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Dual Representation and Young Children's Use of Scale Models

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To use a symbolic object such as a model, map, or picture, one must achieve dual representation; that is, one must mentally represent both the symbol itself and its relation to its referent. The studies reported here confirm predictions derived from this concept. As hypothesized, dual representation was as difficult for 2½-year-olds to achieve with a set of individual objects as it was with an integrated model. Decreasing the physical salience of a scale model (by placing it behind a window) made it easier for 2½-year-old children to treat it as a representation of something other than itself. Conversely, increasing the model's salience as an object (by allowing 3-year-old children to manipulate it) made it more difficult to appreciate its symbolic import. The results provide strong support for dual representation.

INTRODUCTION

Among the most significant achievements of the first years of human life is the ability to understand and use symbols. Normally developing children in all societies of the world acquire language and master a variety of symbolic artifacts. In spite of the universality of symbolization, the first steps toward proficient symbol use are challenging.

The term *symbol* has been used in many different ways. This paper is concerned primarily with symbolic artifacts—entities that have been created or drafted to serve a representational function. Such a symbol is an "entity that someone intends to stand for something other than itself" (DeLoache, 1995a, p. 67). Virtually anything can serve a symbolic function so long as some person intends that it should be interpreted nonliterally. Symbolic artifacts are at their very core social products and tools typically employed to facilitate communication (Tomasello, 1999).

According to a theoretical model of the early understanding and use of symbolic artifacts (DeLoache, 1995a, 1995b), *representational insight* must be achieved to use a symbol such as a picture, map, or model. One must detect and mentally represent, at some level, the relation between the symbol and what it stands for, its referent. The attainment of this insight depends on the interaction of several factors, including the degree of physical similarity between symbol and referent, the level of information provided about the symbol–referent relation, and the amount of prior experience the child has had with symbols.

The achievement of representational insight is not an across-the-board, stage-like acquisition with respect to symbols in general, but rather depends on the particular stimuli and situation. Thus, a child could be aware of the relation between symbol A and its referent, but oblivious to the relation between symbol B and what it stands for. The level of awareness involved in representational insight can vary, from an explicit mental representation of the relation that is accessible to conscious reflection, as an adult might have, to the inexpressible, implicit sense of relatedness more likely to underlie the behavior of a young child (Zelazo & Frye, 1997).

The theoretical model was developed primarily on the basis of research using a retrieval task in which young children are given information about the location of a hidden toy via a symbol (e.g., model, map, picture, video). For example, children watch as a miniature toy is hidden somewhere in a scale model of a room or as an experimenter points to a picture of the room to indicate the location of the hidden toy. To retrieve the toy, the children must detect and represent the relation between the room and the model or picture of it. In other words, they must achieve representational insight. If they do, they can infer where the hidden toy is; otherwise, they have no way of figuring out where to search for it. In the standard task, children's performance is supported by a high level of physical similarity between the room and the representation of it, as well as by an extensive description and demonstration of the relation between them.

Dramatic developmental differences appear in this task. For example, in the standard version of the scale-model task that has been used in many studies, 3-year-old children have reliably performed very well (75–90% errorless retrievals), whereas children only 6 months younger have consistently done very poorly (15–20% errorless retrievals; DeLoache, 1987, 1991; DeLoache, Kolstad, & Anderson, 1991; Dow & Pick, 1992; Marzolf & DeLoache, 1994).

Children's performance can be very different in different versions of this task. Older children perform

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more poorly if there is a lower level of physical similarity between a scale model and the larger space it represents (DeLoache et al., 1991), if the model–room relation is not fully and explicitly described and demonstrated for them (DeLoache, 1989; DeLoache, DeMendoza, & Anderson, 1999), or if a delay is imposed between the hiding event and the opportunity for retrieval (Uttal, Schreiber, & DeLoache, 1995). In contrast, younger children do well in the standard task if they first have a successful experience with an easy symbolic task (Marzolf & DeLoache, 1994). These factors all interact, such that a higher level of one can compensate for the lower level of another. Thus, successful performance is not linked to a particular age, but instead varies in a fairly dramatic fashion depending on specific task features.

Representational insight—and successful symbol use—requires *dual representation.* This is the focus of the research reported here. Symbolic artifacts have a "dual reality" (Gibson, 1979; Gregory, 1970; Ittelson, 1996; Potter, 1979) in that they have both a concrete and an abstract nature. They are real objects and, at the same time, they stand for something other than themselves. To use a symbol, one must mentally represent both facets of its dual reality; that is, one must represent the concrete entity itself and, at the same time, its abstract relation to its referent. In Ittelson's (1996) terms, it is necessary both to "see" the symbol itself and to "see through" it to its referent. To obtain information about a room from a scale model of that room, one must "see," or form a mental representation of, the model itself; and at the same time, one must "see through" the model, that is, mentally represent the relation between the model and the room it stands for.

"Dual representation" thus refers to the existence of multiple mental representations of a single symbolic entity. Achieving dual representation is a challenge to very young children for many reasons, some having to do with cognition in general and others arising from the characteristics of specific types of symbolic artifacts. Having two active representations of a single entity is generally difficult for young children (Zelazo & Frye, 1997). Because of their relatively limited experience with symbolic artifacts, young children are generally less sensitive than older individuals to the possibility that a novel entity has symbolic import, that it is more than an object in and of itself. Further, a symbolic object such as a model creates a conflict between its real and its symbolic affordances (Tomasello, 1999). The physical salience of a scale model as an attractive, interesting object makes it particularly problematic for young children to treat it as a representation of something other than itself. They are inclined to respond to the model exclusively in terms of its salient physical reality; preoccupied with the model as an appealing toy, they remain innocent of its specific symbolic role. The younger the child, the more difficult it is to think about both the concrete model itself and the abstract "stands for" relation between it and the room.

Although all symbolic artifacts require dual representation, it is easier to achieve with some than with others. Pictures are relatively nonsalient and uninteresting as objects, so they present less of a challenge with respect to dual representation. This claim is supported by the picture-superiority effect that has been reported in several studies (DeLoache, 1987, 1991; Marzolf & DeLoache, 1994) using different kinds of pictures. Children 2½ years old are much more successful at finding a toy hidden in a room when they see an experimenter simply point to the correct location in a picture of the room than when they observe a miniature toy being hidden in a model of the room. This result is counterintuitive in that there is a large literature showing pictures to be generally less effective than three-dimensional objects in supporting learning, memory, categorization, and other cognitive activities (e.g., Daehler, Leonardo, & Bukatko, 1979; DeLoache, 1986; Hartley, 1976; Sigel, Anderson, & Shapiro, 1966; Steinberg, 1974). The a priori prediction of a counterintuitive result lends strong support to the concept of dual representation in symbol understanding and use.

The research to be reported here involved further tests of the dual representation hypothesis—the prediction that the salience of a symbolic artifact as an object should influence the difficulty of achieving dual representation and hence should affect performance in the model task. Study 1 tested the prediction that dual representation should be difficult for 2½-year-olds even with a simple set of objects in place of a scale model. The idea of the other three studies (Studies 2a, 2b, and 3) was that decreasing the salience of a scale model as a concrete object should make the task easier for young children compared to the standard task, whereas increasing its salience should make it more difficult.

STUDY 1

As mentioned before, 2½-year-old children can readily use pictures in an object retrieval task. In previous studies (DeLoache, 1987, Experiment 2; DeLoache, 1991; Marzolf & DeLoache, 1994), the experimenter pointed either to one of the items of furniture depicted in a wide angle photograph or drawing of a room or to one of a set of four color photographs, each depicting a single item of furniture in the room. The experimenter told the child, "This is where Snoopy's hiding in the room." The 2½-year-olds were very successful (nearly 80%) at using this information to find the hidden toy.

The interpretation offered for these results was that it is easier for young children to achieve dual representation for two-dimensional pictures than for a three-dimensional scale model. It is possible, however, that children succeeded in the picture task because it involves a simpler situation than the standard model task. The wide-angle pictures show only part of the room, and the four individual photos depict only a subset of the objects in the room. The scale model, in contrast, contains elements representing virtually all elements of the room. The question addressed in Study 1 is whether greater task simplicity could account for the picture superiority effect. Specifically, we asked how 2½-year-old children would perform with a small set of individual objects instead of either pictures or a model. According to the dual representation hypothesis, individual real objects, like a model, should involve more representational challenge than pictures; hence, performance with objects should be more similar to that reported for this age group with models than with pictures.

Method

Participants. The participants were 8 (4 female, 4 male) 2½-year-old children (30 to 32 months, $M = 31$ months). As in all the studies reported here: (1) the names of potential participants were obtained from files of newspaper birth announcements and parents were contacted by telephone, (2) the sample was predominantly middle class and white, and (3) within each gender, children were randomly assigned to one of two trial orders. (In no study was there any effect for order.)

Materials. Four of the pieces of furniture from the scale model used in Studies 2 and 3 were used, including a miniature chair, couch pillow, dresser, and floor pillow. The four objects sat on a table in the control area adjacent to the room. Just as in previous picture tasks, the objects were arranged in a semicircle in an order that preserved their relative left-to-right positions in the room. The miniature and larger Snoopy toys were the hidden objects.

Procedure. In the orientation, the instructions were modified to refer to "Little Snoopy's furniture" rather than "Little Snoopy's room." It included the item-to-item comparison of the four pieces of miniature furniture from the model with the corresponding full-size items in the room. This orientation was essentially the same as that in previous studies with sets of individual pictures (DeLoache, 1987, 1991). The retrieval trials were exactly like those in the standard task: On each of the four trials, the child watched as the experimenter hid the miniature toy behind or under one of the miniature items of furniture, and the child was then asked to find the larger toy in the room. Then the child was asked to retrieve the miniature toy he or she had originally observed being hidden in the array of objects.

Results and Discussion

The children were markedly unsuccessful in this task. Only 1 of the 8 participants was successful on three or more of the four trials. The level of errorless retrievals was only 16%—the same as the typical rate of 15% in the standard-model task and obviously much worse than the approximately 80% errorless retrievals typical in picture tasks. The retrieval 2 score was 88%. It is clear that presenting 2½-year-old children with a simplified three-dimensional display does not produce better performance than they achieve with a more complex scale model. Hence, the better performance that has been observed in picture tasks cannot be attributed to their involving a simpler situation than the model task.

These results accord very closely with recent research (Tomasello, Call, & Gluckman, 1997) using a retrieval task similar to that in the present study. A desirable toy was hidden in one of a set of three distinctive objects. In one condition, an adult provided a hint about the location of the toy by holding up a replica of the object under which it was hidden. A group of 2½-year-olds was not very successful at using the replica object as information about where to find the hidden toy. Indeed, only 1 of the 24 children was significantly above chance (five or six out of six trials). Thus, like the 2½-year-olds in Study 1, these young children did not understand the relation between an individual object and the hiding place it represented. The results of the Tomasello et al. (1997) study, along with those reported here, provide another demonstration of the difficulty that young children of this age have achieving dual representation and treating a real object as a symbol of something other than itself.

STUDY 2A

The hypothesis tested in Studies 2a and 2b is that *decreasing* the salience of the model as an object should make it *easier* for very young children to achieve dual representation. To reduce the model's salience, it was placed behind a window and the children never touched any part of it. Our idea was that physically distancing the children from the model might help them achieve psychological distance (Sigel, 1970), thereby making it easier to mentally link the model with something other than itself. Specifically, we predicted that 2½-year-old children would perform better in this window task than children of the same age in the standard task. Study 2a is a preliminary test of the hypothesis, comparing the performance of a group of children tested in the window task to earlier data from the standard task. Study 2b replicates Study 2a with two new groups of children.

Method

Participants. The participants were 12 (6 female, 6 male) 2½-year-old children (29 to 32 months, M = 30.3 months). For purposes of comparison, data were used from 8 children (29 to 32 months, M = 30.6 months) in a previous study using the same model and room (the High–Low condition in Experiment 1; DeLoache et al., 1991). Because performance in the standard task is highly reliable, it seemed reasonable to perform a cross-study comparison in this preliminary test of the hypothesis.

Materials. The model and room used here have been used in several previous studies (DeLoache et al., 1991; Marzolf & DeLoache, 1994). The larger space was a tent-like portable room (1.85 × 2.57 m) constructed of plastic pipes supporting white fabric walls (1.88 m high). The smaller space was a scale model (48.3 × 62.9 cm, with walls 38.1 cm high) of the portable room, with walls of white cardboard rather than fabric. The room held several items of furniture (fabric-covered chair, dresser, set of shelves, basket, etc.); the model contained miniature versions of these items that were highly similar in surface appearance to their larger counterparts. The relative size and spatial arrangement of the objects were the same in the two spaces.

The unique feature of the window condition in the present study was that, unlike in the standard task and the comparison group, the scale model was placed behind a clear plastic window in a puppet theater (see Figure 1). It was 54 cm off the floor and readily visible to the children. The model was to the side of the portable room so that, as in other model studies, the child could not simultaneously see the model and the interior of the room.

The target object was a stuffed toy dog (15 cm high), referred to as "Snoopy."

Procedure. The children were given an extensive orientation in which the correspondence between the model and room and between the individual items within the two spaces was described and demonstrated. All the objects in both spaces were labeled, and the experimenter emphasized the object correspondences by holding each miniature object from the model up against its counterpart in the room while commenting on their similarity.

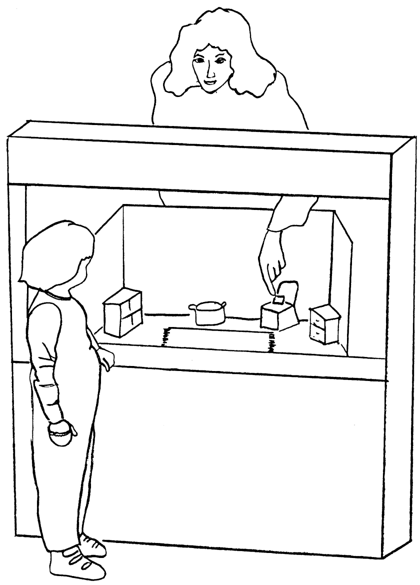

Figure 1 The scale model was sitting on the stage of a puppet theater behind a clear plastic window. The child never touched the objects in the model. The assistant experimenter is pointing to the miniature pillow on the chair in the model to indicate to the child that the larger toy is hidden under the larger pillow on the chair in the room.

In the window condition, the child watched as an assistant (who was standing behind the puppet theater) pointed to a hiding place in the model (see Figure 1), while the experimenter told the child, "This is where Snoopy's hiding in the room." The hiding places were never named, and a different item of furniture was designated on each of the four trials. Then the child was asked to find the toy in the room. If the child's first search was not correct, he or she was allowed to search additional places and/or the experimenter provided hints as to the correct location. Thus, the child found the toy on every trial; however, only the first search was counted.

The comparison group (DeLoache, 1991) had participated in the standard-model task, using the same room and model, with the model on the floor and readily accessible to the child. On each trial, the child watched as the experimenter hid a miniature toy dog under or behind a piece of furniture in the model. She announced that she would hide the larger dog in the "same place" in the room itself. The child then searched for the larger toy that was hidden in the corresponding location in the room (retrieval 1) and afterward returned to the model to retrieve the toy he or she had originally observed being hidden (retrieval 2; for more details of the standard-model task, see DeLoache, 1991).

Results and Discussion

The children in the window condition found the hidden toy on their first search on 54% of the trials (M = 2.2 errorless retrievals). In contrast, the retrieval 1 performance of the comparison group was only 28% (M = 1.1). Their retrieval 2 performance was 78%, indicating that the poor retrieval 1 score was not due to memory or motivational difficulties.

Seven of the 12 children in the window condition were successful on three or four of the four trials; but of the remaining 5 children, 4 were never correct, and 1 was correct only once. In contrast, only 1 of the 8 participants in the standard model task was correct three or more times. Because of the distinctly bimodal distribution in the window condition, we used a nonparametric test to compare the number of children who were successful (scored 3 or 4 correct) in the two groups. According to a Fisher's t-test, the difference between the two groups was significant ($p < .05$).

The differential performance of the two groups is attributable to the degree of access the children had to the model rather than to procedural differences between the two conditions. In previous research, 2½-year-old children performed the same in the standard-scale model task and in a task in which they simply saw the experimenter point to the relevant location in the model (Hide-Model and Point-Model conditions of Experiment 1; DeLoache, 1991). Furthermore, performance in both of those tasks was 25%—almost identical to the 28% for the comparison group here (even though a different model and room were used). Thus, the difference in performance reported here is not due to the experimenter designating the correct location by pointing versus hiding or to the children retrieving objects in one versus two spaces.

Another procedural difference is the fact that the model in Study 2a was elevated rather than on the floor as has usually been the case. In a previous study, however, the model rested on a table, providing 2½-year-olds a straight-on, rather than a bird's-eye view of the model (DeLoache, 1990). The performance of 10 children tested with the model near eye level was 30%, essentially the same as that typically found with the model on the floor. Thus, the results of Study 2a are not attributable to procedural differences other than the salience manipulation of interest.

These results therefore provide support for the dual representation hypothesis. A more direct comparison would still be desirable, however, especially given the counterintuitive nature of the predicted results. The goal of Study 2b was thus to replicate Study 2a, using a different model–room arrangement and including a comparison group in the design.

STUDY 2B

Method

Participants. The participants were 24 (12 female, 12 male) 2½-year-old children (29 to 33 months, M = 30.6 months). Half the children of each gender participated in the window condition and half in the standard model task.

Materials. A two-room suite was used for this study. The larger room (6.51 × 5.49 × 2.55 m) was furnished like a living room. A scale model (84 × 74 × 33 cm) of the large room was constructed of wood and duplicated the main features and furnishings of the room. Most of the miniature furnishings were perceptually similar to their counterparts in the room. The model was in an adjacent room and aligned in the same spatial orientation as the large room. For the window condition, as in Study 2a, the model was placed behind a clear plastic window; it was 54 cm off the floor and was readily visible but physically inaccessible to the children. The target object was the same stuffed dog used in Study 2a.

In the standard-model task, the scale model rested on the floor, making it easily accessible to the children. A small plastic dog (2 cm high) was hidden in the model.

Procedure. All aspects of the procedure for the window condition were similar to those followed in Study 2a. The standard-model task employed the same procedures that have generally been used (essentially the same as for the comparison group in Study 2a), including the fact that the children performed both a symbol-mediated (retrieval 1) and a memory-based (retrieval 2) search on every trial.

Results and Discussion

Performance in the standard-model task was similar to that reported in previous studies: 81% for the memory retrieval, but only 13% (M = 0.5) for retrieval 1. None of the 12 subjects succeeded on three or more trials on retrieval 1. The children in the window condition were more successful, with an average of 48% errorless retrievals (M = 1.9). Five of the 12 children were successful on three or four trials. This difference in number of successful subjects was significant (Fisher's t, $p < .05$).

Studies 2a and 2b together provide substantial support for the dual representation hypothesis. Making the model inaccessible to the children—putting it behind a window and not letting them ever touch it—made the task easier. Physical distance from the model apparently helped the children achieve psychological distance (Sigel, 1970), enabling them to represent the abstract model–room relation. It is difficult to think of any basis other than the dual representation hypothesis on which this prediction could have been made a priori.

STUDY 3

This study follows the same logic as the previous two studies, but in reverse. Here, the attempt was to *increase* the salience of the model as an object, hypothesizing that this would make it *more difficult* to achieve dual representation. To effect an increase in the salience of the model itself, 3-year-old children were encouraged to play with it for a few minutes before participating in the standard-model task. The reasoning was that physically interacting with the model in a nonsymbolic mode should make it more difficult to subsequently appreciate its symbolic function. Thus, 3-year-olds, who typically succeed in the standard-model task, should be less successful.

Method

Participants. The participants in the model-experience group were 12 (6 female, 6 male) 3-year-old children (36 to 40 months, $M = 38.3$ months). For purposes of comparison, data were used from 16 children (8 female, 8 male, $M = 38$ months) who had previously participated in the standard-model task using the same room and model (DeLoache, 1987).

Materials. The study took place in a different two-room suite from the one used in Study 2b. The general nature of the larger room ($4.80 \times 3.98 \times 2.54$ m) and the scale model ($71 \times 65 \times 33$ cm) was the same as the model–room combination in Study 2b, and the same target objects were used.

Procedure. When each child in the model-experience group arrived for the session, the model was sitting on the floor in the middle of the larger room. A few toys were present in the model, including the dog that would later be the target object and a set of plastic people. The children were invited to play with the model and toys. After 10 minutes, or any time after 5 minutes that the child seemed to be losing interest, the experimenter indicated they would "do something different now." The toy people were removed, the model was moved into the adjacent room, and the experimenter began the extensive orientation to the standard task. Each child received four trials of the standard task in which he or she watched while the miniature toy was hidden in the model; the child searched for the larger toy in the room (retrieval 1) and then for the miniature toy in the model (retrieval 2).

The children in the no-experience group had simply participated in the standard task with no preexposure to the model.

Results and Discussion

The 3-year-old children in the model experience group achieved only 44% errorless retrievals on retrieval 1 ($M = 1.75$), a rate substantially below the 75% ($M = 3.00$) for the comparison group with no preexposure. (The level of performance in the comparison group is similar to that achieved by other groups of 3-year-olds in several studies employing the standard task; DeLoache et al., 1991; Marzolf & DeLoache, 1994.) Only 4 of the 12 children in the experience group scored 3 or more correct, in contrast to 12 of 16 in the comparison group. The difference in number of successful participants was significant (Fisher's t, $p < .05$).

In contrast to the relatively poor performance of the model-experience group on retrieval 1, their success rate on the memory retrieval was 98%—similar to the 88% for the comparison group. The fact that the children in the experience group could find the toy they had observed being hidden in the model, combined with the their being generally attentive and cooperative, indicates that preexposure to the model did not decrease their general level of motivation in the model task.

The results of Study 3 provide support for the dual representation hypothesis. Here, interacting directly with the model in a nonsymbolic mode made a group of 3-year-olds less likely to reason successfully from the model to the room. These results thus provide a nice counterpoint to Studies 2a and 2b; in both cases, changing the salience of the model as an object affected performance in the direction predicted a priori by dual representation. Like the previous results, these are also counterintuitive; in this case, familiarizing young children with the experimental materials, which often facilitates performance, led to poorer performance.

GENERAL DISCUSSION

The results presented here provide strong support for dual representation, especially since some of them were counterintuitive yet predicted a priori. A coherent, consistent picture emerges from the integration of the results reported here with previous tests. Increasing the physical salience of a symbol such as a scale model makes it more difficult for young children to respond to it as standing for something other than itself (Study 3). A lower level of physical salience leads to better performance, whether the salience of a symbolic object is diminished by physically distancing it (putting the model behind a window as in Studies 2a and 2b) or by using a less salient object (a picture or video display) as the source of information (DeLoache, 1987, 1991; Marzolf & DeLoache, 1994; Troseth & DeLoache, 1998).

Further, removing the need for dual representation altogether enhances young children's performance in a model task. In a recent study (DeLoache, Miller, & Rosengren, 1997), 2½-year-old children were led to believe that a machine could shrink a room, that is, it could transform a room into the model of the room. The children watched as the larger toy was hidden in the room (the portable room used in Study 2a), and then the machine supposedly shrunk the room. Believing that the model actually was the room after having been shrunk, the children successfully retrieved the miniature toy. The shrinking machine scenario worked because it removed the need for dual representation; there was no longer a "stands for" relation between room and model.

Why is dual representation so difficult for very young children? It is *not* because they are incapable of symbolic representation and use. Children are reasonably proficient with various symbols by the third year of life when they still have great difficulty using scale models. They have made a good start toward mastering the preeminent symbol system, language, and they also produce and understand a variety of symbolic gestures (Acredolo & Goodwyn, 1990). It is possible that one reason—among many—that language and gestures emerge so early is that they do not require dual representation. The evanescent nature of these communicative symbols means that, unlike the situation with symbolic artifacts, there is little to deflect children from the correct interpretation that they stand for something.

Pictures are another medium with which toddlers have some competence (DeLoache, Pierroutsakos, & Troseth, 1997). Although infants often treat depicted objects as if they were real objects, trying, for example, to pick them up off the page (DeLoache, Pierroutsakos, Uttal, Rosengren, & Gottlieb, 1998), they stop doing so in the second year of life. Two-year-olds can interpret simple pictures, and by 2½ years of age children can reliably use pictures as a source of information in a retrieval task (DeLoache, 1991; DeLoache & Burns, 1994). As discussed earlier, it is relatively easy to achieve dual representation with pictures, because they offer little of interest as objects; what is depicted in a picture can be fascinating, but the flat surface itself generally is not. Once the critical difference between pictures and objects is understood, there is no strong competing hypothesis about how to respond to a picture, as there is with a model.

Symbolic play is another domain of early symbolic competence. Well before 2½ years of age, children perform object substitutions in which one object is made to take the place of, or stand for, another object (Lillard, 1993). Thus, a banana can serve as a telephone receiver, a pencil as an airplane, a block of wood as a boat. Tomasello (1999) describes this process as detaching and interchanging the intentional affordances of objects. Object substitution requires dual representation, in the sense that a single object must be represented in two different ways—as the object itself (involving whatever the child knows about that object or kind of objects) and as whatever the child is pretending it is. While the block of wood is a boat, however, the child can think primarily of boats. The real identity of the object must be kept in mind only to the extent needed to inhibit a literal response to it; it would not do to actually bite into the cardboard circle serving as a make-believe cookie (Lillard, 1993). In the model task, in contrast, the child must keep equally in mind both the model itself and what it stands for.

Dual representation becomes less of a challenge with age; the 2½-year-olds who have such difficulty in the standard-model task find the same task very simple 6 months later. Several factors probably contribute to this improvement. For one thing, experience with a range of symbols makes children increasingly sensitive to the possibility that a given entity should be interpreted as a representation of something other than itself (DeLoache, 1995a, 1995b; Liben, 1999; Marzolf & DeLoache, 1994). Between 2½ and 3 years of age, most American children have a great deal of experience with various symbols, especially pictures, and they engage in a substantial amount of symbolic play. Such experiences presumably help them to achieve "psychological distance" (Sigel, 1970) and contribute to the development of abstract thought.

A closely related development occurs in young children's understanding of the thoughts and intentions of other people. Interpreting a symbol involves understanding what someone else intends to communicate by using it (Tomasello, 1999). In the model task, the child has to understand at some level what relation the experimenter intends there to be between the model and room. Discerning the communicative intent of the experimenter's instructions is part of achieving dual representation (DeLoache et al., 1999).

The ability to achieve dual representation is presumably facilitated by other, very general developmental accomplishments. One is probably children's steadily increasing capacity for representing multiple relations (e.g., Case, 1992; Halford, 1993; Zelazo & Frye, 1997). Especially important is their growing skill in relying on deeper, structural (rather than superficial) relations among entities as the basis for reasoning between them (Gentner, Ratterman, Markman, & Kotovsky, 1995; Goswami, 1992).

A related development occurs in young children's ability to understand that a given entity can be perceived in more than one way. Flavell and his colleagues (Flavell, Green, & Flavell, 1986) have provided a wealth of examples of young children's difficulty in understanding that something can appear to be one thing when it is actually something different. In a related vein, Rock, Gopnick, and Hall (1994) recently reported that preschool children have difficulty perceiving both aspects of ambiguous figures. A 3-year-old who perceives a rabbit in the classic duck-rabbit ambiguous figure has trouble appreciating that it also looks like a duck.

Another likely source of young children's burgeoning symbolic ability in general, and their increased ease of achieving dual representation in particular, is increased ability to inhibit a prepotent response. To exploit the symbolic potential of a picture or scale model, a child must inhibit responding to a depicted object as if it were a real object or to a model as an interesting entity in its own right. The more salient and interesting a symbolic object is, the more difficult it is for the child to inhibit responding to the object itself. Dramatic improvement occurs throughout the first few years of life in general inhibitory control of behavior (Diamond, 1990; Harnishfeger & Bjorklund, 1993; Luria, 1973).

The ability to inhibit responding to a symbolic artifact just as an object thus underlies insight into its representational nature. There is a second, equally important relation between inhibition and symbol use. It is apparent in research showing that use of a symbol helps in the inhibition of a prepotent response. For example, in the classic studies of delay of gratification, children could delay longer when a picture indicated the prize they could have if they waited than when the prize itself was present (Mischel & Moore, 1973).

A similar result has been reported for chimpanzees who have been trained to use numbers (Boysen & Berntson, 1995; Boysen, Berntson, Hannan, & Cacioppo, 1996). In a challenging task, the chimps are simultaneously presented with two displays of different numbers of desirable objects. The rule is that the chimp will receive whichever display he or she does *not* choose. Success thus requires pointing to or otherwise indicating the smaller of the two displays. When the displays are constituted of real objects, the chimps are unable to inhibit responding to the larger set, thereby ending up with the smaller reward. When numerals constitute the displays, however, the chimps readily indicate the smaller number, thereby securing the larger reward for themselves.

In conclusion, a primary function of symbols is to free us from the here and now (Sigel, 1970; Werner & Kaplan, 1963), to enable us to think abstractly, to achieve a contemplative mode. The child's entree into the enormous cognitive power afforded by symbolic artifacts is the ability to achieve dual representation. Symbol–referent relations are never fully transparent (DeLoache et al., 1997; Liben, 1999); that is, one never sees directly through the symbol to what it represents without registering the symbolic medium (Ittelson, 1996). Many factors influence the attainment of dual representation, some specific to experience with symbols and some having to do with aspects of cognitive development in general.

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