Child Development, November/December 2004, Volume 75, Number 6, Pages 1708–1718

Transfer by Very Young Children in the Symbolic Retrieval Task

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Cumulative experience with a variety of symbolic artifacts has been hypothesized as a source of young children's increasing sensitivity to new symbol-referent relations. Evidence for this hypothesis comes from transfer studies showing that experience with a relatively easy symbolic retrieval task improves performance on a more difficult task. Significant transfer was found for the $2\frac{1}{2}$-year-old children in the 3 studies reported here, even with relatively low levels of contextual support (according to the taxonomy of transfer by Barnett & Ceci, 2002). Transfer occurred even though the 2 tasks were encountered in very different settings and there was a prolonged (1-week) delay interval between them. Transfer also occurred to a much more difficult task (one that even 3-year-olds typically fail).

A major developmental task in which children are engaged from the beginning is acquiring world knowledge, and a great deal of vital information about the world comes from direct observation. Children learn about the physical world through observing objects and events, and they learn about the social world by observing and imitating the behavior of other people. World knowledge could not grow without some direct experience.

Children are not, however, limited to direct experience as a source of knowledge. Their symbolic capacity enables them to acquire vast stores of information indirectly. Through language, other people provide children with factual information, instruct them in how to do things, describe past and future events, and so on. Symbolic artifacts also provide a wealth of information. Through pictures, even very young children become familiar with novel entities, and with age they increasingly benefit from information conveyed via video, maps, calendars, graphs, and many other symbolic artifacts.

For a symbolic artifact to be an effective informational tool, a child must have some understanding of the relation between the symbol and its referent; the child must achieve representational insight with respect to that particular symbol–referent relation (DeLoache, 1995). Research has established that over the first few years of life children become increasingly adept at detecting and exploiting symbolic relations (see Bloom, 2000; DeLoache, Miller, & Pierroutsakos, 1998; Liben, 1999; Newcombe & Huttenlocher, 2000). A substantial body of research employs tasks in which a symbolic artifact is the only source of information to solve a problem. For example, in symbol-based retrieval tasks, such as the scale model task first used by DeLoache (1987), children have to use their memory for where they saw a miniature toy being hidden in a scale model to figure out where to find a larger toy hidden in the corresponding location in the larger space.

This task is in essence a form of analogical reasoning problem that involves mapping a common relational structure from one space to another (Chen, 2003; DeLoache et al., 1998; Gentner & Rattermann, 1991; Loewenstein & Gentner, 2001; O'Sullivan, Mitchell, & Daehler, 2001; Rattermann & Gentner, 1998). The relational structure includes, at the lowest level, the relation between the toy and its hiding place in one space. At the next level, that space is related to the other in that they contain corresponding objects (small chair, large chair) that are similar in appearance and are situated in corresponding positions. At the highest level, the hiding event observed in one space is related to and provides information about the unseen event in the other space. That relation exists only through the intentional actions of the experimenter: A child can know where to search in the room only because the experimenter creates corresponding toy-hiding place relations on every trial. Thus, the overall relational structure of the model task is that an adult hides two toys in

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The research reported here was supported by National Institutes of Health (NIH) Grant HD25271 to the first author, as well as by a grant from the Institute of Educational Sciences, Department of Education, Grant R305H020088, and NIH Training Grant HD07323. It was conducted by the first and third authors at the University of Illinois. We thank Kathy Anderson for her many invaluable contributions to the research.

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 0009-3920/2004/7506-0006

corresponding locations in two spaces. The task taps young children's ability to detect symbolic relations and to perform analogical mappings from the event observed in one space to the unseen event in the other (Chen, 2003).

At all ages tested, children's performance in the model task is a joint function of multiple variables, including the instructions provided to them, the perceptual similarity of the corresponding objects in the two spaces, the congruence of spatial relations among those objects, and the similarity in the overall size of the two spaces (see DeLoache, 2002, for a summary). Comparing across several studies, there is a progressive decrement with age in the amount of information children must be given to solve the model-room task.

As Table 1 shows, $2\frac{1}{2}$-year-olds succeed in the model task only if (a) they are given full and explicit instructions about the relation, (b) the corresponding objects in the two spaces look very much alike, (c) the corresponding objects are in the same relative positions in the two spaces, and (d) the overall dimensions of the two spaces are highly similar (i.e., a small scale model and a space only twice as large). In contrast, 3-year-olds usually perform successfully in the task even if the size difference between the two spaces is large (e.g., a small scale model and a large room). They must, however, receive full instructions, and there must be a high degree of surface similarity between the corresponding objects. Not until 5 years of age can children figure out the model-room relation on their own without having it explicitly described to them (DeLoache, deMendoza, & Anderson, 1999). Thus, younger children need extensive contextual support to exploit a model-room relation, but with age children become increasingly capable of detecting and using such symbol-referent relations on their own.

One factor that has been hypothesized to make an important contribution to children's increasing ability to achieve representational insight with novel symbolic artifacts is their prior experience with symbols (DeLoache, 1995, 2002; Marzolf & DeLoache, 1994). It has been proposed that children's cumulative experience with a variety of symbolic artifacts (pictures, picture books, video, replica toys, and so on) contributes to the development of symbolic sensitivity—a general readiness or proclivity to interpret a novel entity primarily in terms of something other than itself (DeLoache, 1995, 2002). Thus, with age and symbolic experience, children become increasingly likely to appreciate that a novel entity is being used by another person to stand for something other than itself.

A prediction that follows from this view is that achieving representational insight with one symbol should increase the likelihood that a child will achieve representational insight with others. This hypothesis has received support from transfer studies using the scale model and related tasks with very young children. In an adaptation of the standard easy-to-hard transfer paradigm often employed in research on analogical reasoning in young children (e.g., Brown, 1989), children first participated in a symbolic retrieval task known to be relatively easy for their age group and then in a task known to be difficult for them. Thus, in one transfer study (Marzolf & DeLoache, 1994), $2\frac{1}{2}$-year-olds were first given the similar-scale task (in which the model and larger space are relatively similar in size). As expected, they performed reasonably well (67% correct retrievals). The next day, they were tested in the standard model

Table 1
Summary of Performance in Scale Model Tasks as a Function of Multiple Variables

	Object similarity	Size similarity	Spatial similarity	Instructions	Performance
Age group					
2.5-year-olds					
Similar scale	High	High	High	High	Good
Standard model	High	Low	High	High	Poor
Low object similarity	Low	High	High	High	Poor
Minimal instructions	High	High	High	Low	Poor
3-year-olds					
Similar scale	High	High	High	High	Good
Standard model	High	Low	High	High	Good
Low object similarity	Low	Low	High	High	Poor
Minimal instructions	High	High	High	Low	Poor
Spatial relations	High	Low	Low	Low	Poor

task (using a small model of a full-sized room). These children were much more successful in the standard, difficult task (67%) than were children who had not had the easy task first (35%).

Transfer effects have also been established for 3-year-olds: After successful performance in the standard model task (88%), children of this age were equally successful in the difficult model task with a low level of similarity between the objects in the two spaces (88%; Marzolf & DeLoache, 1994). Thus, for both $2\frac{1}{2}$ - and 3-year-old children, prior experience with a model task that they understood helped children appreciate a model–room relation that would otherwise have eluded them.

Following the same logic, transfer has also been shown from picture and video tasks to scale models. In multiple studies, $2\frac{1}{2}$-year-olds' performance in the standard model task was better after they had experienced the easier task in which the experimenter pointed out the relevant hiding place on a picture of the room (DeLoache, 1987; DeLoache, Kolstad, & Anderson, 1991; Marzolf & DeLoache, 1994). Similarly, after a task in which the hiding event is observed on a video monitor, $2\frac{1}{2}$-year-olds were more successful in the standard model task than is typical for their age group (Troseth, 2003; Troseth & DeLoache, 1998). The successful transfer in all these studies has been interpreted as evidence that achieving representational insight into the relation between one symbol and its referent makes children more sensitive to the existence of another such relation.

Further evidence for the importance of representational insight in young children's transfer performance comes from microgenetic studies of analogical transfer reported by Chen (2003). Children between $2\frac{1}{2}$ and 4 years of age were given a series of problem sets, each involving a different pair of small models—a source space and a larger target space. The stimulus sets included small and larger toy trains, bird houses, kitchens, and bedrooms. On each trial, children saw a miniature toy being hidden in the source space, and they were then asked to search for a toy that had been hidden in the corresponding location in the target space. Unlike in the standard model task, the children were told nothing about the relation between the two spaces or about the fact that the toys were always hidden in corresponding locations. Over the four problem sets, the retrieval performance of the older children (40–49 months) improved substantially. Notably, it was primarily the children who offered ''insightful'' explanations of the relation between the source and target spaces who were proficient problem solvers. Through experience with multiple, highly analogous retrieval problems, these children had inferred the basic structure of the tasks—that the initial hiding event they observed gave them information about the unseen hiding event.

One limitation of all previous studies is that they primarily involved near transfer according to Barnett and Ceci's (2002) taxonomy of transfer. These authors proposed that transfer should be considered with respect to two broad factors: content (what is transferred) and context (when and where something is transferred from and to).

As shown in Table 2, the content factor includes three dimensions. The first is the nature of the learned skill that is transferred. For near transfer, it is a specific fact or routinized procedure, whereas far transfer involves a general problem-solving heuristic or principle. In the symbolic retrieval studies, children extract a rule from their initial experience—the hiding event that occurs in one space provides information about the outcome of an unseen hiding event in a different space. They then apply this rule to a new problem. This rule would seem to fall somewhere intermediate between what Barnett and Ceci (2002) considered near transfer (a routinized procedure) and far transfer (a general heuristic).

The second content dimension concerns how performance change is assessed. In the transfer studies using the model and related symbolic retrieval tasks, the dependent measure has always been accuracy of response (retrieving the hidden object). This measure is intermediate in the taxonomy between simple increased response speed (near) and having to decide whether a learned approach should be executed (far). With respect to the third content dimension—memory demands—all of the model transfer studies involve hints (instructions) as to the approach that should be followed. These tasks thus fall on the near side of the memory continuum.

The second factor identified by Barnett and Ceci (2002) is the overall context, that is, the degree of similarity between the original situation in which learning occurred and the situation in which transfer is assessed. As Table 2 shows, all of the previous transfer studies involving symbolic retrieval tasks assessed near transfer. The original and transfer tasks both involved highly similar domains of knowledge (symbol-based retrieval tasks), tests in the same physical setting, relatively minor delays between initial experience and test, similar general presentation as games played in a laboratory, and administration by the same people. In most of the prior studies, the stimulus modality was highly similar (scale models), although in some studies

Table 2
Applying Barnett and Ceci's (2002) Taxonomy of Transfer to Scale Model Tasks

Transfer taxonomy	Previous model studies	Current model studies
	Content: What is transferred	
Learned skill	Children use information from one space as guide to searching in another space. Intermediate	Children use information from one space as guide to searching in another space. Intermediate
Performance change	Transfer assessed as response accuracy: retrieval of hidden object. Intermediate	Transfer assessed as response accuracy: retrieval of hidden object. Intermediate
Memory demands	Child has to execute same strategy; reminders provided. Near	Child has to execute same strategy; reminders provided. Near
	Context: What and where transferred from and to	
Knowledge domain	Use of symbol-mediated information to guide search for a hidden object. Near	Use of symbol-mediated information to guide search for a hidden object. Near
Physical context	Both tasks in same lab room. Near	Tasks in different labs in different buildings. Intermediate
Temporal context	Transfer tested 1 day after initial experience. Near	Transfer tested 1 week after initial experience. Intermediate
Functional context	Both tasks conducted in lab and presented as games. Near	Both tasks conducted in labor and presented as games. Near
Social context	Same experimenters administer both tasks. Near	Different experimenters administer two tasks. Intermediate
Modality	Transfer from picture or model tasks to model and map tasks. Near/Intermediate	Transfer from picture and model tasks to model tasks. Near/Intermediate

transfer was assessed across different modalities (pictures, video, maps, models).

Barnett and Ceci (2002) argued that most psychological research on transfer assesses only near transfer. To get a better sense of the potential role of transfer in symbolic development in general, it is important to study young children's transfer in the model task in more challenging situations. Specifically, in the three studies reported here, we examined transfer with lower levels of contextual support than those involved in previous research.

EXPERIMENT 1

In the first study, we examined the role of the physical and social context in young children's transfer from one symbolic task to another. In all previous transfer studies, the two tests took place in the same laboratory and the children were tested by the same experimenter(s). If success in a symbolic retrieval task results in a relatively robust, abstract representation of the symbol–referent relation, contextual similarity might not be so essential. Hence, in Experiment 1, children first experienced an easy task in one setting with one pair of experimenters and then a more difficult task in a very different setting with different experimenters.

Method

Participants

The sample consisted of sixteen $2\frac{1}{2}$-year-old children ($M = 30.6$ months, range = 29 to 32 months; half girls and half boys). The participants for this and all subsequent experiments were recruited through records of newspaper birth announcements, and the sample was predominantly White and middle class. Eight participants were randomly assigned to the transfer condition ($M = 30.7$ months) and 8 to the control condition ($M = 30.4$ months).

Materials

Two different model-room sets were used for each task, both of which have been used in prior model studies (DeLoache et al., 1991; Marzolf & DeLoache, 1994). The materials for the similar-scale task included a small-scale model ($62.9 \times 43.3 \times 38.1$ cm) of a somewhat larger space ($2.57 \times 1.85 \times 1.88$ m). Both were constructed of white fabric supported by plastic pipes. The larger space had a door-sized opening in one wall, and the smaller space had three walls with one open side. The model was always in the same spatial orientation as the larger space, and a screen separated them so the child was unable to view the interiors of the two spaces simultaneously.

The larger space was furnished with a dresser and a shelf unit made of heavy cardboard, a child's chair covered with fabric, a small chair pillow, a floor pillow, a basket, and a rug. The hiding places were behind the dresser, behind the chair, under the floor pillow, and in the basket.

The materials for the standard task included a small-scale model ($84 \times 73.5 \times 33$ cm) of a large room ($6.51 \times 5.49 \times 2.55$ m). The model, which was constructed of plywood walls painted white, was in a separate room just outside the large room and in the same spatial orientation. The room was furnished with standard living room furniture, including two couches, a couch pillow, a large stuffed chair, a round table covered with a long tablecloth, a wooden side table with a basket on it, a wooden coffee table, a large plant, and a set of built-in wooden bookshelves along one wall. The hiding places were under the couch pillow, behind the chair, under the tablecloth, and in the basket.

For both tasks, the smaller space contained miniature hand-made versions of the larger items, constructed of the same basic shape and painted the same color or covered in the same material as their larger counterparts. The items occupied the same relative positions within the two spaces.

The hiding objects for the similar-scale task included two plastic trolls: a 4-cm-high toy troll (Little Terry) for the model and a 17-cm-high toy troll (Big Terry) for the larger space. The toy set for the standard model task included two dogs: a 2-cm-high plastic toy dog (Little Snoopy) for the model and a 17-cm-high stuffed toy dog (Big Snoopy) for the room.

Procedure

Each child participated in two sessions separated by 1 day. The children in the transfer group received the relatively easy similar-scale model task at one location during Session 1 and the relatively difficult standard model task at a different location during Session 2. Although both locations were labs in university buildings, the general physical context was otherwise different. On the 1st day of testing these children walked from an adjacent parking lot through a capacious lobby to a small, first-floor lab room containing (and essentially filled by) the similar-scale model and tent-like room. On the 2nd day, they crossed the street from a different parking lot to enter a different building, took the elevator to the sixth floor, and entered a large room furnished like a standard living room. The control group was given the difficult standard model task in a single location in both the first and second sessions. For both groups the same procedures were followed for the two tasks, but different experimenters tested the children in the two sessions, using different toy sets.

Session 1

Orientation. In Session 1, after the child had become acquainted with the experimenter, he or she was given an extensive orientation to the model room and the larger space. During this orientation, the correspondence between the toys in each space was explicitly described and demonstrated. First, the child was introduced to the large toy (Big Snoopy and Big Terry) and was shown the toy's "room." The experimenter labeled each item of furniture in the room. Next, the experimenter showed the child the miniature toy and model, explaining that the large toy had a little friend (Little Snoopy and Little Terry) who had similar but smaller room. To highlight the correspondence between the two spaces, the experimenter took the furniture from the model room to the larger space and compared each item of furniture from the model with the matching item in the larger space. The miniature items of furniture were then returned to the model. Finally, the experimenter placed the miniature toy on the miniature shelves in the model and got the child to place the large toy "in the same place in his big room."

Test trials. Following the orientation, there were four test trials during which the child observed the miniature toy being in the model and then searched for the large toy in the larger space. Each trial began with a hiding event, in which the child watched the experimenter hide the miniature toy in the model. The hiding place was never labeled. The experimenter told the child that the larger toy would be hidden in the same location in the larger space, and the child waited by the model with an assistant while the large toy was hidden. The experimenter returned and reminded the child the larger toy was hidden in the same place as in the model. There were two orders of hiding places, each of which was randomly assigned to half the children within each condition.

Next, the experimenter led the child to the larger space and encouraged him or her to search for the hidden toy—Retrieval 1. If the child failed to search or searched in the wrong location, increasingly explicit prompts were given until the toy was retrieved. However, only the child's first, unprompted search was counted.

Finally, the child returned to the model and was asked to locate the miniature toy that he or she had originally seen the experimenter hide—Retrieval 2.

Retrieval 2 served as a memory check to ensure that the child remembered the original hiding place. If necessary, the same prompts were provided as for Retrieval 1.

Session 2

One day later, both groups participated in the standard model task. The children in the control condition returned to the same location they had visited on the previous day and participated in the same task. In contrast, the children in the transfer condition were given a new task in a different lab in a different building from Session 1. The general procedures were identical to those for Session 1, except that the children were tested by a different experimenter and assistant.

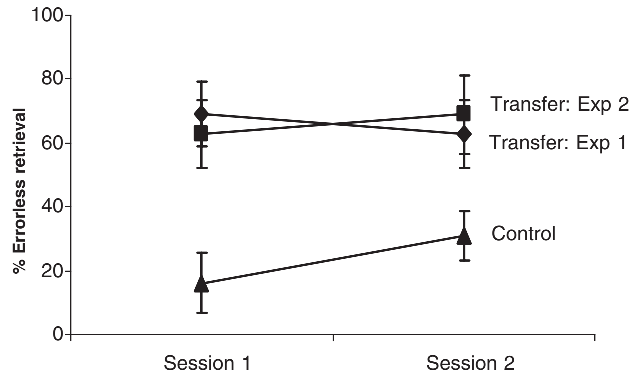

Figure 1. Retrieval 1 transfer in Experiments 1 and 2 from the similar scale to the standard model task in a new context. The delay between tasks was 1 day in Experiment 1 and 1 week in Experiment 2.

Results and Discussion

To summarize the main findings, the Retrieval 1 results provide strong evidence of transfer. As expected from prior studies, the transfer group was successful (69%) in the relatively easy, similar-scale task in Session 1. They were almost equally successful (63%) in the harder, standard model task in Session 2. Of most importance, their performance in the standard task was much better than that of the control group in both Sessions 1 (16%) and 2 (31%).

These results were confirmed in a 2 (condition: transfer, control) × 2 (session) repeated measures analysis of variance (ANOVA), with session as the within-subjects variable, and a series of follow-up comparisons. (Preliminary analyses indicated no effects involving gender; therefore, the data were collapsed across gender for all subsequent analyses.) There was a significant main effect of condition, $F(1, 14) = 11.32$, $p < .005$; $\eta^2 = .45$. As shown in Figure 1, the children in the transfer condition searched more accurately than did the children in the control condition. There was also a significant Condition × Session interaction, $F(1, 14) = 4.57$, $p = .05$; $\eta^2 = .25$, because of a slight (nonsignificant) increase in performance from Session 1 to Session 2 by the control group and a slight (nonsignificant) decrease by the transfer group.

The Condition × Session interaction for Retrieval 1 was examined further for specific evidence of transfer. First, a comparison of children's Session 1 performance revealed that the children in the transfer condition performed significantly better on the similar-scale task (69%) than did the children in the control condition on the standard task (16%), $t(14) = 3.82$, $p < .005$; Cohen's $d = 1.92$. This result established that the general level of performance and age differences in this study closely replicated those reported for this age group in these two tasks (e.g., DeLoache, 1987, 1991; DeLoache et al., 1991; Marzolf & DeLoache, 1994).

To test for transfer, the performance of the transfer group in Session 2 was compared with that of the control group in Sessions 1 and 2. Independent-samples *t* tests showed that the children in the transfer condition were significantly more successful in the standard model task in Session 2 than were the control children in either Session 1, $t(14) = 3.32$, $p < .005$; Cohen's $d = 1.74$, or Session 2, $t(14) = 2.38$, $p < .05$; Cohen's $d = 1.19$.

Retrieval 2 performance was consistently high (transfer group: Session 1 = 78% and Session 2 = 78%; control group: Session 1 = 75% and Session 2 = 66%), with no significant differences between the groups or sessions.

In accord with previous transfer studies (DeLoache, 1987, 1991; Marzolf & DeLoache, 1994), the results of Experiment 1 indicate that experience with a symbolic task in which it is relatively easy to detect the symbol–referent relation subsequently enhances children's appreciation of a new symbol–referent relation that they would otherwise not notice. What is new about the current results is the occurrence of transfer even with a substantial change in context. The transfer group in Experiment 1 performed better than the control group on the second task even though the two sessions involved different buildings, labs, models, furniture, toys, and experimenters, and larger spaces. The main factor that was common to Sessions 1 and 2 was the underlying relational structure of the tasks: A hiding event occurred in one space in which *toy a* was hidden with *object x*, and in an analogous hiding event in the second space, *Toy A* was hidden with *Object X*. This suggests that the children's representational insight into the symbol–referent relation was relatively abstract.

If the results of Experiment 1 indicate that if representational insight into one symbol–referent relation promotes a relatively abstract representation, transfer should be robust and should occur in other challenging situations as well. Experiments 2 and 3 were designed to probe further the limits of transfer in two ways—by extending the time between the initial experience and the subsequent test and by examining transfer to an even more difficult task than that used in Experiment 1.

EXPERIMENT 2

The focus of Experiment 2 was the temporal context of transfer in the symbolic retrieval task. Experiment 1 established that $2\frac{1}{2}$ -year-old children were relatively impervious to a substantial change in the physical context of two model tasks. Here, we asked if they would be similarly unaffected if an additional change were made. Thus, the children in Experiment 2 had the same experience as the children in the transfer group in Experiment 1 except that there was a 1-week delay between their experience with the relatively easy task and with the more difficult task.

Method

Participants

The sample consisted of eight $2\frac{1}{2}$ -year-old children ($M = 31$ months, range = 29.5 to 32.5 months; half girls and half boys). One additional boy was excluded for refusing to participate in Session 2. For purposes of comparison, the data from the control group of Experiment 1 were used. The approach seemed justified, given that the Session 1 performance of the children in the standard task closely replicated the performance of children of the same age in that task in several previous studies. (In eight replications using two model-room combinations, performance has ranged from 15% to 26%, with an average of 19%; Sharon & DeLoache, 2003). In addition, the children's performance across the two sessions replicated the results for the control group in the transfer studies reported by Marzolf and DeLoache (1994). This comparison group provided a conservative standard for transfer, assuming that Session 2 performance would be worse after a 1-week delay than after only a 1-day delay.

Materials

The materials were identical to those in Experiment 1: two small-scale models, the tent-like room, a regular room, and two sets of toys.

Procedure

The children in the transfer group participated in two sessions that were the same as those for the transfer group in Experiment 1, except that the two sessions were separated by 1 week. Thus, they received the similar-scale model task with the dogs at one location during Session 1, and the standard model task with the trolls at a different location with a different experimenter 1 week later during Session 2.

Results and Discussion

As shown in Figure 1, the transfer group's Retrieval 1 performance was almost identical to that of the transfer group in Experiment 1 (63% in Session 1 and 69% in Session 2) and was clearly superior to that of the comparison group (16% and 31%, respectively). The children's Retrieval 2 performance was high (transfer group: Session 1 = 88% and Session 2 = 94%).

In a 2 (condition: transfer, control) × 2 (session) repeated measures ANOVA of the Retrieval 1 data, with session as the within-subjects variable, there was a significant main effect of condition, $F(1, 14) = 9.91$, $p < .01$; $\eta^2 = .41$, and a significant main effect of session, $F(1, 14) = 4.57$, $p = .05$; $\eta^2 = .25$. The children in the transfer group searched correctly more often than did the children in the comparison group, and there were more successful searches in Session 2 than in Session 1. There was no Condition × Session interaction.

Next we conducted a series of independent-samples *t* tests for evidence of transfer. The children in the transfer condition performed much better on the similar-scale task (63%) than did the children in the comparison condition on the standard model task (16%), $t(14) = 3.32$, $p < .005$; Cohen's $d = 1.66$. This result replicated findings for the relative difficulty of these tasks in both Experiment 1 and past research (e.g., DeLoache, 1987, 1991; DeLoache et al., 1991; Marzolf & DeLoache, 1994).

The primary test for transfer showed that the children in the transfer condition were more successful on the standard model task in Session 2 (69%) than were the control children in Session 1(16%), $t(14) = 3.44$, $p < .005$; Cohen's $d = 1.72$. Finally, children's Session 2 performance showed the same pattern of significantly better performance by children in the transfer condition (69%) compared with children in the control condition (31%), $t(14) = 2.58$, $p < .05$; Cohen's $d = 1.52$. Thus, even after a 1-week delay and a change in setting, children who had first experienced an easy symbolic task succeeded on a task on which inexperienced children failed.

EXPERIMENT 3

Experiment 3 was designed to test for transfer in an even more challenging situation. We asked whether prior experience in an easy symbolic retrieval task could enable $2\frac{1}{2}$ -year-olds to succeed on a task that children perform poorly on until $3\frac{1}{2}$ years of age (DeLoache et al., 1999; DeLoache et al., 1991). Based on the robust transfer effects found in Experiments 1 and 2, it seemed possible that once children have insight into an easy symbol–referent relationship, the facilitative effect of this insight might enable them to perform like children a full year older. To find out, we first gave children a picture task (DeLoache, 1987, 1991) that we knew would be within their capabilities and then tested for transfer to the very difficult low-similarity model task—a task that most 3-year-olds fail (DeLoache et al., 1991).

Method

Participants

The sample consisted of twelve $2\frac{1}{2}$ -year-old children ($M = 30.7$ months, range = 29 to 32 months; half girls and half boys). Comparison data came from eight $2\frac{1}{2}$ -year-olds ($M = 30.8$ months, range = 29 to 32.5 months; half girls and half boys) who experienced only the low-similarity model task in DeLoache et al. (1991, Experiment 1).

Materials

The materials for Session 1 included the tent-like room ($2.75 \times 1.85 \times 1.88$ m) used in Experiment 1 and four color photographs (20×25 cm), each depicting one item of furniture from that room (e.g., the dresser, the basket, the floor pillow, and the chair). The photographs were displayed in a semicircular array on a shelf in an adjoining room in the same relative order as the furniture in the room (as in DeLoache, 1987, 1991). The hiding object used in the photograph task was a toy bird (13 cm) referred to as Big Bird.

The materials for Session 2 were the tent-like room and the scale model for the low-similarity model task (DeLoache et al., 1991; Marzolf & DeLoache, 1994). The model differed from the larger space in three ways known to affect negatively children's performance. The model was a small surveyable space ($69.9 \times 45.7 \times 38.1$ cm), but the larger space was the tent large enough for the experimenter and child to enter together. The two spaces also differed with respect to the surface appearance of both the surrounding walls and the objects within them. The model was constructed from a cardboard box covered in white paper with the top and one side open, and the items of furniture in it were dissimilar in appearance from those in the larger space. (For example, there was a tan wicker basket in the tent-like room and a pink plastic wastebasket in the model, and different colored fabric covered the chairs in the two spaces.) The corresponding items of furniture were in the same relative positions in the two spaces. The hiding objects were the toy dogs used in Experiments 1 and 2.

Procedure

The children were given experience with the easy photograph task followed by the very difficult low-similarity task in the same lab 1 day later. In Session 1, the extensive orientation to the correspondence between the photographs of the furniture and the corresponding items in the room was similar to that in Experiment 1. On each of the four trials, the experimenter conveyed the information about the hiding place by pointing to the appropriate photograph, saying, "This is where Big Bird is hiding in the room. He's hiding (back, under, in) here." The child was then asked to go into the room to retrieve the hidden toy. (As no miniature object was hidden, there was no Retrieval 2.) The prompts and instructions used throughout were essentially the same as in the standard model task. In Session 2, 1 day later, all children participated in the low-similarity model task with procedures and instructions identical to those in Session 2 of the previous experiments.

Results and Discussion

The results provided evidence of transfer by $2\frac{1}{2}$ -year-olds to the very difficult task. Children in the transfer group were moderately successful on both the relatively easy photo task (65%) in Session 1 and the extremely difficult model task in Session 2 (52%). Most important, their performance on the model task was far superior to that of the comparison group of the same age (16%). As expected, the children's Retrieval 2 performance in the model task was high—85% for the transfer group and 81% for the comparison group.

In the transfer test, the Retrieval 1 performance of the transfer group in the model task in Session 2 was better than that of the comparison group, as shown by a significant difference in an independent-samples t test, $t(18) = 2.62$, $p < .05$; Cohen's $d = 2.2$. The 52% success rate of the 30-month-olds in the difficult task is fairly remarkable given that even 38-month-olds perform very poorly (only 17%) on this task (DeLoache et al., 1991).

According to the logic of the transfer design used here, individual children who were successful in the first, easy task should be much more likely to succeed in the second, difficult task than should children who were unsuccessful the first time. Thus, a further transfer test is a comparison of the performance of individual children on the two tasks. We combined the data for all participants in the transfer groups in Experiments 1, 2, and 3 ($N = 28$). Children were classified as successful if they attained an errorless retrieval score of 75% or better (three or four trials correct out of four). Of the 16 children who had been successful in the first session, 10 (67%) also succeeded in the second session. In contrast, only 3 of the 12 (25%) children who had been unsuccessful in the first session were successful in the second session. This difference was marginally significant ($p < .07$) according to Fisher's exact test. Thus, children whose performance suggested they had achieved representational insight into the easy task were more likely to perform well in the more difficult task.

GENERAL DISCUSSION

In the three studies reported here, significant transfer was found for $2\frac{1}{2}$-year-old children in relatively challenging circumstances. The children in the first two studies transferred from an easy to a difficult task with a relatively low level of contextual support and even after a 1-week delay. The degree of transfer in the third experiment was lower, but still noteworthy, in that a group of $2\frac{1}{2}$-year-olds transferred from a picture task to a model task that even 3-year-olds typically fail.

As in previous transfer studies with similar tasks, it was primarily children who were successful in the first task who succeeded in the second task, consistent with the idea that children who have attained representational insight in the first task are responsible for the general transfer effect. Similarly, in Chen's (2003) research, transfer primarily occurred for children who had demonstrated awareness of the higher order relation between spaces. Further support for this claim is that little increase occurred for the control group, indicating that general familiarity with the task, setting, people, and so forth does not lead to increased performance. What supports successful performance in a more difficult task is prior success in an easier task.

This point is reinforced by research by MacConnell, Evans, and Daehler (2001), who tried to promote a more abstract representation in a symbolic retrieval task by giving $2\frac{1}{2}$-year-old children experience with two scale models before asking them to search in the corresponding room. The children saw a hiding event in one model, and they then searched in an identical or a similar model before finally searching in the room. The extra model experience did not improve retrieval performance in the room over that of a control group that received the standard (one-model) task. The reason this procedure did not improve performance may be that the children were not very successful (only around 50% correct) when searching in the second model. If few of the children achieved representational insight with the models, there would be little basis for transfer to the room.

Changes in the physical context also have dramatic negative effects on infants' memory (Borovsky & Rovee-Collier, 1990; Butler & Rovee-Collier, 1989; Rovee-Collier, Schechter, Shy, & Shields, 1992). Infants who have mastered a contingency relation in the conjugate reinforcement paradigm in one setting show excellent retention of the stimulus–response relation when tested in the same context, even over relatively extensive delays, but their memory is substantially impaired by seemingly small contextual changes. Similarly, 6-month-olds successfully imitate a novel action when tested in the context in which it was learned, but not if tested in a different context (Hayne, Boniface, & Barr, 2000).

The disruptive effect of novel contextual cues on memory is, however, age related: Twelve- to 18-month-olds show deferred imitation regardless of substantial changes in context (Hannah & Meltzoff, 1993; Hayne et al., 2000; Klein & Metlzoff, 1999). The current evidence of transfer by 30-month-olds even with delays and changes in context is consistent with the existence of a major developmental change in the resilience of young children's ability to remember and apply what was learned in one situation to another.

Examining our transfer studies in light of Barnett and Ceci's (2002) taxonomy (see Table 2) makes clear that even very young children are capable of at least intermediate transfer in symbol-retrieval tasks. Specifically, after performing successfully in a relatively easy task, they are able to apply the same general approach to solving a similar but more difficult task even when certain aspects of the general context differed for the two tasks. These findings suggest that having represented one retrieval task in terms of the higher level relations involved in it, young children generally apply the same relational structure to a new task.

Applying Barnett and Ceci's (2002) taxonomy of transfer to symbolic retrieval transfer studies suggests directions for future research to illuminate further the dimensions of transfer by young children. It would be particularly useful to examine the effect of changes in task content, which has not been manipulated before. For example, after successful experience in an easy model task, children could be asked to hide (rather than find) the larger toy in the room based on where they observed the experimenter hide the smaller toy in the model. Perhaps children with successful experience in the basic task could perform this different response in a transfer task. Another approach to investigating transfer with changes in content could focus on the memory demands of the task. What if children were not reminded on the 2nd day of the rules of the game (i.e., the fact that the two toys would be hidden in the same places)? Could they spontaneously apply what they had learned previously?

Additional manipulations of context could tell us more about the limits of transfer. For example, parents could be trained to administer a version of the picture task to their children at home, and we could assess transfer to the model task in the lab with experimenters. Success would constitute relatively far transfer in terms of physical context. An even greater degree of far transfer could be assessed by giving children experience with a standard model task in the lab and then testing their use of a model of their own preschool classroom to solve a different problem. For example, they might be asked to use the model to figure out where to find a tool in the real classroom to use for some desired activity (e.g., to find the markers needed for an art project).

Another potentially interesting avenue for future research concerns the delay between initial and transfer task. Here and in our previous studies (DeLoache, 1991; Marzolf & DeLoache, 1994), transfer was assessed after a delay of at least 1 day. Is it possible that ''sleeping on it'' contributed to successful transfer? There is substantial evidence in adult cognition that sleep can enhance procedural learning (Walker, in press), as well as insight (which might be of particular relevance to our transfer studies; Wagner, Gais, Haider, Verleger, & Born, 2004).

It seems possible that a delay of 1 or more days between initial exposure and test could enhance children's awareness of the underlying structure of the original symbolic retrieval task. Suggestive evidence in this regard is the lack of transfer reported by MacConnell et al. (2001), whose training and transfer tests occurred in the same session. In future research, children's performance could be compared when assessed after a few hours delay, but on the same day, versus after an overnight interval. Superior performance on the transfer task by the overnight group would be an interesting result.

In summary, the extent of transfer shown in the three studies reported here reveals that a substantial proportion of the young children in these studies achieved a relatively abstract representation of the basic structure of the symbolic retrieval task, a representation that freed them from the specific features of the individual tasks. These results lend credence to the idea that repeated experience achieving abstract representations of symbol–referent relations contributes to the general increase in symbolic sensitivity that occurs during the first few years of life (DeLoache, 1995, 2002). This research thus provides a glimpse into the enormous and cumulative power of symbols to liberate the mind from the lure of direct experience.

References

Barnett, S., & Ceci, S. (2002). When and where do we apply what we learn? A taxonomy for far transfer. *Psychological Bulletin*, *128*, 612–637.

Bloom, P. (2000). *How children learn the meanings of words*. Cambridge, MA: MIT Press.

Borovsky, D., & Rovee-Collier, C. (1990). Contextual constraints on memory retrieval at 6 months. *Child Development*, *61*, 1569–1583.

Brown, A. L. (1989). Analogical learning and transfer: What develops? In S. Vosniadou & A. Ortony (Eds.), *Similarity and analogical reasoning* (pp. 369–412). London: Cambridge University Press.

Butler, J., & Rovee-Collier, C. (1989). Contextual gating of memory retrieval. *Developmental Psychobiology*, *22*, 533–552.

Chen, Z. (2003, April). *Learning to map: Strategy discovery in young children*. Poster presented at the meeting of the Society for Research in Child Development, Tampa, FL.

DeLoache, J. S. (1987). Rapid change in the symbolic functioning of very young children. *Science*, *238*, 1556–1557.

DeLoache, J. S. (1991). Symbolic functioning in very young children: Understanding of pictures and models. *Child Development*, *62*, 736 – 752.

DeLoache, J. S. (1995). Early symbol understanding and use. In D. Medin (Ed.), *The psychology of learning and motivation* (Vol. 33, pp. 65 – 114). New York: Academic Press.

DeLoache, J. S. (2002). Symbolic development. In U. Goswami (Ed.), *Blackwell handbook of childhood cognitive development* (pp. 206 – 226). Oxford, England: Blackwell.

DeLoache, J. S., deMendoza, O. A. P., & Anderson, K. N. (1999). Multiple factors in early symbol use: The effect of instructions, similarity, and age in understanding a symbol-referent relation. *Cognitive Development*, *14*, 299 – 312.

DeLoache, J. S., Kolstad, V., & Anderson, K. N. (1991). Physical similarity and young children's understanding of scale models. *Child Development*, *62*, 111 – 126.

DeLoache, J. S., Miller, K. W., & Pierroutsakos, S. L. (1998). Reasoning and problem-solving. In D. Kuhn & R. S. Siegler (Eds.), *Handbook of child psychology: Vol. 2. Cognition, perception, and language* (5th ed., pp. 801 – 850). New York: Wiley.

Gentner, D., & Rattermann, M. J. (1991). Language and the career of similarity. In S. A. Gelman & J. P. Byrnes (Eds.), *Perspective on thought and language: Interrelations in development* (pp. 225 – 277). New York: Cambridge University Press.

Hannah, E., & Meltzoff, A. N. (1993). Peer imitation by toddlers in laboratory, home, and day-care contexts: Implications for social learning and memory. *Developmental Psychology*, *29*, 701 – 710.

Hayne, H., Boniface, J., & Barr, R. (2000). The development of declarative memory in human infants: Age-related changes in deferred imitation. *Behavioral Neuroscience*, *114*, 77 – 83.

Klein, P. J., & Meltzoff, A. N. (1999). Long-term memory, forgetting, and deferred imitation in 12-month-old infants. *Developmental Science*, *2*, 102 – 113.

Liben, L. S. (1999). Developing an understanding of external spatial representations. In I. E. Sigel (Ed.), *Development of mental representation: Theories and applications* (pp. 297 – 321). Mahwah, NJ: Erlbaum.

Loewenstein, J., & Gentner, D. (2001). Spatial mapping in preschoolers: Close comparisons facilitate far mappings. *Journal of Cognition & Development*, *2*, 189 – 219.

MacConnell, A., Evans, M., & Daehler, M. W. (2001, April). *Do dual models facilitate dual representations*? Poster presented at the biennial meeting of the Society for Research in Child Development, Minneapolis, MN.

Marzolf, D. P., & DeLoache, J. S. (1994). Transfer in young children's understanding of spatial relations. *Child Development*, *64*, 1 – 15.

Newcombe, N. S., & Huttenlocher, J. (2000). *Making space: The development of spatial representation and reasoning*. Cambridge, MA: MIT Press.

O'Sullivan, L. P., Mitchell, L. L., & Daehler, M. W. (2001). Representation and perseveration: Influences on young children's representational insight. *Journal of Cognition & Development*, *2*, 339 – 366.

Rattermann, M. J., & Gentner, D. (1998). More evidence for a relational shift in the development of analogy: Children's performance on a causal-mapping task. *Cognitive Development*, *13*, 453 – 478.

Rovee-Collier, C., Schechter, A., Shy, G. C., & Shields, P. (1992). Perceptual identification of contextual attributes and infant memory retrieval. *Developmental Psychology*, *28*, 307 – 318.

Sharon, T., & DeLoache, J. S. (2003). The role of perseveration in children's symbolic understanding and skill. *Developmental Science*, *6*, 289 – 296.

Troseth, G. L. (2003). TV guide: Two-year-old children learn to use video as a source of information. *Developmental Psychology*, *39*, 140 – 150.

Troseth, G. L., & DeLoache, J. S. (1998). The medium can obscure the message: Young children's understanding of video. *Child Development*, *69*, 950 – 965.

Wagner, U., Gais, S., Haider, H., Verleger, R., & Born, J. (2004). Sleep inspires insight. *Nature*, *427*, 352 – 355.

Walker, M. P. (in press). A refined model of sleep and the time course of memory formation. *Brain and Behavioral Sciences.*