

PARENT SCAFFOLDING DURING GUIDED PLAY AND CHILDREN'S SPATIAL ABILITY

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ABSTRACT

Parent scaffolding has been closely linked to children's learning. In the present study, we examined parents scaffolding behaviors during a dyadic spatial activity, and explored whether these behaviors related to child age and their spatial ability. Forty-five parents and their 4- and 5-year-old child ($M_{age} = 4.82y$, $SD = 0.42y$, $n = 25$ females) participated. Children's general and spatial vocabulary, as well as their mental rotation, and performance on two jigsaw puzzle tasks were assessed. Parent-child dyads then used a magnet board to create an elephant from a laminated card. Parent scaffolding, such as their use of gestures, labels and assistance with the activity, was coded. Parents tended to provide more scaffolding for younger children. Controlling for child age, parents provided more scaffolding for children who scored lower on the spatial and puzzle tasks. These results suggest that parents provided greater guidance to children with lower spatial ability.

BIOGRAPHICAL SKETCH

Jinghe Ji is currently perusing her master degree of Human Development at Cornell University. She received a Bachelor of Arts in Economics, a Bachelor of Arts in Psychology, and a minor in Mathematics from University of Colorado Denver. During her undergraduate years, she was granted with CLAS Academic Athlete Scholarship and ICB Merit Scholarship several times, and was on Deans list for several semesters. She is interested in cultural influence, parent scaffolding and children cognitive development.

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CHAPTER 1

INTRODUCTION

Preschoolers spend a great amount of time with their parents, as well as engaging in free, unstructured play. Although free play provides children the opportunity to learn through their own discoveries, another type of play, guided play, has been argued to hold greater educational value for children [6]. Guided play has been defined as falling between free, unstructured play on one end of the continuum and formal education on the other end of continuum [26]. Inspired by Vygotsky's zone of proximal development, guided play embodies a child-centered, adult-assisted activity with a focus on learning objectives [18]. Guided play has two key elements, child autonomy and adult guidance [27]. Children actively engage in the play and control their own learning process, while adults encourage children to explore and pursue their interests. Guided play requires equal participation from both children and adults and is dynamic, with adults adapting to the skill level and interest of the child [30]. It weaves together adult mentor-ship and child learning outcomes in the context of play. As such, guided play relies heavily on adult scaffolding of children's behaviors. To yield optimal learning, adults must provide the appropriate amounts and types of scaffolding. However, it is unclear which parent scaffolding behaviors are most effective in promoting children's cognitive skills. The goal of the present study was to examine the relation between parents' scaffolding and children's performance on spatial tasks to begin to identify those adult-guided behaviors that may promote the growth of children's spatial skills.

A number of studies have explored the effectiveness of guided play in promoting child learning. In Eason and Ramani [6]'s study, parents of four- and

five-year old children were found to engage in more math talk during guided play than unstructured, free play. Compared to formal learning, parents rated guided play as more enjoyable, and felt that it provided similar amounts of support for math learning as formal learning [6]. In another study, mothers instructed to use guided play provided more spatial language and spatial guidance than mothers who were asked to play with their children as they typically do. Children in the same study also produced more spatial language when engaged in guided play in comparison to when engaging in free play [2]. An advantage to guided play over unstructured free play was reported in a study of children's knowledge of geometric shapes. Fisher, Hirsh-Pasek, Newcombe, and Golinkoff [7] compared four- and five-year old children's ability to recognize geometric shapes under one of three learning conditions, guided play, free play, or didactic instruction. Children in the guided play group demonstrated a greater increase in their shape knowledge than children in the other learning conditions, and this advantage was maintained one week later. Together, these findings provide initial support for the value of guided play in promoting children's knowledge.

The research on guided play intersects with the rich literature on the effect of parent scaffolding on cognitive outcomes. Across many cognitive domains, parents' scaffolding has been shown to predict gain in children's cognitive abilities. A study of Hmong families in the United States showed that maternal scaffolding during problem-solving tasks before kindergarten predicted children's reasoning skills in kindergarten [21]. For children that were very low birth weight, maternal verbal scaffolding was positively related to children's verbal IQ [13]. In a longitudinal study, Hammond, Miller, Carpendale, Bibok, and Liebermann-Finestone [10] assessed children's executive function (EF) at age two, three, and

four. Parental scaffolding at age three predicted children's EF at age four [10]. Maternal scaffolding also been associated with children's academic competence. For example, maternal scaffolding at the beginning of fourth grade predicted both teachers' report and children's own reports of their academic competence at the end of the academic year [15].

Despite the many studies exploring the effect of parent scaffolding on cognitive outcomes, there are few studies that have examined how parent scaffolding, more broadly, and guided play, more specifically, may promote children's spatial ability. Spatial ability, the capacity to mentally manipulate and appreciate the spatial configuration of objects in the environment, is important for everyday functioning [23]. It also is a significant predictor of mathematical skills and is related to success in the the science, technology, engineering, and mathematics (STEM) fields [8]. Individual differences in infants' mental rotation performance predicts both their spatial and mathematical skills as preschoolers [11]. Similarly, preschoolers spatial skill at age three predicts their mathematics skills at age five, after controlling for vocabulary, executive function (EF), and earlier mathematical skills [25]. Spatial skills are amenable to training. A meta-analysis of 217 experimental studies indicated that even a small amount of spatial training results in enduring gains in spatial ability for both males and females as well as both children and adults [23]. These findings document how spatial skills can be improved and that bolstering spatial skills has the potential to yield positive academic outcomes, particularly in mathematical achievement. Preschool in particular has been argued to be an ideal developmental period for targeting and bolstering spatial skills [24]. However, not many preschools have a curriculum that focuses on promoting this cognitive ability. Incorporating spatial education into everyday life through guided play has been cited as

a more engaging pathway for ensuring a positive trajectory in the development of children's spatial ability in comparison to formal instruction and more likely to optimize children's spatial learning [24].

Guided play holds promise as an effective tool for promoting children's learning, but it is not clear if this pedagogical approach is perhaps better suited for children during a particular developmental period, or perhaps for those at a particular level of skill. Several studies suggest that the relationship between guided play and learning outcomes may not be straightforward but rather, may vary with a child's developmental skills. For example, Eason and Ramani [6] found that parents of five-years-old children adapted their guidance in a joint problem-solving task for children with low versus high executive function (EF). For low EF children, parent elaborate guidance, which was defined as statements and questions that fitted children's needs, was related to better performance on the problem-solving task. On the other hand, for children with high EF, their problem solving performance was unrelated to parents' guidance. This result suggests that children with less developed skills may benefit most from parent scaffolding. Thompson, Foster, and Kapinos [22] also found that parents tended to use less questioning for older children and children with higher language ability ($M_{age} = 4.43$, range = 3.18-6.86), suggesting that parent scaffolding is more frequent for children with less developed skills. Research on preschool children attention regulation also showed that for children with lower self-regulation and poorer attention, mothers tended to use more questions, in the form of hints and prompts, during a dyadic puzzle-matching play session [19]. As these studies show, during dyadic play, parents adapt their scaffolding behaviors in response to children's skills. This change in scaffolding is necessary to optimize children learning outcomes. Parents are familiar with their child's

skill level and are adept at tailoring their scaffolding to fit their child's cognitive needs. For this reason, as children's ability increases, parents may adjust their guidance style to match children's needs and may provide less scaffolding as child competence increases.

1.1 The Current Study

The present study builds on the previous research on guided play and parent scaffolding to examine the relation between children's spatial skill and their parent's scaffolding behavior during a dyadic play task. The task was spatial in nature. Parents and children were provided with a magnetic board with various geometric shapes that differed in size and color. The dyads were given a laminated card of an elephant made from a configuration of specific geometric shapes. Dyads were invited to use the magnetic shapes to create the elephant. This task was expected to be within the skill-level of most 4-year-old children, but sufficiently challenging as to provide opportunities to observe individual differences in child skill in creating the elephant. The task also provided opportunities for a parent to scaffold child's play as they created the elephant with the magnetic shapes. Children were also assessed on their spatial skill, by completing a measure of mental rotation, the Picture Rotation Task [17]. Both measures were designed to assess mental rotation in preschool-aged children. Children also completed a jigsaw puzzle and a jigsaw-puzzle task to document their skill in spatial play as well as explore the relation between their spatial skill and spatial play. To control for general cognitive ability, children's receptive language skills were assessed on the NIH Toolbox, Picture Vocabulary Test. The parent-child play activity with the magnet board was the last activity that children

completed and was always given after children's spatial and language skills had been assessed.

1.1.1 Adult Scaffolding: Gestures

There is a rich literature on the range of parent behaviors that are linked to cognitive growth. These behaviors range from parents' use of gestures, whether deictic or iconic, to the quantity and quality of language input. In particular, parents' gestures during dyadic play shape their child's learning outcomes. Rowe and Goldin-Meadow [20] found that parents' use of gestures was positively related to their child's use of gestures, and that children's gesture use at 14 months predicted their vocabulary size at 54 months. Other studies have reported similar associations between parents' use of gestures and children's spatial vocabulary. Cartmill, Pruden, Levine, Goldin-Meadow, and Center [3] followed 52 parent-child dyads longitudinally from the time that children were 14 months until they were 46 months of age. They examined parents use of two types of gestures, deictic gestures and iconic gestures. Deictic gestures are gestures that point to a person, object, or location, and which depend on context to convey meaning. On the other hand, iconic gestures represent an aspect of the meaning expressed verbally, as when parents traces a circle while saying "circle" [1]. Carmill and colleagues found that the amount of both gestures parent used along with spatial languages was positively related to the total number of different spatial words children used from 14 to 42 months [3]. Based on these results, in the present study, we focus on parents use of both deictic and iconic gestures to evaluate parents' scaffolding behaviors in guiding their children during the dyadic spatial-play activity with the magnet board.

1.1.2 Adult Scaffolding: Language

Engaging in conversation with parents has been shown to be critical to developing language skills and to be more important than simply hearing language [9]. Pruden, Levine, and Huttenlocher [16] researched on the relationship between parent spatial language input and children's spatial ability. This longitudinal research followed 52 parent-child dyads from child age 14 to 46 months, and found that the amount of spatial language children produced can be predicted by parents use of spatial language. Children spatial language usage was positively related to their performance on the Children's Mental Transformation Task [12], the Block Design sub-test of WPPSI-III, and a Spatial Analogies test. In addition to the use of spatial language, it is also important to consider how the spatial knowledge is delivered. Yu, Landrum, Bonawitz, and Shafto [29] compared the effectiveness of direct instruction and questioning as a teaching strategy. Preschoolers were randomly assigned to learn functions of a toy from a knowledgeable teachers direct instruction, a knowledgeable teachers pedagogical question, and a naive informants questioning. Results showed that although direct instruction can successfully transmit knowledge to children, it reduced children's exploration and learning. In contrast, pedagogical questioning effectively transmitted knowledge and also promoted exploration and further learning [29]. In addition to color and spatial words that were related to the magnet board task parent-child dyads played in present study, parents used a lot of metaphors to refer to each magnetic piece. Using metaphors instead of spatial word might reduce the amount of spatial words input, and therefore, might not be beneficial for children to develop spatial knowledge. In present study, parent use of pedagogical questions and their use of color words, shape words and metaphors were coded to evaluate their verbal scaffolding quality.

1.1.3 Adult Intrusive Behaviors

A central tenet of guided play is that the child is provided with autonomy during adult-child interactions [27]. If child autonomy is central to learning outcomes, then parents' who provide their children with less autonomy in a dyadic task would be expected to demonstrate less competence on spatial tasks. Examples of hindering children's autonomy would be parents who take over the dyadic spatial activity. Such parents fail to effectively engage their child and take ownership away from child, possibly removing opportunities for children to learn from the task. These "doing-for" parent behaviors are predicted to hinder children's learning and to be negatively related to children's performance on the spatial tasks. We also predicted a negative relationship between parents positive scaffolding and the intrusive parent behaviors. If parents are aware of the importance of guiding children, it is predicted that they will give children more opportunities to complete a task rather than interceding to complete the task for their child. Parents also may tend to engage in corrective behaviors. When children fail to perform as desired, parents may sometimes choose to physically interfere with children's play process. They may just adjust children's imperfect performance, or correct their mistakes without given children a chance to try and correct an error on their own. This kind of corrective behavior can potentially reduce children's autonomy during guided play, and therefore can be a kind of negative scaffolding. Therefore, in present study, parent doing-for and corrective behaviors were also included to evaluate the quality of parent scaffolding and in particular, to capture intrusive parent strategies when interacting with their child during the magnet task.

1.2 Research Questions

We hypothesized that parent scaffolding during guided play would be related to children's spatial ability. Although the literature suggests a positive role of parent scaffolding on children's learning, we remained agnostic as to whether the relationship between children's spatial skills and parent scaffolding would be positive or negative. One possibility is that parents who have high-quality scaffolding would have children with stronger spatial skills. However, an alternative possibility is that parents may provide more scaffolding for younger children, who may also have lower spatial scores. Thus, children with stronger spatial skills may be more adept at completing the dyadic spatial activity and might invite minimal scaffolding on the part of the parent.

We also considered the relation between intrusive parenting behaviors and children's performance on the spatial tasks. We expected that parents who engaged in more intrusive behaviors, such as completing parts of the elephant, would be related to lower child scores on the spatial tasks. On the other hand, parents tended to adjust their scaffolding strategy based on their children's ability. For children with lower spatial ability, parents tended to provide more scaffolding. As children's spatial skill get better, during spatial play, parent may provide less physical scaffolding, but give children the chance to complete spatial game solely. So, in present study, it was also possible to observe that parents who engaged in more positive scaffolding, had children with lower spatial ability. If children perform poorly on the spatial task, they might have trouble complete the magnet board task, and parents might interfere children's play process, and engage in more negative scaffolding, like doing-for and corrective behaviors. Since spatial ability is closely related to age, parental scaffolding also

can be related to age. Younger children tended to have lower spatial ability, therefore, probably would receive more scaffolding. However, as noted above, parents tend to adjust their scaffolding strategy based on children's ability. It is also possible that the amount of parental scaffolding strategy is negatively related to children's spatial ability, since parents will provide more help to children with lower spatial ability.

The present work was guided by the following research questions: What are the scaffolding behaviors parents use during dyadic spatial play? Do parents provide more scaffolding for younger than older children? Do parents provide more scaffolding with children who score lower on the spatial task? And which parent scaffolding behaviors are most closely related to children's spatial skill, even when controlling for child age?

CHAPTER 2

METHOD

2.1 Participants

Forty-five parents and their 4- and 5-year-old child from Ithaca area were recruited from a database of potential participants ($M_{age} = 4.82y$, $SD = 0.42y$), of which 25 children were females, 20 were males. Most parents ($n=36$) were college educated, and spoke English at home ($n=42$). Children were predominately non-Hispanic Caucasian. An additional ten parent-child dyads were excluded from the final sample: four dyads were missing the video of their play session, three children did not complete the magnet board activity with their parent, one participant was blocked from view by the parent, one dyad conversed in a foreign language unfamiliar to coders, and one participant received scaffolding from both parents (the mother and father).

2.2 Materials

General vocabulary The NIH Toolbox Cognition Batteries was used to assess children's general vocabulary. The task is a normed measure of children's receptive language skills. Children are guided through the task by a recorded voice that asked children to touch the image that is named. Children choose among four images and the task adapts in difficulty based on children's accuracy. The task takes about 3 minutes to complete.

Spatial vocabulary Children also were assessed on their expressive vocabu-



Figure 2.1: The picture shows sample items of the spatial vocabulary assessment, with expressive items on the left and receptive items on the right.

lary for geometric shapes, locations and directions. They were first presented with 15 geometric shapes (circle, rectangle, square, triangle, oval, diamond, star, heart, rhombus, trapezoid, pentagon, hexagon, octagon, moon, rhomboid), and nine spatial configurations of a toy bear and a red cup (in, under, on top of, in front of, behind, next to, middle/between, above, below). Children were asked to name the geometric shapes, or spatial relation of the bear. In order to assess children's receptive spatial vocabulary, children were asked to point out 21 locations, directions and geometric shapes that the research assistant named from an array of four response options (in, under, behind, below, left, far away, in the middle, right, upside-down, circle, square, triangle, diamond, rectangle, semi-circle, hexagon, pentagon, octagon, diagonal line, horizontal line, vertical line) [4] (see Figure 2.1). Children's responses were scored as either correct or incorrect for each word, and their final score ranged from 0 to 45 points.

The Picture Rotation Task The picture rotation task contained 12 items, and was used to assess children's ability to mentally rotate images [17] (see Figure 2.2). Children were presented with one target stimuli and three response options. Within the three response options, two were mirror images of the target, while the third one was identical to the target. The response options was rotated 45, 90, 135, or 180 clockwise or counterclockwise. Children were asked to



Figure 2.2: This is a sample item from the Picture Rotation Task, or the PRT.

choose the response option that was identical to the target. Children completed three practice items with feedback prior to the 12 test items. The test items were scored as either correct or incorrect. No feedback was given on the test items. Children's final score on this mental rotation task ranged from 0 to 12 points.

Complete the jigsaw puzzle Children were asked to complete a 24-piece jigsaw puzzle. With the exception of six target jigsaw pieces, the puzzle pieces were glued together. Two of the target pieces fit in the corner, two fit at the edge, and two pieces fit in the middle of the puzzle. Target pieces were given individually to children by a research assistant who asked children, "Where would you put this piece?" Children were then allowed to place the puzzle piece. After children placed a puzzle piece at a correct location, they would receive another puzzle piece. The time children used to complete the puzzle were coded in seconds.

Place-a-piece puzzle task The place-a-piece puzzle task was a structured task in which children viewed a single puzzle piece, rotated 90 degrees clockwise, placed under a 24-piece puzzle, in which three of puzzle's pieces were missing. The missing puzzle pieces were a corner piece, an edge piece and a piece in the middle of the puzzle. The puzzle and puzzle piece were glued to a sheet of paper and inserted in a clear sleeve so that children could not manipulate



Figure 2.3: Image of the magnetic board and elephant that parents and their child built during the dyadic activity.

the puzzle piece. In addition, the puzzle and puzzle piece were turned over so that only the brown cardboard backing of the puzzle was visible and children could not use color cues from the puzzle image to match the piece to its location in the puzzle. Children were asked to indicate where the puzzle piece would fit in the puzzle. The task was designed to assess children's ability to attend to the contours of the puzzle piece to identify its correct location in the puzzle. Children's point to the location of the piece was coded as correct or incorrect. Children completed 6 of these place-a-piece puzzle items, with each a different puzzle and a different piece. Children's score on this task ranged from 0 to 6 points.

Magnet Board and Geometric Shapes A magnet board game with 42 colorful wooden magnetic blocks and 50 full-color laminated puzzle cards was used. The laminated puzzle card with an elephant printed on it was used in the present study. The elephant was comprised of 16 distinct magnetic shapes that

when arranged, formed the elephant (see Figure 2.3). Among the magnetic shapes were arcs, rectangles, squares, semi-circles and a circle.

2.3 Procedure

Children were tested in a quiet room of a university research lab. Children were tested on the spatial task by a research assistant, then was asked to complete the jigsaw puzzle followed by place-the-piece puzzles task. As the final assessment, children complete the spatial vocabulary assessment and then the NIH Toolbox Picture Vocabulary Test. As the final activity, the parent and child were invited to create the elephant using the magnet board and magnetic geometric shapes. So that parents and children would feel comfortable, the research assistant left the room. The spatial, puzzle, and vocabulary measures as well as parent-child dyadic task were filmed using a Canon FS200 camera.

2.4 Coding Procedures

Children's performance on the spatial tasks and puzzle tasks were coded by research assistants. Parent and child speech during the magnet-board play interaction was transcribed using the Children Language Analysis program, CLAN [14]. This transcription program allows the transcriber to code utterances produced by the parent and child and to compute the number of tokens (total words) and types (number of unique words) produced by each speaker. The coding program Datavyu was used to code parents' behavior. Coding reliability was achieved by having 20 percent videos coded by two coders. Discrepancies

were discussed and high inter-rater reliability was reached ($r=.90$).

Parent pointing behavior The definitions of parent gestures were taken from Cartmill et al. [3]. In the present research, we refer to parents' deictic gestures as indicating (i.e., points) and their iconic gestures as outlining (e.g., tracing the shape of a magnet piece). Indicating gesture were used to direct child's attention to an object or location by pointing to that object or location. During dyadic play, parent might indicate a magnetic piece, the magnet board, or the laminated card of the elephant. In addition to indicating, parent might also direct child's attention to certain object or location and emphasize the spatial features of that entity by outlining the shape or tracing the outer edge of that object. Parents could outline the magnetic piece itself, the magnet board, or the laminated card of the elephant.

Parent corrective behavior and action All parent corrective behaviors and doing-for behaviors were also coded. During dyadic play, parents sometimes interfered with their child's actions in order to correct their child's mistakes or assist with the task. Parent corrective behaviors were divided into corrections and adjustments. Corrections were defined as those behaviors parents performed to physically correct their child's mistake. On the other hand, parent adjustments were those behaviors performed when children put the piece at a slightly tilted angle, or at a position which might affect the building process, but was not intended to correct an error. Parent doing-for behaviors were divided into locating, handing, or placing a magnetic piece. More specifically, locate was when parents pointed out the needed magnetic piece among the magnets. Handing was when parents found and handed the needed piece to their child. Placing was when parents found and placed the magnetic piece at the correct place for

their child, without giving their child the ownership of that piece.

Parent questions and their use of label Once parents' speech was transcribed using CLAN, the Datavyu coding program was used to categorize the type of questions parents asked of their child during the dyadic task with the magnet board. Pedagogical questions were defined as a question to which the parent knows the answer, but asks to encourage their child to learn. Information-seeking questions, on the other hand, are defined as questions to which the parent does not know the answer and is seeking the answers from the child. While, rhetorical questions are not intended to be answered verbally [28]. We also included command questions, although this kind of questions were grammatically interrogatives, they indirectly served as a command or instruction [5].

Parents' labels were also coded. In particular, their use of the word color, the word shape, all color words, all shape words, and metaphors in each utterance were coded. We defined metaphors as the kind of words parents used in place of the shape words to suggest a likeness or analogy between them (e.g., instead of name the semicircle, parent called it the head of the elephant; here, the word head was a metaphor).

CHAPTER 3
RESULTS

3.1 Child cognitive measures

Two participants' NIH vocabulary score were missing, so were omitted from this analysis, descriptive statistics for each child spatial and language measures are reported in Tables 3.1. As can be seen in Table 3.2, both child age corrected

Table 3.1: Descriptive Statistics: Children Cognitive measures

	Missing	Mean	Std. Deviation
NIH vocabulary (age corrected)	2	109.80	16.50
NIH vocabulary (percentile)	2	68.79	24.69
Spatial vocabulary	0	28.42	5.03
Picture Rotation task	0	6.33	3.10
Complete the puzzle	0	154.00	95.45
Place a piece	0	3.22	1.82

NIH vocabulary score and their NIH vocabulary percentile were significantly and positively correlated with their spatial vocabulary scores, even when controlling for child age in a partial correlation. However, children's general vocabulary, as assessed on the NIH Picture Vocabulary Task, was not related to any of the spatial measures or to either puzzle task.

In contrast, children's score on the spatial vocabulary measure was significantly and positively correlated with their performance on the mental rotation task, the Picture Rotation Task (PRT), even when controlling for child age. The

Table 3.2: Inner correlation (Children cognitive measures): the correlations among child age and their cognitive measures are listed in the top half of the table, the partial correlations, controlling for child age are listed below the diagonal. Statistically significant correlations are noted with an asterisk.

	Age	NIH(age-c)	NIH.per	spatial.vocab	PRT	Puzzle	Placepiece
Age	1	0.188	0.213	.510**	.357*	-.411**	0.144
NIH(age)		1	.937**	.454**	0.247	-0.217	0.247
NIH(per)		.934**	1	.536**	0.249	-0.217	0.273
spatial.vocab		.424**	.508**	1	.410**	-.324*	0.218
PRT		0.196	0.189	.320*	1	-.324*	.365*
Puzzle		-0.156	-0.145	-0.169	-0.170	1	-.413**
Placepiece		0.226	0.251	0.206	0.291	-.358*	1

PRT, complete the puzzle, and place-a-piece puzzle task were significantly correlated with each other in zero-order correlations. However, once controlling for child age, only the two puzzle tasks were significantly correlated with each other. In sum, children's general receptive language skills were unrelated to their spatial skills, although children's spatial vocabulary was related to their mental rotation skills. Children's mental rotation score on the PRT was not related to the puzzle tasks, once child age was controlled.

3.2 Parent use of scaffolding

On average, parents performed more indicating gestures than outlining gestures ($t(44)=7.81, p < .001$), as can be seen in Table 3.3. An analysis of variance (ANOVA) on the frequency of parents' indicating behaviors to the board vs. magnet pieces vs. laminated card yielded a significant effect of the referent of the parent pointing, $F(2,132)=35.71, p < .001$. Parents indicated with significantly greater frequency to the laminated card than either the board, $p < .001$, or magnetic pieces, $p < .001$.

Similarly, the frequency of parents' outlining differed significantly to the board, magnetic pieces and laminated card as indicated by an ANOVA with outlining referent as a within-subjects variable, $F(2,132)=26.07, p < .001$. As was the case with indicating, parents outlined significantly more often to the laminated card than the magnetic pieces, $p < .001$, or board, $p < .001$.

Most parental pointing behaviors were significantly and positively correlated with each other, with the exception of parent's outlining to the board (see Table 3.4).

Table 3.3: Descriptive Statistics: Parent Physical Scaffolding

			Mean	Std. Deviation
Parent pointing	indicating	board	3.60	4.11
	indicating	magnet	4.33	3.93
	indicating	picture	17.61	14.24
	indicating	total	25.54	20.62
	outlining	board	0.27	0.65
	outlining	magnet	0.56	0.97
	outlining	picture	3.28	3.60
	outlining	total	4.10	4.44
	pointing	total	29.64	23.47
Parent correction		adjustment	5.51	4.79
		correction	2.99	3.61
		correction.total	8.50	7.27
Parent doing-for		hand	1.97	3.97
		locate	1.29	2.06
		place	1.93	3.91
		action.total	5.19	5.61

Total indicating (i.e., the sum of indicating to the board, magnets and picture) and total outlining (i.e., the sum of outlining to the board, magnets, and picture) were positively correlated with each other. That is, parents who tended to use the deictic gestures of indicating also tended to use the iconic gestures of outlining. This correlation remained significant even after controlling for children's age.

Parents used more adjustments than corrections during parent-child dyadic

Table 3.4: Inner correlation (Parent pointing behavior): Ind and out stand for indicating and outlining. B, m, p stand for magnet board, magnetic pieces, and the laminate picture. P.total is the composite score of all parent pointing behaviors.

Age	ind.b	ind.m	ind.p	ind.total	out.b	out.m	out.p	out.total	p.total
1	-.330*	-0.230	-.403**	-.388**	-0.181	-.297*	-0.277	-.316*	-.401**
ind.b	1	.725**	.701**	.822**	0.111	.380*	.431**	.448**	.807**
ind.m	.707**	1	.756**	.857**	0.222	.542**	.356*	.439**	.836**
ind.p	.658**	.745**	1	.974**	0.143	.492**	.563**	.585**	.967**
ind.total	.797**	.856**	.970**	1	0.163	.518**	.543**	.577**	.988**
out.b	0.055	0.188	0.078	0.103	1	.450**	.443**	.603**	0.258
out.m	.312*	.510**	.425**	.458**	.422**	1	.396**	.604**	.570**
out.p	.374*	.313*	.514**	.492**	.416**	.342*	1	.962**	.659**
out.total	.384*	.397**	.527**	.520**	.585**	.563**	.959**	1	.696**
p.total	.780**	.835**	.961**	.986**	0.205	.515**	.623**	.656**	1

Table 3.5: Inner correlation (Parent corrective behavior): corr.total refers to total parent corrective behavior

	Age	adjustment	correction	corr.total
Age	1	-.486**	-.417**	-.528**
adjustment		1	.483**	.900**
correction			1	.816**
corr.total				1

Table 3.6: Inner correlation (Parent doing-for behavior)

	Age	hand	locate	place	action.total
Age	1	0.033	-0.220	-0.166	-0.152
hand		1	-0.090	0.094	.728**
locate			1	0.029	.319*
place				1	.646**
action.total					1

play ($t(44)=3.85, p < .001$). Parent corrections and adjustments were positively correlated with each other, with or without controlling for children's age (see Table 3.5). In addition, parents' frequency of adjustments and corrections increased as child age decreased. With respect to the doing-for behaviors of handing, locating, and placing magnet pieces, parents did not perform many of these behaviors in general. An ANOVA failed to yield a significant effect of doing-for behaviors, $F(2,132)=.65, p = .52$. Nor were the doing-for behaviors of handing, locating and placing magnetic pieces significantly correlated with each other. Those parents who handed children pieces were not likely to also locate and place pieces. However, as can be seen in Table 3.6, there were few of these behaviors and the null effects related to these behaviors could arise because of

their low frequencies.

We explored parents' use of questions. There was a significant difference in the frequency in the types of questions parents used during dyadic play, as indicated by a one-way ANOVA, $F(3,176)=19.05$, $p < .001$ (see Table 3.7). Parents used significantly more pedagogical questions, in comparison to com-

Table 3.7: Descriptive Statistics: Parent Verbal Scaffolding

		Mean	Std. Deviation
Parent question	command	6.11	6.02
	information-seeking	8.58	6.96
	pedagogical	16.76	11.69
	rhetorical	5.82	5.05
	question total	37.27	21.66
	other utterance	60.42	28.61
Parent use of color	color	2.36	3.45
	specific color	13.02	11.08
	color.total	15.38	12.42
Parent use of shape	shape	2.43	3.08
	specific shape	7.13	7.43
	shape total	9.57	8.90
Parent use of metaphor	metaphor	13.81	10.21

mand, information-seeking, and rhetorical questions, all $p < .001$. Nonetheless, parents' use of pedagogical questions was positively correlated with their use of command, information-seeking, rhetorical questions as well as other utterances and total questions (see Table 3.8). We also examined the proportion of each type of parent questions from all questions. Parents' proportion of pedagogical

Table 3.8: Inner correlation (Parent question)

	Age	command	info-seeking	pedagogical	rhetorical	other	questiontotal
Age	1	-.367*	-0.224	-0.285	-.414**	-.364*	-.424**
command		1	0.161	.326*	.353*	.574**	.588**
info-seeking			1	.398**	.471**	0.219	.691**
pedagogical				1	.368*	.652**	.844**
rhetorical					1	.331*	.682**
other						1	.659**
questiontotal							1

Table 3.9: Inner correlation (The proportion of each type of parent questions from all question)

	Age	c.portion	i.portion	p.portion	r.portion
Age	1	-0.159	0.076	0.134	-0.107
c.portion		1	-0.272	-.306*	-0.026
i.portion			1	-.367*	0.039
p.portion				1	-0.282
r.portion					1

Table 3.10: Inner correlation (Parent use of label)

	Age	color.total	shape.total	metaphor	label.total
Age	1	-0.291	-.358*	-.551**	-.453**
color.total		1	.810**	.561**	.923**
shape.total			1	.521**	.884**
metaphor				1	.795**
label.total					1

questions was significantly and negatively correlated with their proportion of command and information-seeking questions. That is, parents' who used more pedagogical questions, considered to reflect high-quality scaffolding, were less likely to use commands or information seeking questions (see Table 3.9).

We also compared the frequency of parents' use of the different labels of geometric shapes, color, and metaphor in a one-way ANOVA. The analysis yielded a significant effect of label, $F(2,132)=3.61, p < .05$. Parents used significantly fewer shape words than color words ($t(44)=-5.29, p < .001$). Parents' use of color words, shape words, and metaphors were significantly and positively cor-

related with each other, even after controlling for child age (see Table 3.10).

3.3 Relation between parent scaffolding and children's age

As can be seen in Table 3.11, children's age was negatively correlated with the frequency of parents' pointing behavior, corrective behaviors, as well as use of labels and metaphors. Parents' doing-for behaviors, their use of pedagogical questions, and the proportion of pedagogical questions were not correlated with children's age.

After controlling for children's age, total pointing was positively correlated to total corrective behavior, parent use of pedagogical questions, and total labels. Parent use of labels was also positively correlated to total corrective behavior and pedagogical questions. Thus, a number of parents' scaffolding behaviors were correlated with each other.

3.4 Relation between parent scaffolding and children's cognitive measures

Examining the zero-order correlations, parents' indicating behaviors were negatively correlated with children's spatial vocabulary, their mental rotation on the PRT, and the place-a-piece puzzle task, but positively correlated with the time it took children to complete the puzzle (see Table 3.12). However, parents' total outlining behaviors were only significantly correlated with spatial vocabulary and the PRT mental rotation score. Parent total pointing behaviors were

Table 3.11: Inner correlation (Parent scaffolding): this table shows the inner correlation between parent total pointing behaviors (p.total), total corrective behaviors (c.total), total doing-for-behaviors (a.total/action.total), parent used of pedagogical questions, the proportion of pedagogical questions from all questions, and parent use of all labels.

	Age	p.total	c.total	a.total	pedagogy	p.portion	metaphor	label.total
Age	1	-.401**	-.528**	-0.152	-0.285	0.134	-.551**	-.453**
p.total		1	.491**	-0.051	.737**	0.257	.422**	.575**
c.total		.359*	1	0.248	.323*	0.006	.457**	.557**
a.total		-0.124	0.200	1	0.034	0.168	-0.042	0.053
pedagogy		.709**	0.212	-0.009	1	.526**	.373*	.517**
p.portion		.342*	0.091	0.192	.594**	1	-0.144	0.031
metaphor		0.263	0.235	-0.152	0.269	-0.085	1	.795**
label.total		.482**	.420**	-0.018	.454**	0.103	.733**	1

Table 3.12: Correlations between parent pointing and children cognitive measures

Control age	ind.total	ind.total	out.total	out.total	point.total	point.total
	raw	partial	raw	partial	raw	partial
NIH(age)	-0.202	-0.142	-0.122	-0.067	-0.201	-0.139
NIH(per)	-0.268	-0.205	-0.231	-0.177	-0.279	-0.216
spatial.vocab	-.397**	-0.262	-.348*	-0.252	-.415**	-0.281
PRT	-.369*	-0.252	-.313*	-0.191	-.384**	-0.260
Puzzle	.519**	.426**	0.278	0.141	.509**	.404**
Placepiece	-.353*	-.318*	-0.096	-0.005	-.328*	-0.283

negatively correlated with children’s spatial vocabulary, PRT, and place-a-piece score, and positively correlated with complete the puzzle, just like indicating behaviors. However, once child age was controlled, parent’s indicating behaviors were only correlated with children’s performance on the two puzzle tasks. That is, parent’s indicating did not relate to children’s spatial skills.

Parental corrective behaviors were negatively correlated with children’s PRT and place-a-piece puzzle score in zero-order correlations. Controlling for child age, parents’ correcting behaviors were correlated with the two puzzle behaviors. Specifically, parents’ corrective behaviors were positively correlated with the time it took children to complete the puzzle and negatively correlated with their place-a-piece puzzle score. In contrast, parents’ total doing-for behaviors were not significantly correlated with any children’s cognitive measures. These results are reported in Table 3.13.

In Table 3.14 are the correlations among parents’ questions and children’s performance on the measures. Parents’ use of pedagogical questions was neg-

Table 3.13: Correlations between parent corrective and doing-for behavior and children cognitive measures

Control age	corr.total		action.total	
	raw	partical	raw	partical
NIH(age)	-0.101	-0.001	-0.224	-0.202
NIH(per)	-0.170	-0.068	-0.269	-0.246
spatial.vocab	-0.294	-0.041	-0.270	-0.236
PRT	-.306*	-0.127	-0.088	-0.023
Puzzle	.479**	.338*	0.016	-0.068
Placepiece	-.537**	-.557**	-0.222	-0.194

atively correlated with children’s spatial vocabulary, PRT, and place-a-piece score, and positively correlated with complete the puzzle. Parents’ use of total questions also negatively correlated with spatial vocabulary and PRT score, but positively correlated with complete the puzzle.

However, the proportion of pedagogical questions and the proportion of all questions were not significantly correlated with any cognitive measures (see Table 3.15). Parents’ use of color words and metaphors was only significantly correlated with PRT score, while parents’ use of shape words was significantly correlated with spatial vocabulary, complete the puzzle, and place-a-piece score. Parents’ use of total labels was significantly correlated with PRT and complete the puzzle score (see Table 3.16).

Since parent pointing, corrective behavior, use of pedagogical questions, and use of labels showed similar relationship with children cognitive measures, they were combined to create a composite score of all scaffolding behaviors. Total scaffolding was significantly correlated with spatial vocabulary, PRT, complete

Table 3.14: Correlation between parent questions and children's cognitive measures

Control	age	pedagogical		pedagogical		command		command		QuestionTotal		QuestionTotal	
		raw	partical	raw	partical	raw	partical	raw	partical	raw	partical	raw	partical
NIH(age)		-0.026	0.029	-0.077	-0.009	-0.016	0.071						
NIH(per)		-0.034	0.028	-0.128	-0.055	-0.007	0.094						
spatial.vocab		-.380*	-.317*	-.362*	-0.229	-.383**	-0.230						
PRT		-.442**	-.346*	-.406**	-.314*	-.554**	-.465**						
Puzzle		.543**	.464**	0.286	0.146	.440**	0.303						
Placepiece		-.348*	-0.278	-0.278	-0.234	-0.285	-0.223						

Table 3.15: Correlation between parent questions and children's cognitive measures

Control age	p.portion		c.portion		question.portion	
	raw	partial	raw	partial	raw	partial
NIH(age)	0.049	0.021	-0.066	-0.038	0.074	0.101
NIH(per)	-0.018	-0.052	-0.100	-0.069	0.159	0.193
spatial.vocab	-0.010	-0.130	-.305*	-0.265	-0.069	0.014
PRT	-0.058	-0.042	-0.247	-0.225	-0.261	-0.302
Puzzle	0.140	0.164	0.035	-0.033	0.021	-0.016
Placepiece	-0.231	-0.183	-0.099	-0.086	-0.050	-0.076

Table 3.16: Correlation between parent use of label and children’s cognitive measures

Control age	color.t		shape.t		metaphor		label.t	
	raw	partical	raw	partical	raw	partial	raw	partical
NIH(age)	0.082	0.145	0.029	0.107	0.063	0.204	0.070	0.178
NIH(per)	-0.007	0.059	-0.053	0.027	0.055	0.212	0.000	0.112
spatial.vocab	-0.275	-0.176	-.297*	-0.158	-0.141	0.192	-0.273	-0.071
PRT	-.375*	-0.270	-0.280	-0.141	-.450**	-.318*	-.428**	-0.290
Puzzle	0.259	0.127	.404**	0.287	0.288	0.071	.355*	0.184
Placepiece	-0.194	-0.113	-.364*	-.319*	-0.189	-0.122	-0.276	-0.206

Table 3.17: Composite score of all scaffolding

Control age	scaffolding	
	raw	partical
NIH(age)	-0.066	0.033
NIH(per)	-0.141	-0.040
spatial.vocab	-.407**	-0.229
PRT	-.481**	-.344*
Puzzle	.540**	.405**
Placepiece	-.398**	-.350*

the puzzle, and place-a-piece score in zero-order correlations (see Table 3.17).

Except for parent doing-for behaviors, other parent physical scaffolding behaviors were all significantly correlated with children's age. Partial correlations that controlled for age between total parent pointing behavior and children cognitive measures revealed that indicating was negatively correlated with place-a-piece score, but was positively correlated with complete the puzzle. However, parent outlining behaviors were not correlated to any children cognitive measures. Parent total pointing behavior was only positively related to children complete the puzzle task result. Parent corrective behaviors were positively related to complete the puzzle and negatively related to the place-a-piece puzzle task. While, parent doing-for behaviors were not significantly correlated to any cognitive measures. Parents' use of pedagogical questions was negatively related to children's performance on spatial vocabulary and PRT, but positively related to complete the puzzle results. However, the proportion of pedagogical questions was not significantly correlated to any cognitive measures. Parents' use of shape words was negatively correlated with place-a-piece score. Use of

metaphors was negatively related to PRT scores. After control for age, parents' total scaffolding was negatively correlated to children's PRT and place-a-piece score, and positively correlated to complete puzzle result.

CHAPTER 4

DISCUSSION

In present study, parents natural interactions during a parent-child dyadic play activity were observed. During the magnetic board game, parents used gestures to guide their children in creating the elephant and did so with much higher frequencies than the corrective and doing-for behaviors. They tended to use more indicating or deictic gestures, in comparison to outlining or iconic gestures. Most questions that parents asked were pedagogical. They used more color words than shape words, and used metaphors. This probably could be explained by the nature of magnet board activity. Some magnetic pieces could be hard to describe using common labels for geometric shapes. However, the color of the magnetic pieces was more salient and easier to use than the shapes of the pieces. Since the target shape on puzzle card was an elephant, parents tended to use metaphors instead of actual shapes during the activity.

Children cognitive task performance was related to their age. Older children performed better on the spatial vocabulary, mental rotation PRT, and complete puzzle tasks. Three spatial tasks, PRT, complete the puzzle, and place-a-piece were significantly correlated with each other. If children performed well on one task, they performed well on the other two tasks too. Most parent scaffolding behaviors were also correlated with children's age. Parents engaged in more pointing, more corrective behaviors, asked more questions, and used more labels when interacting with younger children. That is, parents in general provided more help to younger children.

There was no relation between children's general vocabulary and any parental scaffolding behaviors during the spatial dyadic play. However, most

spatial cognitive measures were correlated with parents' scaffolding behaviors. While participate in a spatial task, children's spatial skills were more closely related to parents' guidance. Parents engaged in more pointing behaviors, asked more pedagogical questions, asked more questions, and used more shape words with children who performed poorly on spatial vocabulary task. Parents also performed more pointing, corrective behaviors, and asked more pedagogical questions when played with children who scored lower on PRT, complete the puzzle, and place-a-piece tasks. They asked more questions and used more labels when children scored lower on PRT and complete the puzzle tasks. These results matched previous studies that parents actively adjust their guidance style in response to children's needs [6, 22, 19]. However, since age was related to children's cognitive measures and parental scaffolding strategies, age might affect the relationship between parental guidance and children cognitive skills. Therefore, partial correlations with children's age controlled were performed. After controlling for age, parents still engaged in more pointing behaviors, corrective behaviors, and asked more questions with children who scored lower on complete the puzzle task. Parents performed more corrective behaviors when children scored lower on place-a-piece task, and they asked more questions with children who scored lower on PRT. So, even after controlling for age, parents still provided more scaffolding to children with lower spatial skills. It was interesting that although parents used more pedagogical questions with children who scored lower on spatial cognitive measures, the proportion of pedagogical question parents asked was not significantly correlated with any measures. Unlike what we expected, parents' intrusive behaviors, like corrective and doing-for behaviors, did not negatively correlated with other positive scaffolding behaviors. Parents' doing-for behaviors were not significantly corre-

lated with any children's cognitive measures at all. This was probably because parents did not engage in many doing-for behaviors during dyadic play.

All different parent scaffolding behaviors shared similar relationship with children's spatial ability measures, except for parent doing-for behavior. Therefore, parents' pointing behavior, corrective behavior, use of pedagogical questions, and use of labels were added up to create a composite score of total parent scaffolding. Correlation test between total scaffolding and cognitive measures showed that for children with lower spatial ability, parents engaged in more scaffolding during parent-child dyad spatial play, with or without controlling for children's age. Parents actively adjust their scaffolding strategy based on children's ability. They are sensitive to children's needs, even without interventions, and create a dynamic guided play. For children who performed poorly on spatial cognitive measures, parents provided help, fulfill children's needs, encourage them to explore, and extend their interest, but for children with high spatial ability, parents tended to sit back and give children the amount of autonomy they need.

Our results showed that even without instruction, parents actively engage in high quality scaffolding and adjust their scaffolding style based on children's spatial ability. Parents provided more scaffolding for younger children and for children who scored lower on spatial cognitive measures. However, there are some limitations. Our study was an observational research, therefore, we could not draw causal conclusions from the results. In future, a longitudinal study can be performed to investigate how parent change their scaffolding strategy as children's spatial ability increase.

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