this volume) in which 18-month-old infants observe an adult apparently trying but failing, to do something to a toy. When children are later given the toy, they imitate what they assumed the adult wanted to do to the toy, rather than what he actually did. Children also rely on an adult’s apparent intention in learning new words. For example, after hearing an adult announce her intention to “dax” a toy, children assumed that “dax” referred to an action that apparently produced an intended result but not to an action that appeared to result in the same outcome accidentally (Tomasello & Barton, 1994).

Intentionality is also important in young children’s judgments about pictures. For example, Bloom and Markson (1998) reported that 3- and 4-year-old children believe that a drawing is of whatever the person who drew it intended it to be. Thus, even though someone’s drawing of X may look at least as much like Y, it is a drawing of X if that’s what the individual intended to draw. Similarly, research by Gelman and Ebeling
(1998) shows that young children regard a picture that looks like some particular entity (e.g., a bear) to be a picture of that entity only if it was produced intentionally, not accidentally.

In a recent series of studies, we have been examining the role of intentionality in young children's success or lack thereof in symbolic object-retrieval tasks. In some studies, we have asked whether we could improve their performance by emphasizing the intentional nature of a symbol-referent relation. In a second series, the focus is the extent to which young children assign precedence to the experimenter's intention over other aspects of the task.

**Emphasizing the intentional nature of the model–room relation**

We have recently tried to improve the performance of two age groups of young children by highlighting the intentional nature of the model–room relation. To do so, we modified the standard task in several ways. First, the children were given a “blind” trial in which they were told that Snoopy was hidden in the room and they should try to find him. The point was to make them realize that they had no way of knowing where the toy was. Next a “helpful” assistant to the experimenter indicated that she could help the child know how to find the toy. She then proceeded to assemble the model of the room, commenting on the similarity between the two spaces and explaining how the model would help the child know where Snoopy was hidden. On the first hiding trial, after the experimenter entered the room to hide the larger toy, the “helper” assumed a conspiratorial stance, peeking through the door as the experimenter was hiding the toy. She then hid the miniature toy in the model, telling the child this would help her know where Snoopy was hiding in the room. Finally, the child searched in the room.

A group of 3-year-old children received this assistance in the context of the low-similarity task that their age group typically fails. Their success rate of 52 percent indicates that they benefited to some degree from the “helpful” experimenter’s efforts to clue them in to the model–room relation. However, a group of 2.5-year-olds, who were given the standard task that their age group typically fails, showed less benefit from the helpful assistant’s conspiratorial behavior (only 31 percent). Thus, we find that emphasizing the intentional nature of the adults’ actions in the task can assist 3-year-olds to appreciate the model–room relation, but, at least in this initial study, 2.5-year-olds were less receptive to the intervention.

**Children’s explicit awareness of the model–room relation**

In another recent study, we asked whether young children’s understanding of the intentional nature of the model–room relation is explicit enough to enable them to ignore irrelevant information. A group of 3.5-year-olds participated in the standard model task, with two very non-standard trials interpolated among four regular ones. On the two “accidental hiding” trials, the children watched as the experimenter hid the miniature toy in the model as usual and then went into the room to hide the larger toy. At this point, a
second, "clumsy" experimenter "accidentally" kicked the model, dislodging its contents. She replaced all the furniture in the correct locations. Then, picking up the miniature toy, she said, "Hmm, I don't know where this was; I'll just put it here." She proceeded to put the toy in a different place from where the experimenter had hidden it.

The question was whether the children would realize that the "accidental" hiding was irrelevant to where the larger toy was hidden in the room. In other words, would they realize that the intention of the first experimenter determined its location, not the last hiding event that had actually taken place in the model.

The results were quite clear. The children ignored the "accidental" hiding to the extent that their retrieval performance did not suffer at all. Performance was 80 percent on the standard trials and 75 percent on the accidental trials. Thus, these children recognized the importance—and information value—of the experimenter's intentions in hiding the two toys. We are currently examining whether younger children (3-year-olds) are similarly sensitive to the intentional basis for the model–room relation.

Representational insight

As noted before, the pivotal element in the model is representational insight, the recognition of the existence of a symbol–referent relation. As figure 10.2 shows, mapping occurs in a particular task only if representational insight is achieved in that task. In the symbolic object-retrieval task, only if children appreciate the way that the model (or picture or video) is related to the room it stands for do they transfer their knowledge from the symbol to the referent. Although previous versions of the model showed some other factors as having a direct impact on mapping, it has become clear that successful performance is always mediated by representational insight.

The level of awareness involved in this insight can obviously be explicit knowledge of the relation that is accessible to conscious reflection and verbalizable, such as an adult or older child would have. However, it can also be some implicit form of insight that enables young children to successfully exploit the symbol–referent relation in our retrieval tasks even though they do not show evidence of awareness of that relation.

There are three aspects of children's performance in the scale model and other retrieval tasks that provide strong support for the idea that the key factor is whether or not children achieve representational insight.

The difficulty of improving performance

A second form of support for the idea that children must achieve representational insight is the great difficulty we have experienced trying to improve children's performance in our tasks. Over the years, we have tried a very large number of manipulations designed, often with great optimism and enthusiasm, to raise the performance of 2.5-year-olds in the scale model task. Although a few have succeeded (most notably the various transfer procedures), most have not. We very recently added some more unsuccessful interventions to the long list.
One was designed to highlight the idea that corresponding hiding events take place in the two spaces. In the orientation to this study, 2.5-year-olds watched two simultaneous hiding events, one in the model and one in the room. The model was positioned so the children could readily see into both it and the room. In the orientation to the task, two experimenters (one near the model and the other in the room) drew the children’s attention to their hiding of the miniature and larger toys in the model and room, inviting them to look back and forth between the two events. Then the children searched – successfully – for both toys. Following this orientation, the children were given the standard model task in which they observed a hiding event in the model and then searched in the room. In spite of the orientation in which they saw the analogous hiding events taking place in the two spaces and searched successfully in both of them, the children now failed to use the hiding event they observed in the model as a guide for searching in the room.

Another unsuccessful effort was based on modeling. Strong evidence exists for imitation by toddlers and even infants (e.g., Barr & Hayne, 2000; Heimann & Meltzoff, 1996; Meltzoff, ch. 1 this volume). We thought that if 2.5-year-old children observed another person successfully performing in the model task, it might help them appreciate the basis for that person’s success – especially if she explained what she was doing (Troseth, 2001). For this study, the child and an adult assistant observed the experimenter hide two miniature toys together in the same location in the model. The experimenter then hid two large toys in the corresponding location in the room. Then the child watched as the assistant retrieved one of the larger toys in the room, narrating her thought processes: “Let’s see, I know Kathy hid Little Snoopy behind the couch, so that means she hid Big Snoopy behind his big couch. I’m going to look there.” Next the child was given the opportunity to search for the remaining hidden toy. At this point, the child had observed the experimenter perform the original hiding event at a location in the model and the assistant search successfully at that same location in the room. Performance was 28 percent. Watching someone else use the model as a source of information clearly did not make these children aware of its relevance and usefulness. Exactly the same result occurred for a group of 2.0-year-olds in an analogous version of the video task. After watching on a monitor as the experimenter hid two toys in the room and the assistant successfully retrieved one of them, the children still failed to use the video-based information to find the remaining toy.

One other recent series of studies provided further evidence of the difficulty of improving the performance of very young children in our tasks (although in this particular case, we actually expected a negative result). This time the goal was to see if increasing children’s motivation to find the hidden object would improve their retrieval performance. In a series of studies referred to in our lab as “Hide-a-Mom,” the hidden object was something we could be certain any child would be extremely highly motivated to find – his or her own mother or father. To do this study, we added some hiding places to the room large enough to conceal an adult (e.g., a card table covered with a floor-length table cloth, a curtain across a corner of the room). Corresponding features were of course added to the model. On each trial, the child’s parent – usually mother – hid in the room. A doll was placed in the model to show the child where Mom was waiting. The children loved the task; they were excited to search for their mothers and were filled with glee when –
typically with the experimenter's assistance—they were reunited. They did not, however, know where their mothers were; the level of correct retrievals was only 38 percent, no significant improvement over the standard level. Again, exactly the same pattern was found in a video study in which 2.0-year-olds watched on a monitor as their mother went into the room and hid herself. Thus, heightened motivation does not increase young children's use of symbol-mediated information in object-retrieval tasks.

These three recent failures to improve young children's performance (and the many that preceded them) testify to the imperviousness of young children to manipulations that any reasonable person might expect would help them. This long list of failures makes all the more remarkable the interventions that have succeeded.

Successful transfer

We have been extremely successful in improving children's performance via transfer (Marzolf & DeLoache, 1994). As described earlier, these studies show that an appreciation of one symbol–referent relation can help children recognize a more difficult one that children their age do not typically grasp, in other words, the attainment of representational insight in one task increases greatly the likelihood that they will achieve representational insight in another one.

A transfer study conducted relatively recently (Marzolf, Pascha, & DeLoache, 1996) provides further evidence that success in the model task involves an appreciation of the higher-order model–room relation. In that study, 2.5-year-old children were first given the easy similar-scale task described previously. This task was administered by two experimenters in a lab in one building using one set of toys as hidden objects. As expected, the children's performance was reasonably good (63 percent). A full week later, the same children were given the more difficult dissimilar-scale (standard) task by two different experimenters in a different lab in a different building using a second set of toys. A control group received the difficult task twice with only one day intervening. Thus, the only thing that was the same over the two sessions was the underlying structure of the tasks—using a model as a source of information about the location of a toy in a larger space. As expected, the control group performed poorly on both days (16 percent and 31 percent). The transfer group performed significantly better than the control group on the difficult task (69 percent): their success with the easy model–room relation helped them recognize a similar but more difficult relation a full week later, even with very little contextual support. Thus, these results indicate that transfer was supported by a relatively abstract representation of the relevant symbol–referent relations.

Very recently, Troseth (2000) found dramatic levels of transfer using the video task in which 2.0-year-old children typically perform relatively poorly (around 40 to 45 percent correct). In this series of studies, 2.0-year-olds were given experience with live video in their own homes before being tested in the lab. The goal was to help the children realize that what they observe on a television screen can have relevance for current reality. In our laboratory studies (Troseth & DeLoache, 1998), children have always been given experience seeing themselves, their parent(s), the experimenters, and the room on live video. However, this orientation typically lasts for only five to ten minutes. In the new study,
the children's parents were asked to film them several times over a two-week period. The film was simultaneously shown live on their television set, and the parents drew the children's attention to the relation between what they were doing and what they saw on the screen. Thus, the children received extensive experience with the relation between their own and others' behavior and images they saw on television.

The children were then brought into the laboratory where they participated in the standard video task in which they watched on video as the experimenter hid the toy in the room next door. They successfully retrieved the toy 77 percent of the time, significantly more often than a control group (approximately 40 percent). Thus, experience with live video at home facilitated these children's insight into the relation between the hiding event they saw on the monitor and the unseen hiding event in the other room. Furthermore, these children were then given a second transfer test - they were tested in the standard picture study. Recall that 2.0-year-old children have been markedly unsuccessful (usually around 15 percent) in the picture task. However, the group of children who had the home video experience and who had then performed well on the video task also performed well on the picture task (60 percent correct). Their success in the picture task could have been based on their home video experience, their success in the video retrieval task, or - more likely - on both.

These and many other transfer studies we have performed using various media provide strong evidence that young children's early understanding of the correspondence between a symbolic artifact and the space it stands for involves insight into the higher-order symbol-referent relation. Once children gain representational insight into one type of symbolic relation, they readily detect another symbol-referent relation of which they would otherwise remain unaware.

**Inhibitory control hypothesis**

An alternative account of young children's difficulty in the basic model task has recently been ruled out. This alternative is the idea that poor inhibitory control, manifested as a strong tendency for response perseveration, causes young children to perform poorly. In the model task (and in object-retrieval tasks generally), the predominant error children make is to perseverate, that is, to return to the location where they found the toy (usually with the experimenter's assistance) on the previous trial. Across many studies and multiple labs, over half of all errors in symbolic retrieval tasks are perseverative (e.g., DeLoache, 1999; DeLoache & Burns, 1994; O'Sullivan, Mitchell, & Daehler, 1999; Sharon, 1999; Solomon, 1999).

It is possible that this high level of perseverative responding masks insight into the basic symbol-referent relation; even if children had some understanding of the model-room relation, for example, they might perform poorly because of difficulty inhibiting a prepotent (previously rewarded) response. Thus, on a given trial, the child might have a representation of the location of the toy, but fail to search there because of being drawn to repeat his or her previous response. Support for this idea comes from some studies in which performance was significantly better on the first trial than on subsequent ones (Schmitt, 1997; Sharon, 1999; Troseth & DeLoache, 1998).
The possible importance of perseveration as a cause of poor performance in the model task was evaluated in two ways. First, Sharon and DeLoache (2000) analyzed existing data from 13 separate groups of 2.5-year-olds in the standard model task. The results did not support the idea that 2.5-year-old children know more about the model–room relation than their performance reveals. Although performance on the first trial was significantly better than on the second trial, the difference was quite small, and performance subsequently improved. In addition, the level of perseveration actually decreased over trials, exactly the opposite of what one would expect if perseveration were a significant factor in children’s performance. Finally, the children almost never corrected their search errors; if children have a mental representation of the correct location but cannot resist repeating their previous response, one would expect that they would go to the correct place after performing an incorrect search.

The second way the limited inhibitory control hypothesis was evaluated was by an experiment designed specifically to address this issue (Sharon & DeLoache, 2000). Following pilot work by Sharon (1999), the standard model task was modified to make it less likely children would repeat their previous response. The question was whether decreasing the level of perseverative responding would lead to an increase in correct responding; if 2.5-year-olds’ typically poor performance is caused by inadequate inhibitory control, then removing the need for inhibitory control should enable them to be more successful. Accordingly, after every trial, the location that the child had just searched was modified to make it clear that it was no longer a potential hiding place, and it was left that way for the remaining trials. For example, after the child searched in the basket, it was turned over and left on its side to reveal its empty interior, and the tablecloth on the table was pulled up to show nothing was beneath it. This manipulation did, as expected, reduce the level of perseverative searching. However, there was no concomitant increase in correct responding.

A very similar study that was simultaneously designed and conducted in another lab (O’Sullivan, Mitchell, & Daehler, 1999) produced the same result. In this case, the item of furniture that had served as the hiding place on a given trial was actually removed (from both model and room). As a consequence, it was impossible to search perseveratively on subsequent trials. In spite of the impossibility of searching where they had looked before, the children still failed to search correctly.

Taken together, the results of our analysis of existing data and the two independently conducted experiments provide strong evidence that the typical poor performance of young children in the model task is not due to difficulty inhibiting a previous response. Perseveration is a consequence, not a cause, of young children’s deficient performance. Thus, there is no evidence that 2.5-year-olds have representational insight into the model task but are prevented from succeeding by perseveration. Rather, the preponderance of the evidence indicates their failure is due to a lack of representational insight in the first place.

Having made the case that success in symbolic object-retrieval tasks is based on insight into the symbol–referent relation, it is important to emphasize again that this insight is not necessarily accessible or verbalizable. Even children who perform successfully in the model task have difficulty explaining what they know about the model–room relation. For example, in one study, 3-year-olds who had participated successfully in the standard
model task were asked to choose which of two models of the room was better (i.e., "which one is just like Snoopy's room"). The items of furniture were either highly similar or quite dissimilar in appearance to those in the room, and they were either arranged in the same spatial organization or in a discrepant array. In spite of having exploited the model–room relation to find the toy in the retrieval task, the children chose randomly among the models. In another study, 3-year-olds were given the standard model task, except that on two trials, the toy was not in the correct location in the room; that is, it was not in the location corresponding to the hiding place of the miniature toy in the model. Although most of the children indicated that the toy should have been in that location, they could not explain how they knew it should be there.

Development in Young Children's Symbolic Functioning

The research we have reviewed here reveals that progress in children's use of symbolic artifacts as a source of information is relatively rapid. Although 2.0-year-old children fail miserably at our basic picture task, 2.5-year-olds are very successful in it. Similarly, 2.5-year-olds generally perform extremely badly in the basic model task, whereas 3.0-year-olds perform extremely well. What accounts for the fact that children who find a task very difficult at one age find it trivially simple only six months later?

But age changes in our symbolic object-retrieval tasks are not all that must be explained. A full account must also address the fact that children of a given age who fail a task find that same task simple after experience with a related one, as well as the fact that children of a given age may be highly successful in one task but fail a very similar one.

Our review makes it clear that there is substantial complexity involved in the understanding and use of simple symbol-referent relations. Therefore, it should not be surprising if the developmental story is similarly complex, involving changes in numerous domains. We think this is exactly the case. It is unlikely that any one or two factors are by themselves responsible for the rapid development we have documented. Some of the likely factors appear in the model shown in figure 10.2.

One course of developmental progress has to do with the ease of achieving dual representation. This development is presumably facilitated by increasing inhibitory control. Although we ruled out response perseveration as a result of poor inhibitory control as a cause of young children's poor performance in the model task, it may very well be important in a different way. To achieve dual representation in the first place, a child has to inhibit responding to a symbolic artifact exclusively or primarily as an object. The more young children respond to a scale model as an interesting toy, the less likely they are to appreciate its role as a representation of something else. General inhibitory control is known to increase during the first several years (e.g., Harnishfeger & Bjorklund, 1993). This improvement is believed to be due in part to frontal lobe development, which is proceeding rapidly throughout this period (Diamond, 1990; Welsh & Pennington, 1991). Thus, basic brain development, leading to improved ability to inhibit their natural
response to symbolic artifacts as objects, may underlie children's increased success in symbolic retrieval tasks with age.

The model in figure 10.2 explicitly specifies symbolic experience as an important source of development. The idea, as described earlier, is that experience with symbols would contribute to the development of symbolic sensitivity—a general readiness to assume that a novel entity may have a symbolic function, that is, that it may be used to stand for something other than itself. This increased symbolic sensitivity results in part from repeated experience achieving dual representation. Presumably, the more experience children have mentally representing the dual nature of symbolic artifacts, the easier it becomes to do so with a novel entity.

There is no question that the mostly middle-class American children who have participated in our research receive an enormous amount of exposure to a wide variety of symbolic artifacts in their early years. From very young ages, they enjoy daily picturebook interactions with their parents and others (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). Joint picturebook reading has been shown to promote vocabulary development (Whitehurst, Falco, Lonigan, Fischel, DeBaryshe, Valdez-Menchaca, & Caulfield, 1988), so it is reasonable to suppose that experience with pictures contributes to symbolic sensitivity. So might the many hours that young children spend watching television and videos.

Young children are not just consumers of ready-made symbols; 2- to 3-year-olds also begin to create symbolic mappings. Although their scribbles may not be decipherable to anyone else, evidence is accumulating that at least some of very young children's earliest artistic products do involve representational intent (Bloom & Markson, 1998). A large literature documents very young children's use of representational toys in pretend or symbolic play, as well as their increasing ability to perform object substitutions (Lillard, ch. 9 this volume). Increasing facility with drawing and pretense presumably contributes to symbolic sensitivity.

We should note that none of these experiences involves the use of symbolic artifacts to solve problems based on current reality, as is required in our symbolic retrieval tasks. To use a model, picture, or video as a source of information about reality, children have to have the cognitive flexibility to treat a familiar kind of artifact in a novel way. Part of what is involved in the development of symbolic sensitivity is increased cognitive flexibility, the ability to achieve psychological distance from something and respond to it abstractly (Sigel, 1970).

The model includes intentionality as a key element. An increasing body of research is establishing impressive levels of understanding of intention by infants and young children (Gergely, ch. 2 this volume), and such understanding expands dramatically during this period and for years to come. Paying attention to and thinking about the reasons for another person's behavior would presumably help young children figure out the basic nature of the symbolic object-retrieval task. There is no evidence, however, that success in these tasks requires full or even substantial understanding of intentionality.

Several other important aspects of early development that are likely to affect performance in symbolic retrieval tasks are not formally represented in the model. One is the large increase that takes place in the first years of life in the basic amount of information that children can mentally represent. Our symbolic object-retrieval tasks require children
to represent and coordinate multiple relations. In the model task, for example, the children must use their representation of the model–room relation to infer from the relation between the miniature toy and its hiding place in the model what relation must hold between the larger toy and a location in the room. Their steadily increasing speed of information-processing and resulting increases in working memory (Kail, 1995) no doubt help young children cope with these cognitive demands. Similarly, their growing ability to represent multiple relations simultaneously would also make developmental progress possible (Case, 1992a; Halford, 1993, and ch. 25 this volume). Any symbolic-retrieval task has, at a minimum, one more relation – the relation between symbol and referent – to represent than does any task based on direct experience (Marzolf & DeLoache, 1997; Troseth & DeLoache, 2001).

In addition, between the ages of 2 and 3, children undergo extensive language development. At a minimum, their increased language skills should make it easier for them to apprehend our instructions. Young children also show substantial improvement in their ability to reason by analogy. Although even infants and toddlers can use information from a base to solve a simple target problem (Brown, 1990; Chen, 1996; Chen & Siegler, 2000a), with age they more readily gain access to analogies and are able to solve increasingly complex problems (Gentner, Ratterman, Markman, & Kotovsky, 1995; Goswami, 1992, and ch. 13 this volume). Young children's increasingly successful performance in symbolic retrieval tasks is presumably supported by more general analogical reasoning skills.

This list of factors known or assumed to contribute to the development of symbolic functioning is by no means intended to be complete; rather, it serves to emphasize that the rapid developmental improvement that occurs in our symbolic object-retrieval tasks is almost certainly attributable to several interacting and converging lines of development.

Conclusion

Children in Western societies are encountering an ever-wider variety of media and symbolic artifacts, and their exposure to these media begins at increasingly younger ages. Many parents begin picturebook interactions with young infants. Some television programming is now designed specifically for toddlers, and children begin learning numbers and letters in preschool. Computers are becoming ubiquitous, and children are being exposed to them increasingly early. Full participation in society thus requires that children begin to understand several kinds of symbolic media quite early in life.

The increasing prominence of symbolic artifacts in the lives of very young children and the importance of symbolic literacy throughout life means that it is more important than ever to increase our knowledge about the developmental processes involved in coming to understand and interpret symbols.