Symbolic Functioning in Very Young Children: Understanding of Pictures and Models

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DELOACHE, JUDY S. Symbolic Functioning in Very Young Children: Understanding of Pictures and Models. CHILD DEVELOPMENT, 1991, 62, 736–752. Before one can understand or use any symbol, one must first realize that it is a symbol, that is, that it stands for or represents something other than itself. This article reports 4 studies investigating very young children’s understanding of 2 different kinds of symbolic stimuli—scale models and pictures. The data replicate previous findings that 2.5-year-old children have great difficulty appreciating the relation between a scale model and the larger space it represents, but that they very readily appreciate the relation between a picture and its referent. This result is interpreted in terms of the dual orientation hypothesis. Models are difficult for young children because they require a dual representation—a child must think about a model both as an object itself and as a representation of something else. Because pictures are not salient as real objects, they do not require a dual representation. Several kinds of evidence supporting the dual orientation hypothesis are presented. An additional result was the occurrence of a transfer effect: Prior experience with a picture task led to better performance on a subsequent model task. This finding suggests that experience with a symbolic medium they understand can help young children figure out a different, unfamiliar medium that they would otherwise not understand.

The benchmark of human cognition is our flexible use, interpretation, and creation of a variety of symbol systems. We expect children in our culture to master or begin to master several different symbol systems during the first few years of life, and young children make important developmental progress in this respect. The infant’s first word typically occurs somewhere near the first birthday, and by age 3, most children are producing and understanding complex, grammatical sentences. Even before the advent of speech, children use a variety of symbolic gestures to communicate with others (Acredolo & Goldwyn, 1985, 1988).

This article concerns the emergence of young children’s understanding of a particular type of symbol—a scale model. Children’s comprehension of models is interesting, not because models play an important role in young children’s everyday lives, but because of what they reveal about early symbolization and cognition in general. Although young children spend a great deal of time playing with representational toys—farm sets, doll houses, toy McDonald’s—these replica toys are not scale models. They have a very generic representational function; they represent a class of entities, but no specific entity. In contrast, a scale model is a three-dimensional artifact that represents a different, larger space. Specific elements in the model correspond to, but differ in some way from, elements in the larger, represented space. Relations among the elements are also preserved in the model.

A dramatic developmental difference was recently reported in young children’s reasoning from a scale model to a full-sized room (DeLoache, 1987). In this research, a young child watched as a miniature toy was hidden somewhere in a scale model of a room. Then the child was asked to find a larger, analogous toy concealed in the cor-

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1 Half the children experience the opposite; they observe the larger toy being hidden in the room, and then they search for the miniature one in the model. In the interests of easier communication, I shall continue to refer to the case in which the child watches the experimenter hide a toy in the model.

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responding place in the room itself. For example, a child observed a tiny toy dog being placed behind the miniature couch in the model and then searched for a larger toy dog that was hidden behind the full-sized couch in the room. To succeed in this task, children must: (1) recognize the correspondence between the model and the room, (2) map the elements of one space onto those of the other, and (3) use their knowledge of where the miniature toy was hidden to figure out where the larger toy must be.

In the original study using this task, a large difference was found in the performance of groups of young children only a few months apart in age (DeLoache, 1987). Three-year-olds who had watched a toy being hidden in one of the spaces knew where to find the analogous toy; they went directly to it 77% of the time. In contrast, most 2.5-year-old children had no idea where to look for the hidden toy, and their performance (15%) was at chance. The large discrepancy in the success of these two age groups was not due to differences in memory for the original location: when asked to retrieve the toy they had originally observed being hidden, both groups were highly successful (88% and 83% for the older and younger children, respectively). (This level of memory performance is very similar to that reported for very young children in location memory tasks—DeLoache, 1985.) The results of the original study have been replicated several times (DeLoache, 1989a, 1989b, 1991; DeLoache, Kolstad, & Anderson, 1991).

The 2.5-year-old children seemed to understand everything about the task except the critical fact that the room and model were related and hence that what happened in one told them something about the other. They understood that there were toys hidden in the model and the room and that they were supposed to find them. They used their memory to retrieve the toy they had seen being hidden. They willingly searched for the other; they just failed to realize they had any way of knowing where it was.

The large difference in performance between the two age groups is striking. Developmental phenomena rarely involve such abrupt change, from floor to near ceiling performance in only 6 months. The 2.5-year-olds’ failure to appreciate the correspondence between the two spaces is made all the more striking by the fact that they are explicitly told about it. Before the retrieval trials start, the children are told that, except for size, the two toys are alike and that the room and model are alike. On every trial, they are told and then reminded that the larger toy is in the place in the room corresponding to wherever the miniature toy is hidden in the model (“I’m hiding Little Snoopy here. I’m going to hide Big Snoopy in the same place in his room.”).

There are two main questions that need answering: (1) Why do 2.5-year-olds do so poorly in this task, that is, why do they have so much difficulty detecting the correspondence between the room and the model? (2) What is responsible for the abrupt change in performance between 2.5 and 3 years of age? This article primarily concerns the first question, although the answers proposed to it are relevant to the second as well.

Why is it so difficult for 2.5-year-olds to detect the correspondence between a scale model and a larger space? The answer may have to do with the inherently dual nature of models. A scale model is a symbol; it represents a larger space. Unlike many other kinds of symbols, however, a model is both a salient real object (or set of objects) itself and a symbol of something else. In the model task, one must think about the model in two different ways at the same time—as the object that it is and as a symbol for something it is not.

According to this line of reasoning, the 2.5-year-old children in the original model study (DeLoache, 1987) performed so poorly because they did not represent the model in two different ways at the same time. They clearly represented it as a concrete object; they played with it briefly before the experiment began, they watched the experimenter hide things in it, and they themselves retrieved objects from it. Perhaps they failed to represent its other, abstract, nature, that is, that the model stood for the room. Thinking of the model only as an interesting object, they failed to appreciate its relation to the room; as a consequence, they did not understand that what they saw happen in the model had implications for the unseen event in the room.

This line of reasoning leads to an unusual prediction—that 2.5-year-old children should actually do better when given information about the location of a hidden object by pictures rather than by a model. A picture is, of course, a real, tangible object. However, although a photograph or other two-dimensional representation is a real object
and hence has a certain "double reality" (Sigel, 1978), its primary function is as a representation of something else. When one looks at a picture, one normally thinks only of what it depicts, not of the picture as an object itself. Thus, it should not require a dual orientation in the way a model does and should, therefore, be easier to interpret. More precisely, using a picture to show 2.5-year-old children where a toy is concealed in a room should lead to a higher level of retrieval performance than is achieved with a scale model.

On other grounds, however, the prediction is counterintuitive. We think of objects as being more interesting, more salient, more informative than pictures. We generally expect young children to do better with real objects as stimuli than with pictorial stimuli, and there are numerous experiments showing such effects in a variety of tasks (e.g., Daehler, Lonardo, & Bukatko, 1979; DeLoache, 1986; Hartley, 1976; Sigel, 1953; Sigel, Anderson, & Shapiro, 1966; Sigel & Cocking, 1977; Sigel & Olmsted, 1970; Sorce, 1980; Steinberg, 1974).

In a study testing the picture-superiority prediction of the dual-orientation hypothesis (DeLoache, 1987, Experiment 2), a group of 2.5-year-old children participated in two tasks—the model task described above and a picture task in which four color photographs depicted the four hiding places (items of furniture) in the room. On each trial, the experimenter pointed to one of the photographs to indicate where the toy was hidden in the room ("This is where Snoopy is hiding; he's hiding back [under] here."). The children participated in the two tasks on different days, with task order counterbalanced across children.

The results were as predicted. The 2.5-year-old children successfully exploited the information in the pictures to retrieve the toy. Their first search was correct on 70% of the trials. Having seen the experimenter point at the picture of the chair, for example, they typically went right to the chair in the room and retrieved the toy from behind it. However, the same children performed very poorly in the model task; their success rate was only 15%. The results thus supported the dual-orientation hypothesis. A scale model is so salient and attractive as an object that 2.5-year-old children tend to respond to it only as a concrete object, and not also as an abstract symbol.

The research reported in this article constitutes a further investigation of the dual-orientation hypothesis. The four studies presented here replicate and extend the original results supporting the dual-orientation hypothesis (i.e., the superior performance with pictures), and they test additional hypotheses derived from it.

**Experiment 1**

Experiment 1 was designed to evaluate the dual-orientation hypothesis in three ways: by (1) probing the reliability of the picture-superiority phenomenon, (2) testing an alternative interpretation of the phenomenon, and (3) testing a different but related prediction from the dual-orientation hypothesis.

The first of these objectives was met by simply replicating the picture and model tasks in the original study (DeLoache, 1987, Experiment 2). Given the highly counterintuitive nature of the picture-superiority result and its central importance for the dual-orientation hypothesis, replication was deemed to be a crucial step in this program of research. Accordingly, one of the four conditions in Experiment 1 was the standard model task, in which the experimenter indicated where the toy was hidden in the room by hiding the miniature toy in the corresponding place in the model. The second condition was the picture task, in which the experimenter conveyed the same information by pointing at the photograph of the hiding place.

The third condition in Experiment 1 was designed to test an alternative interpretation of the picture-superiority result. There is a potentially important difference between the model and picture tasks, other than the necessity for a dual orientation. In the model task, the child has to form a representation of a hiding event—the experimenter placing a toy in a particular position, that is, putting one object (the toy) in a particular relation with a second object (the item of furniture under or behind which the toy is hidden). In contrast, in the picture task, the child may only have to represent the item of furniture to which the experimenter points. It is possible that the previously reported superiority of pictures over the model (DeLoache, 1987) was due to these differences in how the crucial information was communicated—via a hiding event versus pointing—rather than, as claimed, to the medium involved.

This possibility was tested in the third
condition, in which the experimenter simply pointed to the location in the model that corresponded to the hiding place of the toy in the room. If 2.5-year-old children have more difficulty representing a hiding event than a simple point, then they should perform much better when the correct place in the model is simply pointed out for them. On the other hand, if their problem is that they do not detect the model-room correspondence because of the need for dual representation, then it should not matter how the specific hiding place is communicated to them; performance should be equally poor either way. In other words, if a 2.5-year-old responds to the model only as an object and not as a symbol for the room, then that child will connect neither the experimenter pointing nor her hiding an object in the model with the corresponding event in the room.

In the fourth condition in this 2 × 2 design, the experimenter hid a miniature toy behind the appropriate picture to indicate to the child where the larger toy was hidden in the room. This condition provided an additional test of the dual-orientation hypothesis by coming at it from the opposite direction from the previous picture task. In this case, the child must think about a picture both as a representation of something else (e.g., a representation of the couch in the room) and as an object (a hiding place for the miniature toy). Thus, we again asked our young subjects to think about a single reality in two different ways—both as a symbol and as an object. According to the dual-orientation hypothesis, this condition should be difficult for 2.5-year-olds for the same reasons that the standard model task is difficult for them.

**Method**

**Subjects.**—The subjects for Experiment 1 were 32 2.5-year-old children (29 to 31 months, M = 30.6 months). One-fourth of the children of each gender were randomly assigned to one of four experimental conditions: hide-model, hide-picture, point-model, point-picture. Within each condition, half the children received one order of hiding places for the four trials, and the other half had the opposite order. In this and all the other studies reported here, names of potential subjects were obtained from files of newspaper birth announcements and from local day-care centers. Parents were contacted by telephone. The sample was predominantly white and middle class. No subjects were eliminated.

**Apparatus and materials.**—A two-room suite was used for Experiment 1 and for all the subsequent studies reported here. The larger of the two rooms (4.80 × 3.98 × 2.54 m) was furnished like a living room. It was carpeted and contained a couch, a coffee table, a large armchair, a small wooden dresser, a large floor pillow, a small pillow on the couch, and a built-in set of bookcases and cupboards along one wall.

For the model condition, a scale model (71 × 65 × 33 cm) of the large room sat on the floor of the adjacent small room, aligned in the same spatial orientation as the room. The model was constructed of plywood and was open at the top and one side (the wall opposite the couch and chair) for easy access. The model duplicated the main features and furnishings of the room, including carpeting, the built-in wall unit, a window with blinds, and all the items of furniture. Some of the model furnishings were perceptually very similar to their counterparts except for size, and some were not.²

For the picture condition, four 20 × 25-cm color photographs were used (the same pictures used in DeLoache, 1987, Experiment 2). Each photograph depicted one of the hiding places (pieces of furniture) in the room. The photographs were arranged in a semicircle on a low shelf in the small room. They were in the same order as the corresponding objects in the larger room.

The hidden objects for the two hiding conditions were a small plastic dog (2 cm high) and a larger stuffed dog (15 cm high). For the pointing conditions, only the larger toy was used.

**Procedure**

Each child was accompanied to the laboratory by a parent or preschool teacher. In all conditions, the child was given an extensive orientation phase. First, the experimenter showed the child the toy dog that would be used; for the subjects in the model condition, the larger dog was introduced as “Big Snoopy” and the smaller one as “Little

²The miniature couch was covered in the same fabric as the full-sized couch, and the miniature dresser was constructed of unstained, light wood like the dresser in the room. The floor pillows in the two spaces were of different fabric. The large armchair in the room was a black vinyl recliner; the small chair in the model was made of blue fabric pillows resting on a balsa-wood frame.
Snoopy.” In the picture condition, the larger dog was introduced as “Snoopy.” The experimenter then explicitly described and demonstrated the correspondence between the items of furniture in the room and, depending on the child’s condition, the corresponding objects in the model or the photographs. In both cases, she took the four miniature pieces of furniture or the photographs into the room and held each one up against its counterpart, while describing the correspondence between them.

For the last part of the orientation phase, in a further attempt to get across the correspondence between the room and the model or the pictures, the child was given an imitation trial. For the hide condition, the experimenter placed the miniature toy on the model table as the child watched; for the point conditions, she simply pointed to a picture of the table. In both cases, the experimenter said to the child, “[Big] Snoopy wants to go to his room and sit right here. You take him and help him sit there.” Immediately following the imitation trial, the experimental trials began.

Figure 1 shows the four experimental conditions formed by the combination of two different media—pictures and model—and two methods of denoting the location of the hidden toy—pointing and hiding. In each condition, there were four experimental trials, with a different hiding place used on each trial.

1. **Hide-model.**—Each trial in this condition involved three parts. (a) **Hiding event:** the child watched as the experimenter hid the miniature toy in the model, with a different hiding place used for each trial. The experimenter always called the child’s attention to the act of hiding, but she never referred to the hiding place by name: “Look, Little Snoopy is going to hide here.” The child was told that the second experimenter (who had previously been introduced) would hide the other toy: “Now Mary is going to hide Big Snoopy in the same place in his big room.” (b) **Retrieval 1—analagous object:** without retrieving the toy he or she had seen being hidden, the child was led into the adjoining room and asked to find the analogous toy. On every trial, before permit-
ting the child to search, the experimenter provided a reminder of the correspondence between the two hiding places: "Remember, Big Snoopy is hiding in the same place as Little Snoopy." If the toy was not found on the first search, the child was encouraged to continue searching other locations (although only the first search was counted). If necessary, the experimenter provided increasingly explicit hints until the child found the toy (the point being to maintain the child's motivation for the task). After the child retrieved the toy, either on the first or a prompted search, he or she was taken back to the model. (c) Retrieval 2—original object: next, the child was asked to retrieve the original toy that he or she had observed being hidden at the beginning of the trial. Retrieval 2 was thus a standard memory trial. The child was again prompted to continue searching if the first search was incorrect, and the trial always concluded with the child's retrieving the toy. Retrieval 2 was crucial for interpreting the data. If the child could find the original toy on retrieval 2, then any problems with retrieval 1 could not be due to simple forgetting or lack of motivation. The hide-model condition replicated the model task in earlier studies (DeLoache, 1987, 1989a, 1991).

2. Point-picture.—In this condition, the information about the hiding place in the room was conveyed to the child by the experimenter pointing at the appropriate piece of furniture in the photograph, saying, "This is where Snoopy is hiding. He's hiding [back, under] here." Only the larger dog was used in the point condition. The prompts were essentially the same as in the hide-model condition except for slight differences in wording. Since there was no hidden object in the point conditions, there was no retrieval 2. This condition replicated the photograph task used in DeLoache (1987).

3. Point-model.—To show the child where the toy was hidden in the room, the experimenter pointed to the appropriate miniature item of furniture in the model, explaining that the toy was hidden under or behind it. As in the point-picture condition, only the larger toy was used, and there was no retrieval 2.

4. Hide-picture.—This condition was like the hide-model one, except that the photographs were used instead of the model. On each trial, the experimenter hid the miniature dog behind a different one of the four photographs of the hiding place (pieces of furniture) in the room. The child performed both retrieval 1 and 2.

Results
The results are shown in Figure 2. The dependent variable, errorless retrievals, is the proportion of trials on which the child's first search for the toy hidden in the room was correct.

The first objective of this experiment was to assess the replicability of the picture-superiority finding in DeLoache (1987). Retrieval performance in the hide-model (25%) and point-picture (78%) conditions closely replicated the previous model (15%) and picture task (70%) results. The children's retrieval 2 performance was also as expected from the previous research; in the two conditions in which there was retrieval 2, hide-model and hide-picture, the children found the toy they had observed being hidden on 78% and 74% of the trials, respectively. This level of retrieval 2 success rules out memory or motivational deficiencies as possible explanations for the low retrieval 1 performance with the model.

The second purpose of this experiment was to see if children's retrieval 1 performance in the model task would differ as a function of how they learned where the toy was hidden, whether by watching the experimenter hide a toy (hide condition) or point at the appropriate location in the model (point condition). The results could not have been clearer; performance was exactly the same—25% errorless retrievals—in the hide-model and point-model conditions. In other words, the children performed poorly in the model task regardless of how the experimenter communicated where to search in the room. This result means that the difference between 2.5-year-olds' performance in the original model and picture studies (DeLoache, 1987) cannot be attributed to differences in the methods by which the relevant location was conveyed to them.

The third purpose of this experiment was to see if performance in the hide-picture condition would be poor, as predicted from the dual-orientation hypothesis. The errorless retrieval score in this condition was 0.

To evaluate the differences among the conditions, a 2 (medium: model or picture) × 2 (method: hide or point) ANOVA was performed on the retrieval data (retrieval 1 for the two hide conditions). In this and all the succeeding studies reported here, preliminary analyses indicated that neither gen-
under nor order of hiding places had any effect on the results, so they were not included in the analyses. There was a significant main effect of method, $F(1,28) = 16.64, p < .001$, as well as a significant interaction of method $\times$ medium, $F(1,24) = 16.64, p < .001$. As is apparent from Figure 2, performance was best in the point-picture condition. According to post hoc tests, performance in this condition was significantly different from the other three, which did not differ from each other.

One striking aspect of the data reported in previous studies using the model and picture tasks is its all-or-none character: Most subjects in most studies perform at relatively extreme levels (given the narrow range of possible scores), and the performance of most groups is similarly extremely high or low. The individual data for the present study show that pattern—only one of the 32 subjects received an intermediate score of 50% correct. The group data show similar extremes. The number of children (out of eight) who achieved 75% or better was: hide-model, 2; point-model, 1; hide-picture, 0; point-picture, 7.

**Discussion**

The results of Experiment 1 supported the dual-orientation hypothesis. In the two conditions in which the child was required to form a dual representation of a scale model (hide-model and point-model), performance was equally poor. Thus, simplifying the task demands by employing a simple point to one object rather than a hiding event involving two objects did not make the task easier for these young subjects. This was, of course, exactly the result predicted by the dual-orientation hypothesis: if young children fail to appreciate the model-room correspondence in the first place because of the difficulty of forming a dual representation of a single reality, then the difference between hiding and pointing is irrelevant.

The dual-orientation hypothesis was further supported by the results of the point-picture condition, which replicated those of the picture study reported earlier (DeLoache, 1987, Experiment 2). Given the counterintuitive nature of these results, as well as their importance to the theoretical claims being made, replication is obviously very valuable.

Support for the dual-orientation hypothesis also came from the fourth condition in Experiment 1—hide-picture. In this condition, the child watched as the experimenter hid the miniature dog behind one of the four pictures, telling the child, “This is where Snoopy is hiding in the room.” The young children found this condition incomprehensi-
sible; not a single child succeeded on a single retrieval 1 trial. Why should this condition have been so devastating?

One reason is that, as specified by the dual-orientation hypothesis, these 2.5-year-old children needed to achieve a dual representation of a single object to succeed in this condition. This result is thus the counterpart of the original model result. The standard model task (the hide-model condition here) is difficult because the young child is required to treat an object both as an object and as a symbol for something else. The hide-picture condition is difficult because the young child is required to treat a symbol both as a symbol for something else and as an object. We apparently induced our subjects to treat the pictures as objects; their high retrieval 2 scores indicated that they understood them as hiding places. However, responding to the pictures as objects seems to have blocked interpreting them as symbols of something else.

A second reason for the extremely low performance of the children in this condition is that it violated the normal symbolic function of pictures. By 2.5 years of age, children have learned a great deal about pictures, including the conventional use of them as representations of what they depict (Burns, 1990; DeLoache & Burns, 1989). Pictures are normally responded to in terms of their referents, not in terms of themselves as objects. In other words, we confronted our subjects with an anomalous use of symbols. Their retrieval score of 0% suggests that they did indeed find the situation anomalous.

Experiment 1 thus succeeded in adding support for the dual-orientation hypothesis: The data from all four conditions of the study are consistent with it. In addition, the results from the hide-picture condition suggest that 2.5-year-old children's familiarity with pictures as symbols (Burns, in progress; DeLoache & Burns, 1989) makes it difficult for them to cope with a task that violates the normal symbolic function of pictures.

Experiment 1a

Experiment 1a was designed to investigate further the intriguing results of the hide-picture condition in the previous study. The goal of this study was to present 2.5-year-old children with a somewhat different situation that again involved using symbols in an anomalous way. To indicate where the toy dog was hidden in the room, the experimenter hid a small cut-out picture of it under a cut-out picture of one of the items of furniture. Thus, both the hidden item and its hiding place were pictures being treated as objects.

Method

Subjects.—The subjects for this study were 10 2.5-year-old children (29 to 32 months, M = 30.6 months). Two orders of hiding places were counterbalanced with gender. No subjects were eliminated.

Materials.—Cut-outs of the four pieces of furniture depicted in the photographs used in Experiment 1 were used, along with a cut-out of a photograph of the small toy dog. The size of the furniture cut-outs averaged approximately 12 × 15 cm, and the dog was 4 cm high.

Procedure.—On each trial, the child watched the experimenter hide the cut-out of the dog under one of the furniture cut-outs (with a different picture used on each trial). Otherwise, the procedure was exactly like that in the hide-picture condition of Experiment 1.

Results and Discussion

The children in this study scored 12% on retrieval 1. All but two subjects had scores of 0. One child got one retrieval right, and the other achieved a perfect score. This overall level of performance does not differ from the 0% of the subjects in the hide-picture condition of Experiment 1, but it is clearly different from the 78% achieved by the subjects in the point-picture condition in that study. The retrieval 2 (the memory and motivation check) performance of the children in Experiment 1a was 90% correct. Thus, the very low score for retrieval 1 was not due to a failure to remember where they had seen the cut-out dog being hidden.

The results of Experiment 1a thus agree with those of the first experiment reported here. Young children have difficulty viewing a two-dimensional symbol both as a symbol and as an object, just as they have difficulty viewing a three-dimensional model both as an object and as a symbol of something else. Our treatment of the cut-out pictures as though they were objects apparently destroyed their symbolic potential for all but one child.

Experiment 2

The general pattern that has emerged from the picture-model comparisons in the original study (DeLoache, 1987) and Experiment 1 here is that a task that requires a dual
orientation is extremely difficult for 2.5-year-old children. A highly similar task that does not require them to represent a single reality in two different ways is very easy for the same children.

Experiment 2 was designed to investigate the generality of the previously reported picture-superiority effect. The two experiments in which the effect has been found (the point-picture condition of Experiment 1 here and Experiment 2 of DeLoache, 1987) both used four color photographs, each of which depicted a single one of the four hiding places in the room. Accordingly, in Experiment 2, two new picture conditions were introduced—a wide-angle photograph of the room and a line drawing of the room. Both of these stimuli showed approximately two-thirds of the room and depicted all of the four objects used as hiding places.

To the extent that the dual-orientation hypothesis is correct, performance in these new picture conditions should be superior to performance in the model task and comparable to that obtained with the multiple-pictures task of the original report (and the point-picture condition in Experiment 1 here). Even though the three types of pictorial stimuli vary quite substantially, none requires a dual representation.

A demonstration of similar performance in the two new picture conditions to that reported for the multipictures condition would provide important support for the dual-orientation hypothesis, since there were many differences among these three conditions that might be expected to produce quite different results. One was in terms of the amount of information depicted. In both the wide-angle photograph and line drawing, there was much more information than was present in the single photographs. Thus, the amount of information the two new pictures contained was comparable to that available in the model. A second potentially important difference was the degree of iconicity. The individual color photographs were highly iconic stimuli; each bore a high degree of resemblance and fidelity to what was depicted in it. In contrast, the line drawing was much less realistic and less iconic than any of the color photographs.

Method

Subjects.—The subjects for Experiment 2 were 32 children (29 to 33 months, M = 30.6 months). Half the girls and half the boys were randomly assigned to one of two picture conditions—wide-angle photograph and line drawing. In order to have a direct comparison of model and picture task performance, all subjects participated in both. Half the children in each condition participated in the picture task first and the model task second, and half had the opposite order of tasks. Within each task and task order, there were two different orders of hiding places. Two subjects were dropped from the study, one for failure to return on the second day and the other for extreme inattentiveness on the first day.

Apparatus and materials.—Two different 28 × 36-cm pictures were used. One of the pictures was a wide-angle color photograph of the room. The second picture was a lightly tinted line drawing. It was produced by tracing over the wide-angle photograph and then lightly coloring in the appropriate shades using color pencils. The two pictures showed the same view of approximately two-thirds of the room, and they clearly depicted all four of the items of furniture used as hiding places, plus the table used for the imitation placement trial during the orientation. The picture sat on a low shelf inside the small room (in the same place in which the four individual photographs had been in Experiment 1 here and in DeLoache, 1987, Experiment 2). The scale model and the toy dogs were the same ones used in Experiment 1.

Procedure.—All subjects participated in both the picture and the model tasks. They were observed in one task in one testing session and the other task in a second session 1 to 2 days later.

The procedure for the model task was exactly the same as the procedure for the hide-model condition in Experiment 1. The procedure for the picture task was the same as the procedure in the point-picture condition of Experiment 1, with one exception. On each trial, the experimenter pointed to the appropriate item of furniture in the single large picture of the room, rather than to the individual photograph of that item.

Results

The data from Experiment 2 are shown in Figure 3. Once again, performance was much better in the picture task than in the model task—84% versus 41% errorless retrievals, respectively (replicating the Experiment 1 data and the original picture study, DeLoache, 1987, Experiment 2). There was no difference between the retrieval 1 scores in the wide-angle photograph and the line drawing conditions (81% and 86%). The re-
The retrieval data for the model task were, as expected, uniformly high, ranging from 75% to 94%.

The retrieval data for the picture task and retrieval 1 of the model task were analyzed in a 2 (task: model vs. picture) × 2 (task order: picture-model vs. model-picture) mixed MANOVA with task as the within-subjects variable. As expected, the main effect of task was significant, $F(1,28) = 60.66, p < .001$. The main effect of order was marginally significant, $F(1,28) = 3.90, p < .06$.

Figure 4 also depicts the significant interaction that occurred between task and task order, $F(1,28) = 21.33, p < .001$. Order made no difference in the picture task; the children were very successful regardless of whether it preceded or followed the model task (80% and 88%, respectively, 26 of 32 subjects with 75% or better). In the model task, however, the children's performance was different for the two orders. The children who received the model task first had a very low score (20% errorless retrievals), one comparable to what has been reported for the model task in Experiment 1 and in previous research. However, children of the same age did much better when they received the model task second (63%), after having first participated in the picture task. This transfer effect accounts for the unusually high retrieval 1 score (41%) achieved in this study. Half (eight of 16) of the children who received the model task second were successful in it (i.e., they had retrieval 1 scores of 75% or better). In contrast, only two of the 16 children who participated in the model task first were successful.

Discussion

Experiment 2 provided two important results—replication of the picture-superiority effect (DeLoache, 1987, Experiment 2) and the discovery of a picture-model transfer effect. The data reported here extend the former effect to a range of pictorial stimuli: the phenomenon has now been shown for separate photographs of individual objects, a wide-angle photograph of a scene, and a line drawing of a scene. These results discourage the possible criticism that the color photographs of individual objects used in the original study may have been too simple or too iconic to provide an adequate test of the dual-orientation hypothesis. As it turned out, the more complex pictures (i.e., pictures with more information in them) resulted in slightly better performance and hence provided even stronger support for the hypothesis.

It is interesting to note that the highest absolute level of performance actually occurred with the line drawing. In other words, the least iconic stimulus, the one that least resembled the objects that it repre-
sented, was certainly as effective as the more iconic representations.

The results of Experiment 2 thus provide additional support for the dual-orientation hypothesis by replicating the original picture-superiority effect and showing that it can be generalized to other stimuli. It should be noted that the necessity for a dual orientation is probably not the only reason young children perform better with pictures. As mentioned in the introduction, young children have little, if any, experience with real models. However, by 2.5 years of age, middle-class children in this culture have typically had a great deal of experience with pictures. They have learned, among other things, the crucial fact that pictures are representations of something other than themselves (Burns, 1990; DeLoache & Burns, 1989). Thus, simple familiarity with the medium probably contributes to the very high level of performance in these picture tasks.

The second major result of Experiment 2 was the discovery of a transfer effect shown in Figure 4. The group of children who participated in the picture task on day 1 performed better in the model task on day 2 than did those children who received the model task on day 1. The picture experience induced approximately half of the 2.5-year-olds to succeed with the model.

A transfer effect was not found in the original picture study (DeLoache, 1987), in which the order of the picture and model tasks was also counterbalanced. The means were, however, in the same direction. The key may be the slight difference in overall performance in the picture tasks: in the original study, errorless retrievals averaged 70% in the picture task, whereas in Experiment 2 here the comparable figures were 80% for the group that received the wide-angle photograph before the model and 75% for the line drawing group. Only children who had been successful in the picture task were successful in the subsequent model task; thus, the slightly lower overall performance in the original study may have been inadequate to support a significant level of transfer.

This significant transfer effect is important for two reasons. First, it suggests that young children's prior symbolic experience may affect their understanding of scale models. Participating in a task in which they understood the relevant symbolic relation (the relation between a picture and what it represents) helped these 2.5-year-olds to catch on to a task with a different symbolic relation that they would otherwise not have appreciated.

It is possible that transfer also occurred in the opposite direction—from the model to the picture task. The children's performance in the picture task on day 2, after par-
participating in the model task on day 1, was slightly but not significantly better than that of the children receiving the picture task first. Thus, experience with the model task on the first day may have facilitated performance in the picture task on the second day, but with a ceiling effect limiting the degree of improvement shown. This possibility is made less likely by the results of some current work explicitly investigating transfer (Marzolf & DeLoache, in progress). In one study, 2.5-year-olds participated in the standard model task on 2 days. There was no evidence of transfer: Performance was equally poor both days.

The second reason that the transfer effect reported here is important is that it demonstrates that 2.5-year-olds are capable, under some circumstances, of understanding scale models. Thus, 2.5-year-olds' failure in a large number of studies using the standard model task does not reflect an absolute inability to appreciate a model-room relation. Rather, the model task is very difficult for this age group, but given adequate support, they can succeed in it.

This result agrees with a finding reported by DeLoache et al. (1991). In one study on the effect of different levels of physical similarity on young children's understanding of models, 2.5-year-olds succeeded in a model task in which there was an extremely high degree of physical similarity between the model and the larger space it represented. The objects in the two spaces had similar surface appearance (as in the model conditions of Experiment 1 here), and the two spaces were also highly similar in scale: the larger space was only twice as large as the model, and both were small-scale, surveyable spaces. Thus, we now know two conditions in which 2.5-year-olds can understand a scale model—when there is an extremely high level of physical similarity between the spaces, and when the children have had prior experience with a different but relevant symbol-referent relation.

This transfer finding raises several questions, the most obvious of which is how general the transfer effect is. One possibility is that it is highly specific. Experience with a picture that depicts a particular room and the objects in it may simply help children interpret a scale model that represents that same room and its furnishings. A second possibility is that the effect is more general. At the extreme, it may be that experience with a task that activates one symbolic system that children understand makes them more receptive to learning a new type of symbolic relation. Thus, there might be some kind of very general heightening of symbolic awareness at work. A less extreme version of a general effect would be that experience with a symbolic relation that does not require a dual orientation—pictures—helps young children to understand a situation that does require a dual orientation—a model.

**Experiment 3**

Experiment 3 was designed to investigate whether the transfer effect reported in Experiment 2 was specific to the particular situation or whether a more general transfer effect might be possible. A modest level of generality was assessed: transfer was examined from a picture task in which the picture represented one room to a model task in which the model represented a different room. Significant transfer in this situation would indicate that the transfer effect found in Experiment 2 was not restricted to the case in which the picture and model represent the same, single space.

**Method**

*Subjects.*—The subjects in the general transfer group in Experiment 3 were 14 2.5-year-olds (29 to 33 months, \( M = 30.7 \) months). Gender and order of hiding places were approximately balanced. Because the focus of the study was transfer from the picture to the model task, only subjects who scored 50% or better on the day 1 picture task were included in the study. Five additional children (29–32 months, \( M = 30.6 \) months) were tested but failed to meet this criterion and were eliminated.\(^3\)

Comparison data came from the children tested in Experiment 2. The same criterion of 50% or better on the picture task was applied to the comparison groups, resulting in the elimination of the data of three of the 32 Experiment 2 subjects. The specific transfer group comprised 14 children (29–32 months, \( M = 30.4 \) months) in Experiment

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\(^3\) Although the overall performance of the 19 children was 70% in the picture task (comparable to the figure reported in the original picture study), the failure of five children to achieve 50% or better was surprising. However, this study was run in a non-air-conditioned room during a very hot summer. The experimenters think the temperature was probably responsible for so many children doing less well than expected.
2 who had experienced one of the picture conditions in their first session, and the no-transfer group included 15 children (29–33 months, M = 30.7) from Experiment 2 who had received the model task first.

**Materials and apparatus.**—The stimuli for this experiment included a scale model of one room and a picture of a different room. One of the rooms was the same one used in all the other studies above, and the scale model of that room was used again. A second room (2.7 × 4.8 m) served as a different retrieval space. The hiding places in this room were under a pillow on a chair, behind a different armchair, under a floor pillow, and behind a dresser. The room’s furnishings also included built-in cupboards and shelves along one wall, a small table, and a waste basket. A 28 × 36-cm line drawing was made of the room (again tracing from a blown-up wide-angle photograph of the room). Like the line drawing in Experiment 2, it was lightly tinted with colored pencil.

**Procedure.**—The procedure was the same as that followed in Experiment 2, with two exceptions: (1) All the general transfer subjects participated in the picture task in the first session and the model task in the second session. (2) The drawing and the model represented two different rooms; the children retrieved the hidden toy from the new room on the first day and from the room used in the previous studies on the second day.

**Results and Discussion**

The general transfer group achieved a high score on the picture task—89% errorless retrievals. The comparable figures for the specific and no-transfer groups were 91% and 92%, respectively. (These figures include only those subjects with scores of 50% or better.)

There were two crucial questions regarding the performance of the general transfer group in the model task: (1) Was there evidence of transfer; that is, was the retrieval 1 score of the general transfer group superior to that of the no transfer group? (2) If so, was the level of performance of the general transfer group equal to or less than that of the specific transfer group?

To evaluate these questions, a one-way ANOVA was performed on the retrieval 1 model task scores of the three transfer groups. There was a main effect, $F(2,40) = 8.22$, $p < .001$. A Newman-Keuls test ($p = .05$) revealed that both the general (55%) and the specific (69%) transfer groups were significantly better than the no transfer (22%) group, but they did not differ from each other. A comparable analysis of performance in the picture tasks produced no significant differences among the three groups.

Our two questions thus received clear answers: (1) There was indeed evidence of transfer. The experience of participating in a picture task with one room helped the general transfer subjects to subsequently appreciate the relation between a scale model and a different room. (2) The general transfer group did not differ significantly from the specific transfer group.

The results of Experiment 2a thus provide further evidence that experience with a symbolic task that does not require a dual orientation helps young children figure out a task that does require a dual orientation. More generally, the results support the idea that participation in one task involving one particular symbolic relation has a generalized effect on participation in subsequent tasks involving different symbolic relations. At the most general level, these results suggest that learning one symbol system may aid young children in learning others through a general heightening of symbolic awareness, an increased proclivity to notice and perhaps even to look for symbolic relations among stimuli in the environment.

**General Discussion**

The four studies reported here provide strong support for the dual-orientation hypothesis, and they also increase our understanding of early symbolic functioning in general. First, the superiority of pictures over the model in the original model report (DeLoache, 1987) was replicated twice. This counterintuitive result is obviously a highly reliable one.

Second, the experiments reported here extend the range of stimuli for which this effect has been demonstrated. The picture tasks involved two different rooms with different furnishings, establishing that the phenomenon is not restricted to a single setting. More important, the same result has now been obtained with three different kinds of pictorial stimuli—color photographs of individual objects, a wide-angle photograph of a scene, and a line drawing of the scene. Not only was performance better with all three of these stimuli than with the scale model, but it was equally good with all three. This equivalence is somewhat surprising, given
the extent to which these stimuli differ from one another in complexity and fidelity. The individual photographs depict a single object; the wide-angle one shows many objects. The wide-angle color photograph is a highly faithful representation of the room; the line drawing is much less so. They are all, however, two-dimensional representations, and they are all more comprehensible to very young children than a three-dimensional model is.

Third, the data reported here provide additional support for the dual-orientation hypothesis by eliminating a reasonable alternative explanation of the picture/model result in the original study (DeLoache, 1987). The results of Experiment 1 showed that the difference between 2.5-year-old children’s performance in the model and picture tasks is not attributable to differences in the method of conveying the relevant information to them. Rather, that difference is due to the medium in which the information is conveyed.

A fourth form of support for the dual-orientation hypothesis comes from what occurred when we asked our 2.5-year-old subjects to treat pictures as objects. In the hide-picture condition in Experiment 1, the four pictures served as "hiding places" for the miniature toy, and in Experiment 1a, a cut-out photograph was hidden under one of four other cut-outs. We apparently succeeded in getting the children to respond to the pictures as objects. As a consequence, however, they almost completely failed to respond to them as symbols. (Only one of the 18 children in the two conditions was at all successful at retrieving the hidden toy.) Two factors presumably combined to produce the dramatic failure evidenced in these two situations—the necessity for a dual representation plus the anomalous treatment of pictures.

Having concluded that the necessity for a dual orientation is what causes young children so much trouble in the model task (and makes a model more problematic than pictures), we must now ask why it is so difficult to achieve a dual representation in this task. This question is especially pertinent, given young children’s success at a dual representation in another sphere—pretense.

It is well established that children become capable of some kinds of object substitutions during the second year of life (Leslie, 1987; Ungerer, Zelazo, Kearsley, & O’Leary, 1981). Most 18-month-olds, for example, can readily pretend that a block of wood is a car or that a banana is a telephone. Thus, they are capable of representing a single thing in two different ways: they can think of a block as what they know it actually is—a rectangular piece of wood—and they can think of it as something they know very well it is not—an automobile. Why do object substitutions such as these emerge so long before competence in the model task?

There are several interrelated and interacting variables that may make it hard for very young children to achieve a dual representation of a scale model. First, as has been referred to before, is the salience of a model as an object. Our model is very compelling as an object. To a child’s eye, it is a highly attractive, unusual, complex toy. Our youngest subjects seem to be captivated by the model as something to play with. They respond to its concrete, physical reality. Its high salience and attractiveness as an object blocks awareness of its symbolic relation to anything else.

Something similar seems to happen in play. Before 2.5 or 3 years, children find it difficult to perform object substitutions with objects whose functions are known. Successful object substitutions tend to be restricted to objects with ambiguous or unknown functions, such as a plain wooden block (Peder son, Rook-Green, & Elder, 1981). Children gradually become capable of pretending with familiar objects; they become increasingly able to ignore what they know something actually is in order to treat it as something else. In other words, they develop the ability to inhibit or disregard their spontaneous, dominant response to a known object in order to respond to it in a novel way, as a representation of something else. In the model task, children override their dominant response to the model as an enticing toy to respond to its symbolic function.

A second factor that makes using a model more difficult for young children than engaging in pretense is “referential specificity” (DeLoache, 1989a, 1991). A scale model represents or stands for a specific other reality. The model used in the research reported here stands for one particular room. Each miniature object in the model represents a particular larger object in the room. The child has to understand the overall relation between the two spaces, as well as the correspondences between all of the individual items, and must apply the infor-
mation gained from the model in a very specific way to the room.

In contrast, it is fairly rare that 2-year-old children represent a specific reality or experience in their play. Their replica toys rarely represent anything in their immediate environment or direct experience. A child may have a fleet of vehicles, but none of them is a model of his or her father's Oldsmobile or any other car the child has ridden in. Similarly, young children's picturebooks mostly contain generic representations. The picture of a dog illustrating the letter "D" in an alphabet book stands for dogs in general, not for any particular dog.

Another difference between our model task and pretense is the source of the representational relation—the child him or herself versus another person. In play, it is the child who incepts the symbolic mapping, who decides that the broom is a serviceable horse (although young children's mothers and siblings often assist them in their early symbolic play—Bretherton, 1984; DeLoache, Asmussen, & Plaetzer, 1990; Dunn & Wooding, 1977). In the model situation, the child must discover the symbolic relation that we have created. In the former case, the starting point is the child's own idea; that idea then guides his or her selection and use of objects to carry it out. In the latter, we try to convey to the child our idea of how the model and room are related. In play, the child starts out with the second representation—what the object will stand for—already in mind; in the model task, the second representation of the model must be generated.

Finally, perhaps the most important factor that makes using a model more difficult than pretense is the fact that success in the model task requires that the child think of the model in two different ways at the same time. Although pretense also involves a dual representation, the child does not need to use both representations. The child knows his car is really a block of wood; however, to use it as a car, he does not have to think about it as a block at all. In the model task, the child must think about and respond to the model both as a symbol and as an object at the same time; both representations must be active.

What does this research on scale models tell us about early symbolic development in general? The results emphasize that the first, crucial step to understanding and interpreting a symbol is the realization that it is a symbol. The inescapable first step is awareness of the existence of a symbolic relation, that one thing stands for another. The model studies make it clear that this is not necessarily a simple step. The relation that is transparent to older children is surprisingly opaque to younger ones.

Awareness of the relevant symbolic relation is presumably the first hurdle for all symbol systems that children encounter. Researchers in language development have long referred to the "naming insight," the child's initial realization that things have names. There is a growing body of research on "print awareness" (Teale & Sulzby, 1986), the insight that those wiggly black marks on the pages of books mean something.

In research currently under way with pictures, it is becoming apparent that the initial hurdle for very young children is coming to understand that a picture can represent a specific other reality, that one can learn something new from a picture that has meaning in the world. In a series of studies analogous to the model research, Burns (1990; DeLoache & Burns, 1989) has been examining very young children's understanding of the symbolic function of photographs. She shows children photographs that depict a toy hidden in a room (e.g., a picture of Big Bird concealed behind a chair). Her 2.5-year-old subjects understand that the pictures represent an existing state of affairs, that is, the precise location of the toy. Having seen the picture, they can find Big Bird. The 2.0-year-olds apparently do not appreciate the symbolic function of the pictures. In spite of the fact that they can recognize and name all the items in the picture ("That's Big Bird. That's a chair."), they have no idea where to find the toy. The younger children know some things about pictures, but they seem not to know that a picture can have a specific, informative relation to reality.

The picture-to-model transfer effects reported in Experiments 2 and 3 are quite provocative in that they suggest that prior experience with a symbolic relation they already understand can help young children appreciate a different symbolic relation they would otherwise fail to appreciate. This effect is powerful. Over a larger number of studies employing different small-scale models of large-scale spaces, only one group of 2.5-year-old children has achieved any ap-
preciable degree of success—those children who had a picture task before a model task. How far can we generalize from this result?

It is possible that symbolic development is cumulative—experience with one symbol system may help children to become aware of and learn other symbol systems. In general, having achieved a "representational insight" with respect to one symbolic relation, young children may more readily become aware of another such relation. This possibility will be explored in future work.

As the model research illustrates, gaining symbolic insight is not fully sufficient to become a flexible symbol user. Children's initial use of a new (to them) symbol system is probably always characterized by rigidity and inflexibility. With respect to language, for example, children who have discovered that words can name things cling to the belief that an object's name is an inherent property of the object itself—the phenomenon of nominal realism. In the studies reported here, the young children who understood a great deal about pictures were not flexible enough to treat them both as symbols and objects. A mature symbol user can adopt an "as if" stance to virtually anything; a fledgling symbol user cannot.

References


