2000

Symbolic thinking :: extending the dual representation issue beyond the model/room paradigm.

Amy Jean Macconnell
University of Massachusetts Amherst

SYMBOLIC THINKING:
EXTENDING THE DUAL REPRESENTATION ISSUE BEYOND THE MODEL / ROOM PARADIGM

A Thesis Presented

by

AMY JEAN MACCONNELL

Submitted to the Graduate School of the
University of Massachusetts Amherst in partial fulfillment
of the requirements for the degree of

MASTER OF SCIENCE

May 2000

Psychology

SYMBOLIC THINKING:
EXTENDING THE DUAL REPRESENTATION ISSUE
BEYOND THE MODEL / ROOM PARADIGM

A Thesis Presented

by

AMY JEAN MACCONNELL

Approved as to style and content by:

Marvin W. Daehler, Chair

Nancy Myers, Member

Arnold Well, Member

Melinda A. Novak, Department Head
Psychology

ACKNOWLEDGMENTS

I would like to thank my advisor, Marvin W. Daehler, for his guidance and valuable contributions to this project, especially in developing the concept for the research. I am grateful for his patience during the many revisions of the thesis and for providing feedback with regard to my presentation style.

I would also like to thank my committee members, Nancy Myers and Arnold Well, for their feedback and suggestions throughout this project, especially regarding the statistical analyses of the data.

I want to thank the National Science Foundation for funding this study as part of Grant BCS - 9907861, as well as the Department of Psychology, for funding travel expenses, experimental materials, and participant compensation.

I am especially grateful to Pearlie Pitts, staff assistant at the Child Study Center, for her great efforts in recruiting and scheduling all of the children for the study. Thanks also to Marie Evans, who assisted in the experiment during the course of the study. I could not have completed this project without their help.

Finally, I wish to express thanks to my family and Robert Mitravich for their support throughout my Master's project, and for their continued encouragement during my graduate school career.

ABSTRACT

SYMBOLIC THINKING:
EXTENDING THE DUAL REPRESENTATION ISSUE
BEYOND THE MODEL / ROOM PARADIGM

MAY 2000

AMY JEAN MACCONNELL, B.S., VANDERBILT UNIVERSITY

M.S., UNIVERSITY OF MASSACHUSETTS AMHERST

Directed by: Professor Marvin W. Daehler

Dual representation is the ability to represent an object both as a concrete entity and as an abstract symbol or representation for something else. This study investigated whether young children would show evidence of dual representation in a setting other than the model/room task, which is typically used in research on the development of symbolic thinking. Thirty- and 36-month-old children were tested for their ability to transfer an event demonstrated by the experimenter from a child-sized workbench to a scale-model of the workbench, or vice-versa. Also, the standard search and retrieval response was replaced with an imitative response to determine whether this change would facilitate dual representation in young children. Half of the children were assigned to the location condition, which consisted of observing as the experimenter selected and placed a tool in a particular place on the workbench. The child then moved to the analogous workbench and reproduced the selection and placement as a test trial. Finally, the child returned to the original workbench to reproduce the selection and placement originally performed by the experimenter. This served as a memory trial. The other half of the children followed the same procedure, except the event consisted of reproducing an activity with the tool as opposed to placing it somewhere on the workbench. The results revealed that children performed significantly better on the memory trials than on the test trials, although their performance was lower than typically evidenced by young children in previous dual representation studies. The age of the child did not affect performance, suggesting that 36-month-old children had no more representational insight in the task than the younger children. The condition to which the child was assigned did not affect performance. Finally, girls performed significantly better than the boys. The findings of the study did not replicate the findings of previous research in dual representation using the model/room task. Significant changes in the methodology associated with the imitation procedure may have contributed to this outcome. Further research is planned to determine whether evidence of dual representation may be found in new settings.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Page

Figure

CHAPTER 1

INTRODUCTION

One of the most interesting topics in cognitive development that is currently under investigation is dual representation. Dual representation is the ability to represent an object both as a concrete entity and as an abstract symbol or representation for something else. For example, one may perceive a model train as both a toy to play with and as a representation for an actual train. Judy DeLoache has done extensive work on the development of representational insight and has consistently found the same results: children 36 months and older are typically successful in maintaining a dual representation, while children 30 months and younger are not (e.g., DeLoache, 1989a). DeLoache normally uses a particular design to investigate this phenomenon, a room and a small-scale model of that room. She may, for example, hide a larger doll behind a chair in the room, and ask the child to find a similar but smaller doll in the same place in the model. The 36-month-olds have little difficulty retrieving the doll in the model, yet the 30-month-olds do very poorly. Moreover, a similar level of performance is obtained when a small doll is hidden in a model and the child is asked to find the larger doll in the larger room. One of the questions addressed in this study was whether the dual representation problem displayed by young children extended to representational situations other than the model-room paradigm, where a clear distinction between operating within a larger, traversable space and operating upon a smaller, surveyable space could be made. That is, did the type of spatial array presented to young children to assess their representational capacities affect dual representation performance? The other question investigated in this study was whether the type of activity the child engaged in during the task affected his or her dual representation performance. In particular, was dual representation facilitated by the child's engaging in specific activities with an object as opposed to watching and remembering where to locate an object?

Review of DeLoache Research

In her model-room design, DeLoache arranges an existing room with several pieces of furniture, which serve as hiding places for a toy animal. She then creates a realistic, three-dimensional model of the room, approximately one-fourth the size of the actual room or smaller. In the standard condition, the model and room have a high degree of similarity with identical pieces of furniture, except for their size, placed in the same locations in the two arrays. The model is located in a room separate from the larger room so the child can not see the two spaces simultaneously. A diagram of the rooms is shown in Figure 1. The child is introduced to two toys, such as Snoopy dolls, which are also identical except for their size. The experimenter explains that the big and little Snoopy like to do the same thing. The child then sees the experimenter hide the big Snoopy in the big room, for example, and the child is asked to find the little Snoopy in the same location in the model. After finding little Snoopy, the child is then asked to find the larger one in the initial space in which he or she saw it being hidden; this serves as a memory trial.

DeLoache consistently finds that 36-month-olds generally perform well, with at least 75% errorless retrievals, yet 30-month-olds typically do not perform higher than 20% errorless retrievals when attempting to retrieve the doll in the analogous location (DeLoache, 1995a). The poor performance of the 30-month-olds is not a memory problem, for almost all of the children are able to find the toy they saw hidden in the original space. DeLoache suggests that the children are failing to use the model-room relation as a source of information to solve the problem. To be successful, the children must perceive the model both as a concrete entity in which a doll is hidden, and as a representation of the room to correctly locate the doll. The model is very salient as a concrete object; it is three-dimensional, contains pieces of furniture, and things can be hidden in it. The salience of the model as a concrete object, according to DeLoache, makes it difficult for the young children to also perceive the model as a representation of the room. Their performance thus reflects a deficit in the ability to process dual representations.

To further investigate this issue, DeLoache (1991, 1995b) tried to make the model less salient as a concrete object, thus making it easier for younger children to perceive it as a representation of the room. In one study, she replaced the model-room with either a color photograph of the model, or replaced the individual pieces of furniture with color photographs of them. In both cases, the 30-month-olds had over 70% errorless retrieval. In another study, described as the Shrinking Room study, 30-month-olds' performance was again quite high (DeLoache, 1995b). As in the original model-room task, children were shown a room with several pieces of furniture and saw a toy hidden within the room. The children were then led to believe that the room "shrunk" so the space and toy were now the size of the model in the original study. The children were then asked to find the toy in the same, but shrunken, space. DeLoache reasoned that if the children believed that the room actually shrunk, there would not be a separate concrete representation of the model; the small room was the *same* space as the big room. She found that this manipulation did, in fact, increase the success of the young children. DeLoache argued that it did so by eliminating the need for dual representation.

DeLoache and other researchers have conducted numerous other studies investigating dual representation, involving the standard model-room task, and have consistently found the same results: 36-month-olds tend to be successful, while the 30-month-olds are not (DeLoache, 1989a, 1989b, 1995a, 1995b; DeLoache, Kolstad, & Anderson, 1991; DeLoache & Marzolf, 1995). These results support the hypothesis that when young children must solve problems that require the use of dual representations, they often have great difficulty.

Dual Representation in Other Paradigms

Most of the studies that have obtained evidence for the dual representation hypothesis have used the model-room paradigm. However, one has been carried out which involved the use of dolls to evoke dual representation in young children (DeLoache & Marzolf, 1995). The purpose of the study was to examine young children's ability to use the doll as a means of remembering an event that the children had experienced. It was motivated by the desire to investigate how effectively young children are able to employ anatomically detailed dolls which are often used in sexual abuse cases. DeLoache did, however, stress the importance of being able to process dual representations in this situation; children must realize not only that the object is a doll but that the doll is a symbol for themselves. This realization is necessary for the doll to be a valid indicator of possible abuse inflicted upon the child.

Part of the experiment involved children ages 2½, 3, and 4 years of age placing stickers on the doll in the same places that the experimenter had placed similar stickers on the children. For example, if the experimenter had placed a sticker on the child's elbow, the child was expected to place a similar sticker on the doll's elbow. The 2½-year-olds had 40% correct placement, the 3-year-olds had 70% correct placement, and the 4-year-olds had 90% correct placement. The results of the sticker placement task again suggested that young children have trouble using salient concrete objects as representations for other objects. However, the personal involvement required in this study, such as having stickers placed on one's body, made it difficult for some children to successfully complete the task. Other children refused to accept the doll as a symbol for themselves. Thus, the unique aspects of this task may have made it difficult to effectively determine what role inabilities associated with dual representation per se played in performance. Nevertheless, 2½-year-olds did somewhat better in this task than on the standard model-room problem.

An important question, then, still remains as to whether limitations in the ability to engage in dual representation extend to settings other than spatial tasks involving the model-room relationship. In the standard model-room task, the child moves about, or traverses, within the larger space in order to see all of the materials and to retrieve the hidden object. In contrast, when presented with the model in the standard task, the child is able to view or survey the entire array at once and, of course, does not move about within it. Could this difference be an important factor in limiting dual representational ability? The present study differs from the standard model-room experiments by employing a child-sized workbench and a much smaller model of that workbench to examine the dual representation hypothesis. By using the workbench and a model of it to test the dual representation hypothesis, the child was able to survey the entire space in both the child-sized array and the model. Thus, all of the materials were immediately visible in both arrays and the visual perspective or point-of-view remained constant in order to solve the problem. The workbenches, then, permit a test of whether the difficulty of dual representations found with the standard room and model setting stems from having to operate both *within* a larger space and *upon* a smaller space.

Maintaining a Common Visual Perspective

In principle, the poor performance of the young children should extend to any problem involving dual representations. On the other hand, if the difficulty is linked to the child's perspective and kind of activity that can be performed upon the two spatial representations, then children might be expected to have far less difficulty in a task where perspective and activity are similar than in the standard model-room task. DeLoache (1995b) conducted one study that differed from the standard model-room task in that two models, one twice as large as the other, were used. Thus, for both settings, the entire space could be seen at once; the child could maintain the same perspective with both spaces. DeLoache found that 30-month-old children tested in this condition were successful 75% of the time. Perhaps children did not realize that the two arrays differed or because their size was relatively similar, had no difficulty on the task. However, these results also raise the possibility that keeping the visual point-of-view constant in both settings eliminated their difficulty in employing a dual representation. Thus, a primary goal of this study is to test whether young children's difficulty with dual representations extends to arrays where a change in perspective associated with traversable and surveyable space is eliminated, while keeping the model one-fourth the size of the room.

Imitative Versus Retrieval Response

In the standard task, children demonstrate their understanding of the relationship between the model and the room by retrieving a hidden object in the second space on the basis of information provided in the first space. However, in the study proposed here involving the workbench, children will be asked to demonstrate this knowledge by carrying out an imitative response. DeLoache (1989a; DeLoache, Kolstad, and Anderson, 1991) directly compared the relationship between retrieval and imitative performance in the standard model-room task. After the child saw how the model and room were similar as part of the initial orientation phase in the standard model-room task, children in the imitative condition watched the experimenter place the Snoopy doll on a piece of furniture in the room. Then, reminding the child that the big and little animals liked to do the same thing, the experimenter asked the child to place the little animal in the same location in the model. The researchers found that the imitative performance was comparable to the retrieval performance. The 36-month-olds successfully imitated the placement of the toy animal (75% correct), while the 30-month-olds did not (16% correct). These results were nearly identical to the retrieval performance. This study, then, indicated that the younger children could do no better when the task demanded an imitative response rather than a retrieval response. The young children were not able to process dual representations of the model irrespective of which response was required.

In some ways, the finding that an imitative response is no easier than a retrieval response is surprising. Although both depend on memory, the child has only the location cue to guide recall when asked to retrieve the hidden object as part of the representational task. However, in producing an imitative response, children have both the location cue and the doll available and need only reproduce the relationship between the two as part of the representational task. In fact, in another study investigating a different issue pertaining to the dual representation hypothesis, Schmitt (1997) directly compared performance and found the imitation task to be somewhat easier than the retrieval task. Schmitt asked 2-year-old children to either find a hidden toy in a room or to imitate the experimenter's placement of the toy in the room after watching the experimenter hide or position the toy through either a window or on a television. The children had approximately 22% correct performance in the search task, yet had about 42% correct performance in the imitation task when they viewed the activity via television. Nevertheless, regardless of whether children had to retrieve the toy or to imitate its placement, they did far poorer when provided the information through television than when observing the experimenter through a window. In this latter condition, children were successful in retrieving the toy or in imitating its placement in over 75% of the trials. Thus, the dual representation demands associated with television yielded poorer performance in both the retrieval and imitation tasks. Indeed, if difficulty in processing dual representations is the primary factor limiting transfer, then performance should be poor in tasks involving either imitation or retrieval.

If the dual representation hypothesis is correct, 30-month-old children in the present study would have difficulty imitating the appropriate placement of the tool on the transfer task. A second major goal of this study was to examine whether the type of imitative response required in the task had some bearing on transfer. Would the children have the same difficulty with dual representations when the imitative response involved a specific activity associated with the appropriate tool? Or, did such an activity serve to assist the child in recognizing the relationship between the child-size workbench and the model? That is, did the physical action performed with the tools serve to mediate conceptual understanding involving dual representations?

Evidence for Young Children's Imitation of Actions

A substantial amount of research has been conducted on the imitative capacities of very young children. Infants as young as nine months are capable of imitating actions, even after a 24-hour delay (Meltzoff, 1988). For example, the young infants were shown an action with a novel toy, such as shaking a plastic egg that contained metal nuts to make a rattling sound. The nine-month-olds were able to reproduce the actions both immediately and after a 24-hour delay. Further research has found evidence of a developmental trend in imitative ability. Barr, Dowden, and Hayne (1996) have found that older infants require less exposure to the target activity. For example, 12-, 18-, and 24-month-old infants displayed deferred imitation after viewing the target behaviors three times over a 30-second interval. Six-month-old infants, however, required twice the amount of exposure to the target actions before they could successfully imitate the actions after a 24-hour delay. Other developmental changes that the researchers found were that older infants are more accurate in their imitation, and they are capable of carrying out multiple-step sequences of actions.

One noteworthy capability of older infants is the ability to show deferred imitation across changes in object color and size, and also across changes in context. Barnat, Klein, and Meltzoff (1996) investigated whether 14-month-old infants were capable of such an ability. For example, children were presented with a miniature, wooden dumbbell that could be pulled apart. In the test phase, they were presented with a dumbbell of different colors about 1½ times larger than the miniature dumbbell, and given time to imitate the same behavior seen by the experimenter. In the context-change condition, children were presented with the objects in an orange polka-dot tent, and tested in a plain, white laboratory room. They found strong evidence of imitation with changes in the salient features of the objects and context changes. Children who had observed the experimenter perform the activity displayed imitation far more frequently than children in the control group, who had not seen the experimenter imitate the action.

Barnat et al. discuss the implications of these findings with respect to symbolic thinking. Although the objects in the encoding and recall contexts may have differed in color and size, the children were able to perceive enough of a resemblance between the objects to transfer the imitation. The children were not simply repeating a familiar behavior since they were not allowed the opportunity to practice the actions before the test phase. The young children needed to maintain a representation of the activity they observed in order to spontaneously recall the imitative response in the test phase with the objects that had changed in size and color.

The imitative literature provides convincing evidence that very young infants are capable of imitating actions performed by another individual. Why, then, do the 30-month-old children in DeLoache's standard task show poor performance when imitating the placement of a doll during the orientation phase? Certainly one explanation is in terms of the difficulties associated with the ability to process dual representations. The imitative response in the model-room paradigm requires both a representation of the two arrays plus an understanding of their relationship to one another.

In the standard model/room paradigm, the child must also complete the goal of positioning the doll in a particular location in the analogous array. In contrast, children in other imitative tasks are generally encouraged to reproduce a specific action, and the actions are primarily linked to the objects in the arrays. This response may be far easier to imitate than the placement of the doll in a particular, yet arbitrary, location in the standard model/room task. The imitative task may also be more difficult for the younger children because it is a *spatial* task. The doll does not cue where it should be placed. On the other hand, the imitative procedures in studies by Meltzoff and others require the child to imitate an activity with a toy that may be suggestive of a particular activity; there are no spatial demands.

Imitation in the Present Study

In the current study involving the workbench, children in one condition were asked to transfer a response that differed significantly from DeLoache's standard task; children did not simply place an object in an arbitrary location, but imitated a specific action with that object. By reducing the spatial demands, 30-month-old children may be able to show greater evidence of dual representation. By observing whether a child was able to select and reproduce a particular action with the analogous tool, rather than selecting and placing that tool in a particular location on the workbench, we can answer the second question posed. That is, whether the type of activity in which the child was engaged affected dual representation task performance.

CHAPTER 2

METHOD SECTION

Subjects

Fifty-nine children participated in this study. Three additional children refused to complete at least three of the four trials required to remain in the study and were dropped from the analyses. Of the 59 children who completed the study, two completed only three of the four trials due to experimenter error. Thirty 36-month-old children (34-38 months, $M = 36.9$ months), with 18 girls and 12 boys, and twenty-nine 30-month-old children (29-31 months, $M = 30.2$ months), with 14 girls and 15 boys were included in the final sample. Most children were Caucasian and middle class. Children were recruited from state birth records, and all were tested at the Child Study Center in Springfield, Massachusetts.

Materials

A plastic, child-sized, Fisher-Price workbench was used in this experiment, as well as a scale model of the workbench. A sketch of the workbench is shown in Figure 2. The child-sized workbench was approximately 24 inches wide and 36 inches high. The workbench included a horizontal top shelf, 21 inches long and 8 inches deep, and a horizontal workspace at the child's waist-level, 16 inches wide and 18 inches deep. The surface of the horizontal workspace resembled a peg-board in which nails or screws could be placed. Below the top shelf, approximately at the child's eye-level, were four hooks for hanging various tools. A bucket, 9½ inches wide and 5 inches deep, hung on right side of the workbench at the level of the workspace. A net bag, 4½ inches wide and 7¼ inches long, hung from the left side of the workspace.

The tools and materials included as part of the workbench were a plastic hammer, saw, screwdriver, wrench, screws, and a plastic block that resembled wood. The tools were each approximately 5 inches long and 1½ inches thick, and the screws were about 2 inches long. The four tools were placed on the workspace at the beginning of each trial, ordered from left to right as follows: hammer, saw, screwdriver, wrench. A scale model workbench was created to be as similar to the child-sized workbench as possible. The model workbench and tools were made of wood, and the components of the model were painted the same color as the larger workbench and constructed so both workbenches and tools were physically similar to one another except for size. The scale model of the workbench and the small tools were ¼ the size of the child-sized workbench. Two Elmo puppets, identical except for their size, were also used. These puppets maintained the same ratio in size as the child-size and scale model workbenches and tools. The child-sized workbench and its model were located in two adjacent rooms so that both arrays could not be seen simultaneously by the child during testing.

Procedure

In each age group, children were assigned to either a location condition or an activity condition. These two conditions differed in the kind of event the child was asked to reproduce in the analogous setting. In the location condition, the child observed as Elmo selected and then placed a tool in a particular place on the workbench and was then asked to show how the other Elmo would place the tool in a specific location on the analogous workbench. In the activity condition, the child observed as Elmo selected and then used the tool in a particular manner on the workbench and was then asked to show how the other Elmo would use the tool on the analogous workbench. Children in both conditions first received an orientation to the materials. Following the orientation, children received four test trials and four memory trials.

Orientation. In both conditions, each child received extensive instructions that emphasized the similarities between the two puppets, the two workbenches, and the analogous tools used in this study. Every effort was made to make the instructions comparable to those used in the model/room tasks within the constraints of the modifications needed to accommodate this particular task. To begin, the child was brought into the room with the child-size workbench and the experimenter introduced the two Elmo puppets, pointing out their similarities except for size. For example, "See little Elmo? He looks just like big Elmo except that he is smaller." The experimenter then explained how the two puppets liked to do the same things, and that they each have their own workbench.

The experimenter then pointed out the similarities between the two workbenches and their tools to the child. She began by saying, "This is big Elmo's tool bench. He has all of these tools to help him build things." The experimenter then proceeded to illustrate various features of the child-size workbench (e.g., the shelf, bucket, hooks, and bag) and pointed out each of the tools to the child. After the child had become familiar with the child-size workbench, the experimenter and child moved to the scale model of the workbench located in the adjacent room. The experimenter said, "This is little Elmo's workbench. He has all of these tools to also help him build things." Again, the experimenter described the bench and its features and pointed out each of the tools to the child. For example, the experimenter said, "See the little blue bucket on the side of this workbench? It looks just like the blue bucket on the big bench. They look the same except that this one is smaller." The child saw how both workbenches contained a top shelf, a bucket, hooks, and a net bag.

To complete the orientation, each of the small tools was compared to its larger counterpart. The experimenter and child returned to the initial room, taking each of the tools from the scale model workbench into the room and pointed out their similarity to the larger tools. The experimenter selected one of the small tools and said, "See this little hammer is just like the big hammer" as she held both of them before the child. "This is little Elmo's hammer and this is big Elmo's hammer". This exchange was carried out with each of the tools. To complete the orientation process, the child was again reminded of the similarity between the two workbenches and the analogous tools. Finally, the experimenter demonstrated the large Elmo puppet waving, and asked the child what little Elmo would do, emphasizing that both big and little Elmo liked to do the same things. If the child failed to reproduce a waving action, the experimenter explained that little Elmo would like to wave as well. Once the orientation process was complete, the test and memory trials began.

<u>Test and Memory Trials</u>

Following the orientation phase, children began a sequence of four experimental trials. Each trial included a) a demonstration event by the experimenter showing the puppet selecting and placing one of the four tools (hammer, saw, screwdriver, wrench) in one of four locations on the tool bench (in the location condition) or selecting and using the tool in a specific way (in the activity condition); b) a test of that event using the materials in the analogous setting, and c) a test of memory for the original event. In the experimental tasks, trials began for half of the children with the child-sized workbench and the test occurred using the model; for the other half of the children, trials began with the model and the testing occurred with the child-sized workbench. Four orders of presentation of the actions or locations were created to ensure that each tool and implementation would be used about equally often on each trial.

Location Condition. In this condition, the demonstration event on each of the four trials consisted of selecting and placing a tool in a specific location. At the initial setting, either the child-size workbench or the model, the experimenter began with the first of four trials while using the puppet. The four distinct locations in which the tools were placed were in the bucket, on the top shelf, hanging from a hook, and in the net bag. For each trial, the experimenter used the puppet to select and place the tool in a particular location while saying, “Watch where big Elmo is putting his tool.” The experimenter did not name the specific tool or location on the workbench during the demonstration. As a reminder the child was told, “Remember where big Elmo put this. Little Elmo wants to put his in the same place. Let’s go help little Elmo put his tool in the same place”.

In the test setting, the experimenter continued to encourage the child to replicate the selection and placement of the tool. She asked, “Can you help little Elmo put his tool where big Elmo put his?” If the child was unable to replicate the selection or placement of the tool after a few attempts, the experimenter prompted the child, reminding him or her that the puppets like to keep their tools in the same place. If the child was unable to select or place the tool in the correct location after several attempts, the experimenter showed him or her the correct location.

After the child completed the test trial in the analogous setting, the experimenter and child returned to the original setting. A second experimenter had moved the tool from where it had been placed earlier to its original position on the workbench. The experimenter then asked the child to show "where big Elmo put his tool" as a memory trial. The experimenter continued this same procedure for the three remaining trials, using a different tool and location on each trial.

Activity Condition. In this condition, the demonstration event on each of the four trials consisted of selecting and using a tool in a specific manner. At the initial setting, either the child-sized workbench or the model, the experimenter began with the first of four trials of selecting one of the tools and performing a distinct tool-appropriate action with it. The four actions were hammering, sawing, twisting the screwdriver, and turning the wrench. The experimenter performed the action using the puppet, while saying, "Watch what big Elmo is doing." The experimenter did not name the specific action or tool (i.e., "hammering", "sawing") while demonstrating the activity to the child. The child was reminded "Remember what big Elmo does with this. Little Elmo wants to do the same thing with his. Let's go help little Elmo do the same thing".

At the test setting, the experimenter encouraged the child to reproduce the same action by asking, "Can you help little Elmo do the same thing that big Elmo did?" Again, if the child did not select the correct tool or replicate the activity after several attempts, the experimenter prompted the child, reminding him or her that the puppets like to do the same things. If the child was still unable to select the correct tool or produce the same action, the experimenter showed the child the correct action with the appropriate tool.

After the action had been performed in the analogous setting, the experimenter and child returned to the original setting where the tool selection and action were first demonstrated by the experimenter. The tools had again been replaced to their original position by the second experimenter. The experimenter then asked the child to reproduce the tool selection and action with the puppet by asking "Can you show me what big Elmo did?" This served as a memory trial for the original tool and action. The experimenter continued this procedure for the three remaining trials, using a different tool and activity on each trial.

Scoring

Each child received four test trials and four memory trials, although the three children who completed only three trials were retained in the study. Each test trial consisted of selecting the appropriate tool (tool selection), and placing or using the tool correctly (tool implementation) in the analogous space. Each memory trial consisted of tool selection and tool implementation in the retrieval space. Therefore, each child who completed the task had four selection scores and four implementation scores for the test trials, and four selection scores and four implementation scores for the memory trials. Each child thus had a total test trial score of zero to four, and a total memory trial score of zero to four. Because some children completed only three trials, proportion scores were calculated for the participants, reflecting the proportion of correct responses out of the total responses made. Analyses were run on these proportion scores.

Two dependent measures were available to determine whether transfer took place, tool selection and tool implementation. These measures were not combined because the action performed in the activity condition may not have been independent of the tool selected. For both the test and memory trials, a correct response was recorded if the child correctly selected the appropriate tool and if he or she reproduced the action or placement on the first attempt. If the child's only response was verbalizing, pointing to, or touching a tool for selection, that response was also scored as correct or incorrect. Verbalizations and pointing were also considered as responses for tool implementation if the child could communicate an appropriate response. If a child gave no response, it was scored as incorrect. Although the child was encouraged to continue the task when the first attempt was incorrect, only the first response was scored. However, each child was praised for completing each trial regardless of whether his or her response was correct. If the child's response was incorrect, the correct response was demonstrated before returning to the original workbench.

CHAPTER 3

RESULTS

Preliminary Analyses

Preliminary analyses were run on order of presentation of the tools over trials, initial setting, and gender to determine whether these factors were related to performance and whether they could be excluded from further consideration in the analyses of the data. A 4 (order of presentation) x 2 (type of trial: test versus memory) Analysis of Variance (ANOVA) with repeated measures on type of trial was run on the proportion of correct responses on tool selection. The effect of order of presentation was not significant. There was a main effect of type of trial, that is, whether the tool selection took place at the analogous space (test trial, $M = .389$) or at the retrieval space (memory trial, $M = .509$), $F(1, 55) = 8.240$, $p < .005$. The effect of type of trial is one of the primary variables of interest, and will be further examined in the main analyses. A 4 (order of presentation) x 2 (type of trial) ANOVA was also run on tool implementation. Again, order of presentation was not significant. The effect of type of trial was again significant, with poorer performance on the test trial ($M = .453$), than on the memory trial ($M = .557$) $F(1, 55) = 6.701$, $p < .012$. Since the order of the presentation of the tools did not affect children's performance, the order variable was dropped from further consideration of the data.

A second variable of interest was the initial setting, that is, whether the child began the test trials at the large workbench or at the model of the workbench. Individual ANOVAs were performed on each dependent measure: tool selection on the test trial, tool implementation on the test trial, tool selection on the memory trial, and tool implementation on the memory trial. A significant effect was found on only one measure, tool implementation on the test trial. Children displayed higher performance when test trials took place with the child-sized workbench ($M = .551$) than with the scale model ($M = .358$), $F(1, 57) = 6.124, p < .016$. The initial setting did not show a significant effect on any of the other three measures. Since previous research in this area has shown that the initial setting in which the child begins the test trials does not affect performance, and its effect in the present study was only significant on one of the four measures, the variable was also dropped from further consideration.

Finally, gender was examined. A gender difference was found on all four dependent measures, with the girls performing better than the boys in every case. Gender was significant on tool selection on the test trials, $F(1, 57) = 4.194, p < .045$; marginally significant on tool implementation on the test trials, $F(1, 57) = 3.662, p < .061$; significant on tool selection on the memory trials, $F(1, 57) = 4.967, p < .030$; and significant on tool implementation on the memory trials, $F(1, 57) = 7.656, p < .008$. Gender was retained in subsequent analyses for further examination of its effects and possible interactions with the main variables of interest in this study.

Main Analyses

Of primary interest in the present study was the performance of the participants on the test and memory trials as a function of age and condition. As indicated above, gender was also included as a factor because of the significant gender effects in the preliminary analyses. The results for children's performance on tool selection is considered first, followed by an examination of tool implementation.

Tool Selection. Table 1 presents the proportion of correct tool selections, grouped by type of trial, age, sex, and condition. As can be seen in the table, an overall higher level of performance occurred on the memory trials than on the test trials. However, this pattern was not found for all groups. For example, 36-month-olds in the activity condition produced a higher proportion of correct responses on the test trials than on the memory trials. As the preliminary analysis involving gender would suggest, the data also indicate that the girls have a higher proportion of correct responses than the boys. However, this pattern was not observed in all groups either. In particular, the 30-month-old girls in the activity condition displayed somewhat lower proportions of correct responses than the boys on both the test and memory trials. Finally, the general performance of the children appeared rather low. One-sample t-tests with Bonferroni adjustments were run on the tool selection measures to determine whether the children's performance was significantly above chance (.25). Most of the scores that were above chance were from the 36-month-old girls and on the memory trials. The proportion scores that are higher than chance are indicated in Table 1.

A 2 (age) x 2 (sex) x 2 (condition) x 2 (type of trial) ANOVA with repeated measures on type of trial was run on these data. The effect of type of trial was significant, as was indicated in the preliminary analyses. Children performed better on the memory trials than on the test trials, $F(1, 51) = 7.995, p < .007$. The main effect of sex was also significant, $F(1, 51) = 7.612, p < .008$, with girls having a higher level of performance ($M = .478$ and .569 on test and memory trials, respectively) than the boys ($M = .301$ and .441 on the test and memory trials, respectively). Age was not a significant factor on the selection measure, nor was the effect of condition. A three-way interaction of age, condition, and type of trial was significant, $F(1, 51) = 8.305$, $p < .006$. This interaction appears to stem from the poorer performance of the 36-month-olds' on the memory trials than on the test trials in the activity condition. In contrast, the children in the location condition performed better on the memory trials than on the test trials. The 30-month-old children performed better on the memory trials than on the test trials in both the activity and location conditions. Figure 3 illustrates the interaction.

Tool Implementation. Table 2 presents the proportion of correct tool implementations as a function of type of trial, age, sex, and condition. As was found for tool selection, higher proportions of correct responses occurred on the memory trials than on the test trials, again with the exception of the 36-month-olds in the activity condition. Table 2 also reveals that the females performed better than the boys, except for the 30-month-old girls in the activity condition. The overall low proportion scores of the children suggested that some of the scores might not be above chance. One-sample t-tests with Bonferroni adjustments were run on the tool implementation measures to determine which proportion scores were significantly higher than chance (.25). The scores that were significantly higher than chance occurred mostly for the 36-month-old girls and on the memory trials; these scores are indicated in Table 2.

A 2 (age) x 2 (sex) x 2 (condition) x 2 (type of trial) ANOVA was run on these data, with repeated measures on type of trial. Again, the effect of type of trial was significant, $F(1, 51) = 5.631, p < .021$, with superior performance on the memory trials than on the test trials. The main effect of sex was also significant, $F(1, 51) = 9.556$,

$p < .003$, with girls ($M = .535$ and .636 on test and memory trials, respectively) performing better than the boys ($M = .369$ and .462 on test and memory trials, respectively). As was the case for tool selection, neither the main effect of age nor the effect of condition was significant for tool implementation. There was, however, a significant two-way interaction of sex and condition, $F(1, 51) = 4.918, p < .031$. The interaction stems largely from the superior performance of the girls compared to the boys in the location condition, whereas the difference in performance for the activity condition was not as substantial. Figure 4 illustrates this interaction.

The results from the analyses of children's tool selection and tool implementation show similar patterns. For both the selection and implementation measures, superior performance was seen on the memory trials. Girls outperformed boys on both measures, whereas the two age groups did not differ in performance, which was similar in both conditions. The consistent pattern found with these two measures suggests that selection of the appropriate tool and the necessary implementation carried out by the child with that tool provided similar information. Two Pearson product-moment correlations were run, one for tool selection and tool implementation on the test trials, and one for tool selection and tool implementation on the memory trials. The two measures were highly correlated on test trials, $r = .786$, and on memory trials, $r = .759$, again suggesting that the analyses of tool selection and tool implementation appear to be providing similar patterns of performance.

Additional Analyses

Trials Effects. Previous research on symbolic development investigating test and memory performance using a room and a model of the room has sometimes revealed trial effects. In some studies, children have been observed to perform better on the first test trial than on any of the three remaining trials (O'Sullivan, Mitchell, & Daehler, 1999a, 1999b; Schmitt, 1997). Performance on each of the four trials was examined in the present study to explore whether trial effects were present. Separate Cochran Q Tests were carried out on the test and memory trials for both the tool selection and the tool implementation measures to determine whether these differences were significant. When collapsed over age, sex, and condition, the only significant trials effect was on tool selection on the memory trial, $Q(3) = 13.067, p < .005$. The proportion of correct tool selections on memory trials collapsing over age, sex, and condition, for trials one through four, can be seen in Figure 5. This figure shows that children performed better on the first trial than on any of the other three trials. More specifically, children were better at remembering which tool had been used by the experimenter on the first trial than on the three subsequent trials. However further inspection of the data suggested that this finding may not extend to both age groups. To further investigate the effect, separate Cochran Q Tests were carried out for each age group. The effect of trials was pronounced in the 2½-year-old group, $Q(3) = 17.903, p < .001$, yet only marginal in the 3-year-old group, $Q(3) = 7.283, p < .10$. The trial on which performance was superior was not consistent, however, for the 2½- and 3-year-olds, as can be seen in Figure 6. The 3-year-olds showed better performance on the first trial than on any other; the 2½-year-olds showed the highest level of performance on the third trial, although they also did relatively well on the first trial compared to trials two and four.

Since memory performance was generally better on the first trial than on any other, test and memory performance on the first trial was further examined. First trial performance is uncontaminated by potential interfering factors from preceding trials, such as memories of a previously correct response. Thus first trial data may provide the clearest account of what factors are contributing to the children's performance. Likewise, since memory performance was generally superior on the first trial, this data may also provide the best opportunity to determine whether transfer occurred. For tool selection, trial 1 data revealed a higher proportion of children (.69) correctly responding on the first memory trial than on trial 2 (.37), trial 3 (.56), and trial 4 (.42). Nevertheless, test trial performance on trial 1 (.40 correctly responded) appeared to be comparable to the test trial performance on the three remaining trials, .40, .37, .37, respectively.

The first trial data were further examined by the age of the participants, to determine whether an age effect exists. Table 3 displays the proportion of correct responses as a function of type of trial, type of response (selection versus implementation), and age. When the scores on trial 1 are analyzed by age of the participants, the proportion of 2½-year-olds who correctly responded on the test and memory trials (.38, .66, respectively) was similar to the proportion of 3-year-olds who correctly responded on test and memory trials (.43, .72, respectively). A 2 (age) x 2 (type of trial) ANOVA with repeated measures on type of trial confirmed that the effect of age was not significant for tool selection on trial 1. This finding provides convincing evidence that even with optimal memory for the tool selection, there is no developmental trend in performance for either the test or the memory trials.

For tool implementation, the proportion of children correctly responding on the first memory trial (.67) was again higher than the proportion of correct responses on memory trials 2 (.46), 3 (.60), and 4 (.51). On test trials, performance on trial 1 (.52) was slightly higher than performance on the three remaining test trials, .45, .41, .44, respectively. When the data from trial 1 are analyzed by age (see Table 3), both age groups evidenced similar scores on the first memory trial; .66 of the younger children correctly responded, and .69 of the older children correctly responded. However, some evidence for a developmental trend is found for performance on the test trial. The proportion of 2½-year-olds who correctly responded on the first test trial is .38, whereas .67 of the 3-year-olds correctly responded. A 2 (age) x 2 (type of trial) with repeated measures on type of trial was performed to determine whether there was an age effect. The analysis revealed that the effect of age was not significant. Although not significant, the superior performance of the 3-year-olds on the first test trial of tool implementation is more in accord with previous research in dual representation. That is, even when memory demands are equally well met, the older children perform better than the younger children on the test trials, perhaps reflecting more representational insight.

Test Performance of Children with High Memory Scores. The children in the present study must remember the event demonstrated by the experimenter in order for transfer to occur. Many children, however, displayed low scores on the memory trials. The test scores of children who performed well on the memory trials may provide more evidence of transfer than test scores of children who had lower memory scores. Children who correctly responded on at least three out of the four memory trials were selected for further examination, and their performance on the test trials was investigated. For tool selection, 18 of the 59 children correctly responded on at least three of the four memory trials. Of these children, seven were 30-month-olds, whose mean proportion of correct responses on the test trials was .46. The mean proportion of correct responses of the eleven 36-month-olds was .52. There appears to be no convincing evidence of a developmental trend in test performance for tool selection among high memory performers.

The same investigation was conducted for tool implementation, again only for the children who correctly responded on the memory trials 75% of the time. Twenty-five of the 59 children had high scores on the memory trials. Of these children, eleven were 30-month-olds, whose mean proportion of correct responses on the test trials was .50. Fourteen of the children were 36-month-olds, and their mean proportion of correct responses was .66. The older children performed better than the younger children on tool implementation, even when both age groups had high memory scores. This finding is in agreement with DeLoache's research, where both 30- and 36-month-old children perform well on memory trials, and the 36-month-olds display more evidence of transfer on the test trials than the 30-month-olds.

<u>Performance of Children with Workbenches at Home.</u> Some participants may have had substantial experience with child-sized workbenches, especially if one was available in their home. Thus, during debriefing, parents were asked whether their children had a similar toy at home or whether their child played with one in school or daycare. The performance of children who had experience with workbenches was compared to the performance of children who did not have workbench experience. Only 18 of the 59 children who participated in this study had experience with workbenches (30%). A 2 (experience) x 2 (type of trial) ANOVA was run, comparing the performance of children with workbenches to those without. On tool selection, the performance of children with workbenches (M = .306 and .431 on the test and memory trials,

respectively) did not differ significantly from the performance of children without workbenches (*M* = .427 and .545 on the test and memory trials, respectively), although children without workbenches yielded slightly higher mean proportion scores than children with workbenches. Tool implementation, on the other hand, was affected by whether the children had workbenches (*M* = .319 and .463 on the test and memory trials, respectively) or did not have workbenches, (*M* = .512 and .600 on the test and memory trials, respectively), $F(1, 57) = 6.688$, $p < .012$. The children without workbenches performed significantly better than the children with workbenches.

Because of the main effect of gender, a 2 (experience) x 2 (type of trial) ANOVA was carried out separately for girls and boys to determine whether the superior performance of the children without workbench experience was mediated by gender. Seven of the girls and eleven of the boys had previous workbench experience. Gender was not a significant factor on tool selection; availability of a workbench did not lead to significantly better performance for either boys or girls on the test or memory trials. However, for tool implementation, having experience with a workbench significantly affected performance for boys, $F(1, 25) = 8.132$, $p < .008$, with superior performance evidenced by the boys without previous workbench experience. The mean proportion of correct responses on the test trials by boys without experience was .45, whereas the proportion of correct responses by boys with experience was only .25. For the memory trials, the proportion of correct responses of boys without and with workbench experience, respectively, was .54 and .35. The effect of workbench experience on tool implementation was not found for the girls. The significant effect of workbench experience is thus limited to the boys, although for both groups previous workbench experience hindered performance.

Perseverative Errors

Further examination of the data was carried out to investigate the types of errors made by the children. Previous research on dual representation tasks has shown that young children often make perseverative errors (DeLoache, 1999; O'Sullivan, Mitchell, & Daehler, 1999a, 1999b; Schmitt, 1997). Perseverative errors in this study are those in which the child responded by selecting and implementing the tool that had been correct on the immediately preceding test and memory trial. For example, if the hammer had been the correct tool to select on trial 1 of the test trials, and the child chose the hammer again on trial 2 of the test trials, the error would be counted as a perseverative error. Similarly, if placing the hammer on the shelf was the correct implementation on trial 1 of the memory trials, and the child repeated this implementation response on trial 2 of the memory trials, the error would be counted as a perseverative error. To examine perseverative errors, the data were collapsed across age, sex, and condition.

For tool selection on the test trials, 40 of the 144 errors (27%) consisted of perseverative errors. For tool selection on the memory trial 44 of the 116 errors (37%) were perseverative. For tool implementation on the test trial, a total of 39 perseverative errors were made out of 128 errors (30%). Finally, for tool implementation on the memory trial, children made 39 perseverative errors out of 105 errors (37%). Some children made more errors than others, and thus could also have made more perseverative errors. As a consequence, a proportion score was calculated for each child reflecting the number of perseverative errors committed out of the total numbers of errors made. The mean proportion of perseverative errors out of total errors was .285 for tool selection on the test trial, .399 for tool selection on the memory trial, .321 for tool implementation on the test trial, and .396 for tool implementation on the memory trial. One-sample t-tests were run on each of these four measures to determine whether children produced perseverative errors at a level higher than chance (.33). On all four measures, the rate of perseverative errors did not differ significantly from chance.

CHAPTER 4

DISCUSSION

The major findings from the study indicate that the children performed better on the memory trials than on the test trials, as had been expected. Both 30- and 36-month-olds performed at similar levels on memory trials, as expected, but performance of both age groups was substantially below the level anticipated. Children's performance on the memory trials was expected to approximate the performance of young children in previous research on dual representation, yet the children in the present study fell below that expectation. In addition, neither 30- nor 36-month-olds performed well on the test trials, suggesting that even the 36-month-old children lacked the representational insight required for this task. Similarly, performance levels were quite equivalent in the location and activity conditions. This finding indicates that both transfer and memory were relatively similar whether the child was required to place the tool in a particular location or imitate an activity with the tool. Finally, superior performance was evidenced by the girls compared to the boys.

The results of the present study can perhaps be best understood in terms of the differences between this study and the research previously conducted in the field of dual representation. Following a summary of the differences in results, possible reasons for why the study revealed different findings, with emphasis on the methodological differences between the present study and the standard model/room paradigm, will be discussed. Finally, conclusions and the future directions of research in dual representation are considered.

Differences in Current and Previous Research Findings

The results of the present study, specifically the test and memory trial performance, were quite different from the findings of previous research on dual representation which has been carried out using a room and a model of the room (e.g., DeLoache, 1989a, 1989b, 1999; O'Sullivan et al., 1999a, 1999b). Four main differences between the results obtained in the present study and those involving transfer between the model and room stand out. First, the present study found a far lower level of performance on memory trials for both 30- and 36-month-olds in both the location and activity conditions than is typically found in the standard DeLoache paradigm. In the model/room studies, 30- and 36-month-old children typically perform quite well on the memory trials, usually recalling well over 70% of the locations in which an object had been hidden. In the present study, both age groups showed a much lower level of performance on memory trials; the highest proportion of correct responses was 70%, which only occurred for the 36-month-old girls. Thus it is possible that this task may indeed have been a more difficult one for very young children.

A second finding in the present study that differed from previous research was the absence of an age effect on the test trials. Children of both ages showed comparable performance on the test and memory trials. Most previous research has shown that 36-month-olds perform significantly better than 30-month-olds on the test trials, indicating that the older children have achieved a higher level of representational insight than the younger children. That finding was not evidenced here. However, 36-month-olds do not always perform better than 30-month-olds; other studies have revealed 36-month-old children can have difficulty in dual representation tasks. For example, DeLoache et al.

(1991) varied the similarity of the materials in one experiment; the furniture in the model and room differed in color and/or pattern. The 36-month-old children's performance was hindered with these changes. DeLoache (1989a) also showed that 36-month-old children's performance may be affected if they do not receive the extensive orientation phase, during which the correspondence between the model and the large room is explained. It is possible that the effort to maintain similarity between the child-sized workbench and the model of the workbench was not successful. This explanation, although possible, seems unlikely given the poor performance of the older children even on the memory trials. Since memory was apparently limited, the opportunity for transfer was thus limited as well.

The present study also found girls performing better than the boys. Gender differences have not been evidenced in previous dual representation research, nor have gender differences been consistently reported in the imitation literature (Bauer & Hertsgaard, 1993; Bauer & Mandler, 1989; Hanna & Meltzoff, 1993; Marzolf & DeLoache, 1994; Meltzoff, 1985). However, in the present study, the gender difference was reliable, occurring on each of the four dependent measures. The reason for a difference in performance between the boys and the girls is not obvious. One might have expected boys to outperform the girls, given that the materials used in the study were tools and a workbench, a toy perhaps of greater interest to young boys than to young girls. If boys have greater interest in such materials, then they might have gained somewhat greater exposure to the workbenches and tools even if they did not have these materials at home or in a day care center they attended. When workbenches were readily available to them, the familiarity appeared to interfere with performance, which could explain why the boys did not perform as well as the girls. Also, the boys may have not performed as well as the girls in this study simply due to a greater impulsivity to engage in the activities associated with the workbenches. If they were preoccupied with the materials before the orientation began, the boys may not have attended to the instructions of the task. Unfortunately, no measure of how quickly participants engaged in tool selection was obtained in this study.

Finally, the children in the present study displayed a lower rate of perseverative errors than in previous research. The rate of perseverative errors in this study did not differ significantly from chance, whereas previous research has shown a rate of perseverative errors as high as 60% (O'Sullivan et al., 1999a, 1999b; Schmitt, 1997).

Possible Reasons for Different Findings

Why did the results of the present study look so different from the findings of previous dual representation studies? The present study introduced several methodological changes that could have contributed to the differences between the present results and the results typically found in this area of research. A primary goal of the present study was to examine whether difficulty in transfer in the standard model/room task is a consequence of two different types of spaces, one traversable and one surveyable. DeLoache (1995b) conducted a study in which the model and room maintained a 2:1 size ratio, and both spaces were surveyable, thus maintaining a similar visual perspective. The 30-month-old children's performance on the test trials was better in that condition (75% correct) than in the standard model/room condition. The present study used a completely different type of array, a workbench and a model of the workbench, in order to eliminate the change of perspective inherent in the model/room task. It was hypothesized that maintaining a consistent perspective would aid the children in the task. However, that was not the case. It is possible that the low level of performance found in the present study indicates that young children may simply not be able to perform well in a task involving materials such as the workbench. The workbench may have been too attractive and interesting to the children, and provided many opportunities for manipulation. However, other methodological changes may have contributed to the lower performance and need to be considered as well.

A second change introduced in the present study that differs from the standard model/room task is that the child was asked to imitate a placement or an action with materials as opposed to searching for a hidden object. The decision to use an imitation procedure was based on the assumption that it was comparable in difficulty to a retrieval response. DeLoache's research indicates that imitative responses and retrieval responses yield similar results (DeLoache et al., 1991). On the other hand, research by Schmitt (1997) showed evidence that imitative tasks were *easier* than search tasks for young children. Based on these findings, the children were expected to execute the imitation procedure as well as, if not better than, the children in the model/room task. The data in the present study did not support this hypothesis. Thus the change to an imitation procedure alone is unlikely to account for the low level of performance of the children in the present study.

Another potential, and perhaps more critical, basis for the different findings in the present study is that the child was required to remember two steps: which tool to select from among the four possible choices; and which implementation response to reproduce with that tool. In order to be successful in the model/room task, children only need to search for a single hidden object. For example, when the child is asked to imitate the placement of the object in these tasks (DeLoache et al., 1991; Schmitt, 1997), the child is given the one object for placement. However, in the present study, the child had to remember which tool to select and then to pick out that tool from among the four choices before engaging in the placement or activity component of his or her response. Selecting from among four alternatives could be far more difficult for the children than had been expected.

Previous research on imitation of event sequences has shown that young children, even children much younger than those tested here, are capable of remembering both familiar and novel event sequences for immediate and deferred recall. For example, a familiar event sequence may consist of placing a toy bear in a tub and washing it with a cloth. A novel sequence may consist of pulling a mitten off of a puppet, shaking the mitten to hear a bell inside, and replacing the mitten on the puppet (Barr et al., 1996). Bauer and Hertsgaard (1993) found that both 13½- and 16½-month-old infants were able to recall two-act sequences immediately and after a one-week delay. Given these findings, the low performance of the children on the memory trials in the present study may seem surprising. However, the imitative responses of the infants did not require them to select from among several objects before executing the imitative response. The object necessary for the imitation was presented to the infant, and they only needed to remember the appropriate action to display with that object. However, the present study required the child to select the appropriate tool from among four choices before executing the imitative response, a seemingly more difficult task than those performed by infants in other imitation studies. Also, most imitative studies with very young children only presented the child with one set of actions to imitate; the child was not required to select among alternative actions to imitate. Since the present study consisted of four trials, the children needed to inhibit selections and responses carried out on previous trials in order to make the correct selection and response on the current trial. The difficulty in inhibiting previous responses may also explain the superior performance of the children on the first memory trial of tool selection.

The present study also differed from previous research in that the Elmo puppet was used as the instigator of action, whereas in the model/room paradigm, the toy serves as the actual target of search. The child needed to observe as the puppet demonstrated the event, and thus needed to identify with the puppet on some level in reproducing the action both on the test and memory trials. At the present time, the increased processing demands that may be required to identify with the toy, and the consequences for performance, are unknown. Anecdotal evidence suggests that most children immediately recognized the puppet as a common television character and were content to engage in the task with Elmo. Nevertheless, this change in the procedure could have affected performance.

One interesting finding of the present study is that the children who did not have previous experience with workbenches performed better than the children who did have previous experience. Although one may predict that practice with a workbench could engage the child's attention to the task and increase performance, it appears that experience with the materials impeded the child's ability to perceive the symbol-referent relationship. DeLoache (1999) states that children without experience with experimental materials are better able to achieve psychological distance from the materials, enabling them to recognize the correspondence between the larger and scale model spaces. She found, for example, that children who were allowed to play with the experimental materials before the task did not perform as well as the children who did not play with the materials. The poorer performance of children with workbench experience may also explain why the boys did not perform as well as the girls in this study. Their greater interest in the materials may have hindered their ability to recognize the relationship between the two spaces.

Conclusions and Future Directions

The purpose of the present study was to investigate whether the dual representation phenomenon existed outside of the model/room context by making two primary changes: first, using a procedure consisting of imitative responses from the child, and second, creating a new context in which to investigate transfer. The imitative procedures incorporated one of two types of conditions, a location condition and an activity condition. The location condition, which required the child to place a tool in a particular place on the workbench, most closely resembles the standard model/room procedure. The child needed to remember the spatial location of the tool on the first workbench, and then to transfer that information to the second workbench to reproduce the spatial placement. Similarly, in DeLoache's standard procedure, the child must remember the spatial location of the toy being hidden in order to correctly find the toy on the test trials.

The activity condition did not impose the same spatial demands on the child. The task consisted of selecting one of the four tools and imitating a behavior with it and thus did not impose the same spatial demands, although imitation was still required. Despite the differences in the demands of the two conditions, no significant effect on performance was found. Activity demands did not lead to more successful imitation than spatial demands. The imitative response required in this task was more difficult for the children than imitative responses required in previous research. Again, the difficulty may stem from the fact that the child was first required to select the appropriate tool before an implementation response could be given.

Despite the lack of age differences over four trials, one of the most interesting findings from the present study was the presence of an age effect when examining the first trial data. The performance of the 30- and 36-month-old children on the first memory trial closely resembles the memory performance of young children in previous dual representation research. Both age groups remembered the event they had observed in the original setting. No age differences were found in tool selection on the first test trial, suggesting that transferring which tool to select was equally difficult for the 30- and 36-month-old children. However, the older children displayed superior tool implementation compared to the 30-month-olds on the first test trial. The older children thus displayed the ability to transfer information from one workbench to the other, displaying more representational insight than the 30-month-old children. The finding provides some support for the hypotheses of previous research, claiming that the ability to represent an object as both an object and as a symbol develops around 36-months of age.

Some evidence of a developmental trend in test performance was also found when examining the performance of children who scored well on the memory trials. When the children remembered the event that had been demonstrated, both age groups displayed similar tool selection performance on test trials. However, the 36-month-old children displayed superior transfer of tool implementation on the test trials. Even when both 30- and 36-month-old children remembered the event, the older children demonstrated more representational insight in transferring where to place the tool or what activity to perform with the tool.

The results of the present study do not provide a clear answer as to whether the different results obtained are due to the different type of space utilized (workbench versus room) or due to the type of activity required by the child to complete the task (imitation versus search). Additional research is planned in which the same type of space, a workbench, will be utilized, but the same activity as used in previous studies, search and retrieval, will also be used. This design should shed light on whether the different type of space is the basis for the different results. Specifically, four hiding places will be created on the workbench, and a similar procedure to DeLoache's search task will be employed. The child will observe as the experimenter hides a tool on the workbench, and will then move to the model of the workbench to find a similar tool that has been hidden in the analogous place. The child will return to the first workbench and retrieve the tool the child had seen hidden by the experimenter.

Dual representation is required in the model/room paradigm. However, it is not clear whether the phenomenon will be evidenced in new settings. The type of setting in which dual representation is studied may have important consequences for the age and extent to which it is displayed. Extending the investigations of the development of representational insight to new settings should provide more information about the nature and limits of this developmental phenomenon.

Table 1.

Proportion of Tools Correctly Selected as a Function of

Type of Trial, Age, Sex, and Condition

Age	Sex	*N*	Location Condition		*N*	Activity Condition	
			Test	Memory		Test	Memory
30 months	Males	8	.219	.375	7	.357	.536
			(.09)	(.08)		(.10)	(.09)
	Females	5	.550	.550*	9	.278	.528
			(.12)	(.10)		(.09)	(.08)
36 months	Males	5	.200	.500	7	.429	.357
			(.12)	(.10)		(.10)	(.09)
	Females	10	.400	.608**	8	.687**	.594*
			(.08)	(.07)		(.09)	(.08)
Means			.342	.508		.437	.503

Note. Numbers in parentheses represent standard errors.
* = significantly above chance at $p < .05$
** = significantly above chance at $p < .01$
*** = significantly above chance at $p < .001$

Table 2.

Proportion of Correct Tool Implementations as a Function of

Type of Trial, Age, Sex, and Condition

Age	Sex	*N*	Location Condition		*N*	Activity Condition	
			Test	Memory		Test	Memory
30 months	Males	8	.250	.416	7	.393	.607
			(.09)	(.08)		(.10)	(.08)
	Females	5	.600	.650*	9	.250	.500
			(.12)	(.10)		(.09)	(.07)
36 months	Males	5	.300	.400	7	.536	.429
			(.12)	(.10)		(.10)	(.08)
	Females	10	.575	.708***	8	.719**	.687***
			(.08)	(.07)		(.09)	(.08)
Means			.431	.543		.474	.555

Note. Numbers in parentheses represent standard errors.
* = significantly above chance at $p < .05$
** = significantly above chance at $p < .01$
*** = significantly above chance at $p < .001$

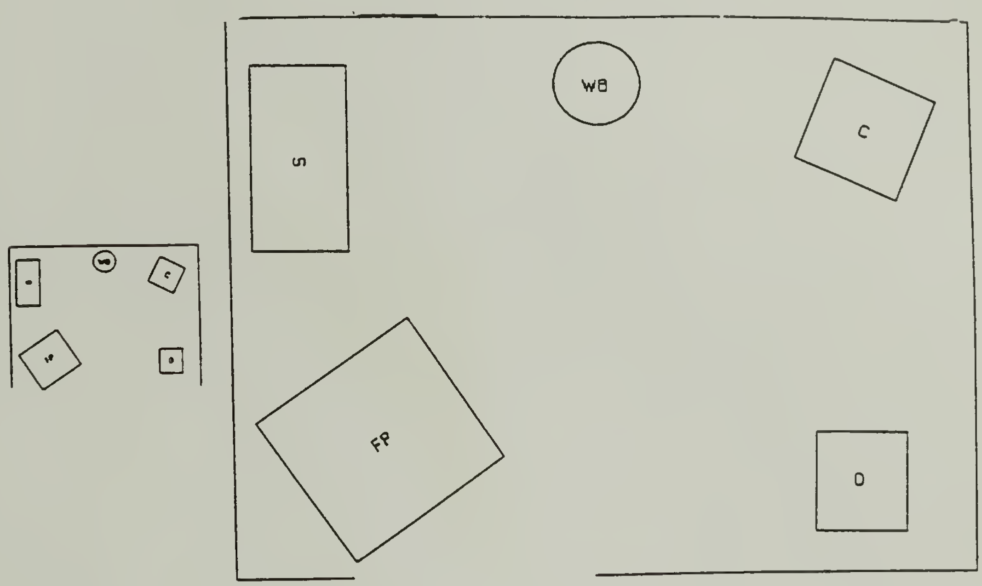
Table 3.

Proportion of Correct Responses on Trial 1 as a Function of

Type of Trial, Type of Response, and Age

Age	Tool Selection		Tool Implementation	
	Test	Memory	Test	Memory
30 months	.38	.66	.38	.66
36 months	.43	.72	.67	.69

Figure 1. Layout of a Room and Model Used in the Standard DeLoache Task



Note. *S* = shelves, *WB* = wicker basket, *C* = chair, *FP* = floor pillow, *D* = dresser
From DeLoache, Kolstad, & Anderson, 1991.

Figure 2. Sketch and Dimensions of the Child-Sized Workbench

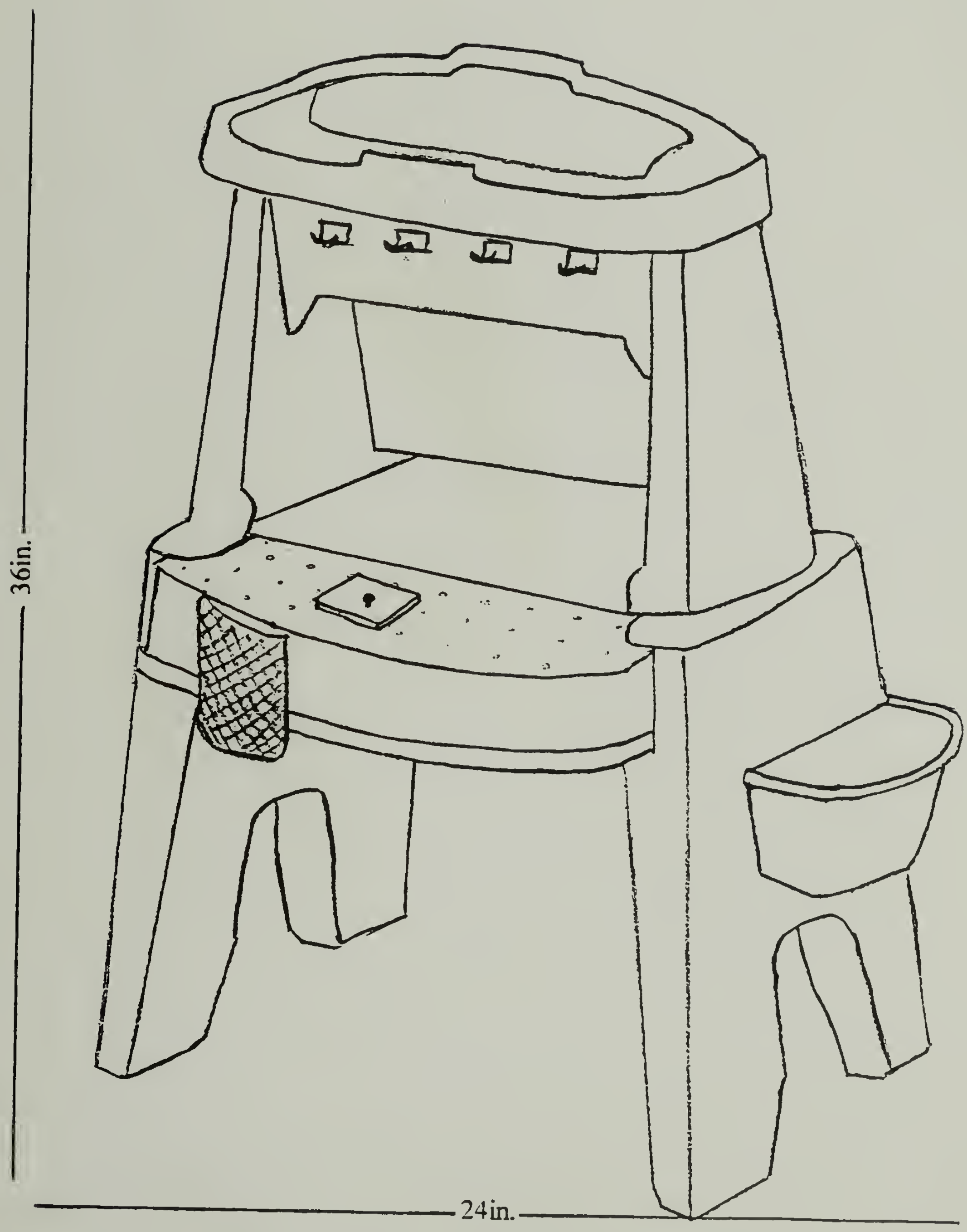
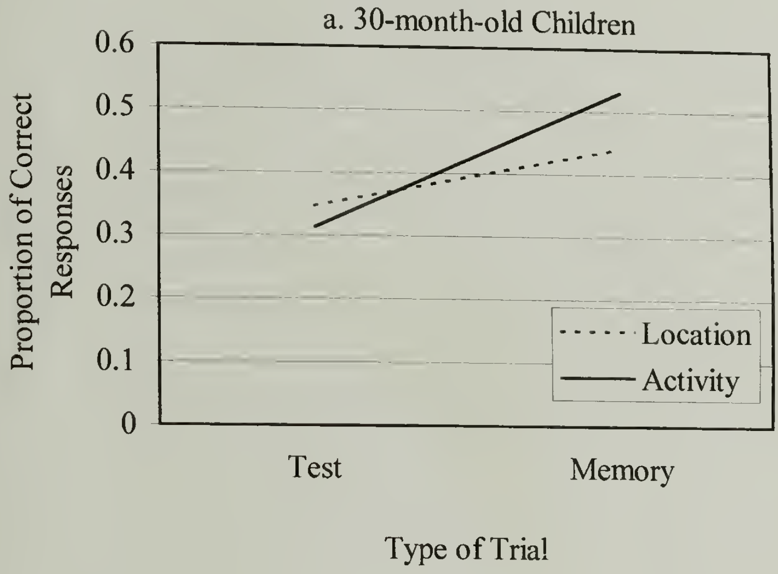


Figure 3. The Interaction of Type of Trial, Age, and Condition

On Tool Selection



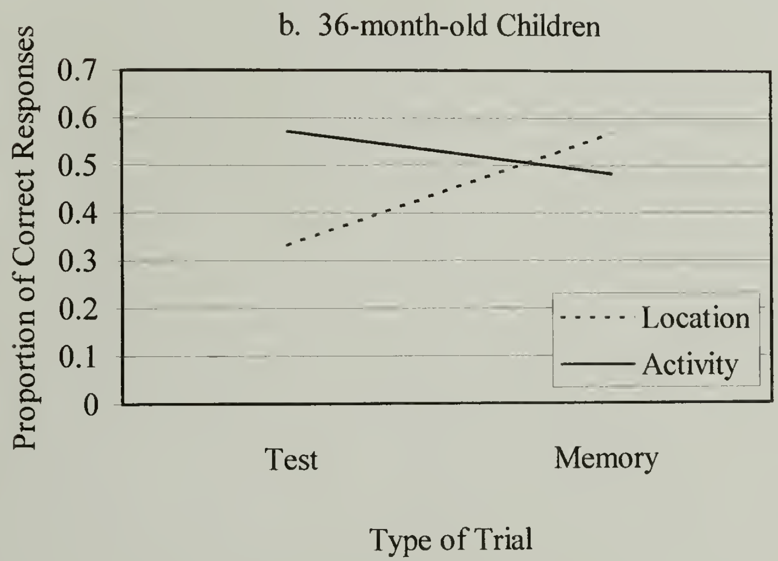


Figure 4. The Interaction of Sex and Condition on Tool Implementation

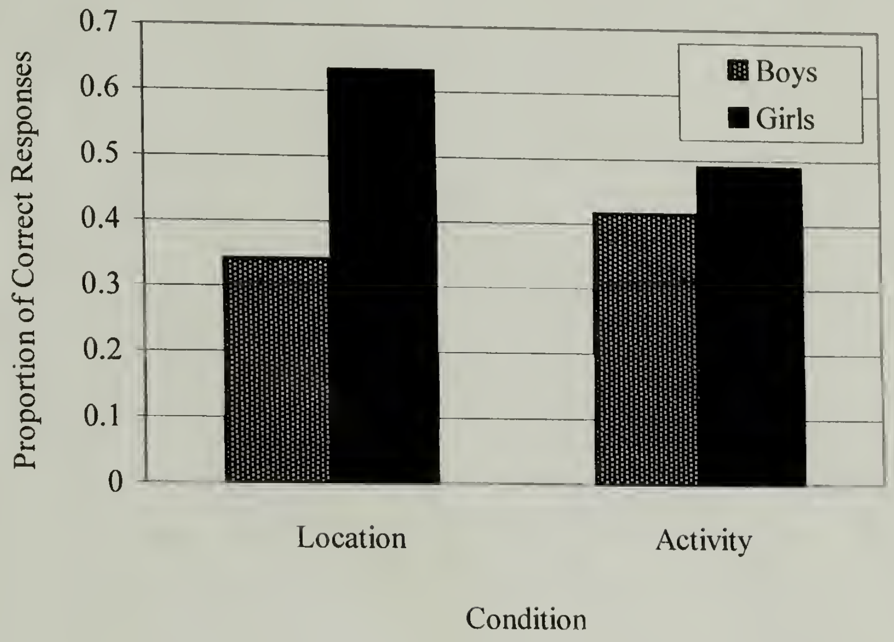


Figure 5. Tool Selection on Memory Trials Collapsing Across Age, Sex, and Condition

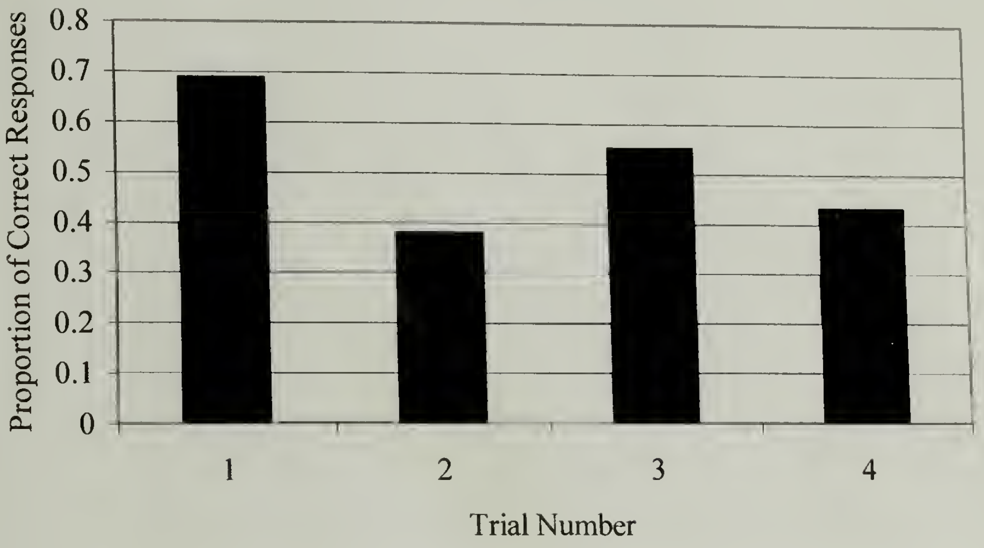
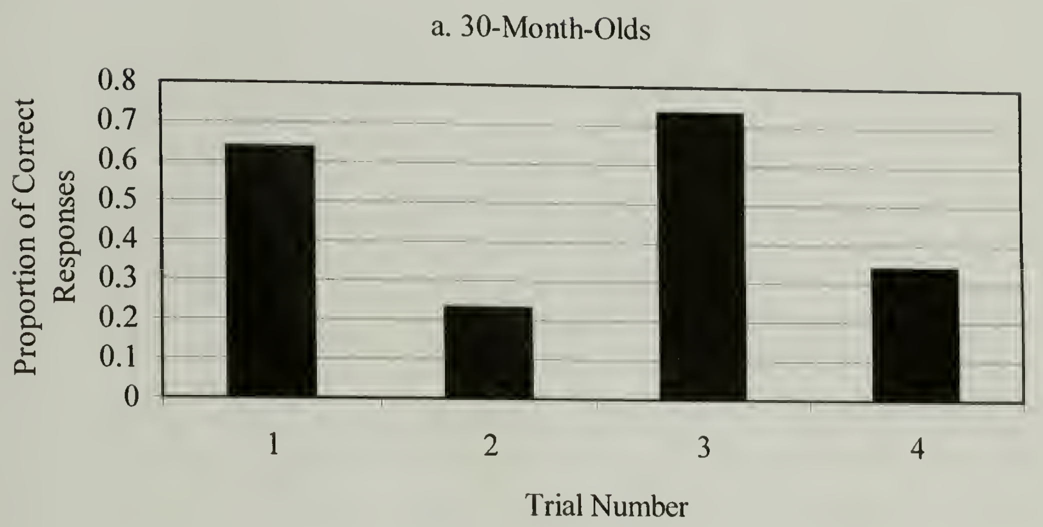
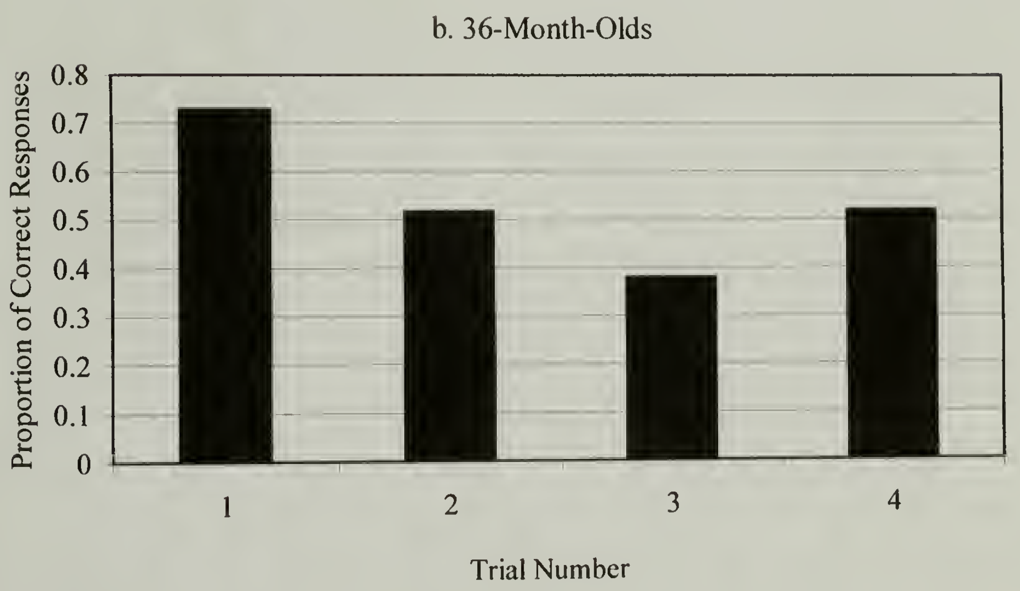


Figure 6. Children's Tool Selection on Memory Trials

Collapsing Across Sex and Condition





REFERENCES

Barnat, S., Klein, P., & Meltzoff, A. (1996). Deferred imitation across changes in context and object: Memory and generalization in 14-month-old infants. *Infant Behavior and Development, 19,* 241-251.

Barr, R., Dowden, A., & Hayne, H. (1996). Developmental changes in deferred imitation by 6- to 24-month-old infants. *Infant Behavior and Development, 19,* 159-170.

Bauer, P., & Hertsgaard, L. (1993). Increasing steps in recall of events: Factors facilitating immediate and long-term memory in 13.5- and 16.5-month-old children. *Child Development, 64,* 1204-1223.

Bauer, P., & Mandler, J. (1989). One thing follows another: Effects of temporal structure on 1- to 2-year-olds' recall of events. *Developmental Psychology, 25,* 197-206.

DeLoache, J. (1989a). Young children's understanding of the correspondence between a scale model and a larger space. *Cognitive Development, 4,* 121-139.

DeLoache, J. (1989b). The development of representation in young children. *Advances in Child Development and Behavior, 22,* 1-39.

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

DeLoache, J. (1995a). Early understanding and use of symbols: The model model. *Current Directions in Psychological Science, 4,* 109-113.

DeLoache, J. (1995b). Early symbol understanding and use. In D. Medin (Ed.), The Psychology of Learning and Motivation, 33, (pp. 65-114). New York: Academic Press.

DeLoache, J. (1999). Early symbolic representation. In I.E. Sigel et al (Eds.), Development of mental representation: Theories and applications (pp. 61-86). Mahwah, N.J: Erlbaum.

DeLoache, J. (1999, April). Inhibitory control and symbol use. In G.O. Deak (Chair), Flexibility and perseveration in early problem-solving. Symposium conducted at the meeting of the Society for Research in Child Development, Albequerque.

DeLoache, Kolstad, & Anderson (1991). Physical similarity and young children's understanding of scale models. *Child Development, 62,* 111-126.

DeLoache, J., & Marzolf, D. (1995). The use of dolls to interview young children: Issues of symbolic representation. *Journal of Experimental Child Psychology, 60,* 155-173.

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

Marzolf, D.P. (1994). Transfer in young children's understanding of spatial representations. *Child Development, 65,* 1-15.

Meltzoff, A. (1988). Infant imitation an memory: Nine-month-olds in immediate and deferred tests. *Child Development, 59,* 217-225.

Meltzoff, A. (1985). Immediate and deferred imitation in fourteen- and twenty-four-month-old infants. *Child Development, 56,* 62-72.

Schmitt, K. L. (1997). Two- to three-year-olds' understanding of the correspondence between television and reality. Unpublished doctoral dissertation, University of Massachusetts, Amherst.

O'Sullivan, L.P., Mitchell, L.L., & Daehler, M.W. (1999a, April). One Dual representation or two? Poster Session presented at the annual meeting of the Society for Research in Child Development, Albequreque.

O'Sullivan, L.P., Mitchell, L.L., & Daehler, M.W. (1999b, October). The role of perseverative errors in performance on scale model tasks. Poster session presented at the first meeting of the Cognitive Development Society, Chapel Hill.