MIND, BRAIN, AND EDUCATION

Block Talk: Spatial Language During Block Play

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ABSTRACT—Spatial skills are a central component of intellect and show marked individual differences. There is evidence that variations in the spatial language young children hear, which directs their attention to important aspects of the spatial environment, may be one of the mechanisms that contributes to these differences. To investigate how play affects variations in language, parents and children were assigned to 1 of 3 conditions: free play with blocks, guided play, or play with preassembled structures (Study 1). Parents in the guided play condition produced significantly higher proportions of spatial talk than parents in the other two conditions, and children in the guided play condition produced significantly more spatial talk than those in the free play condition. Study 2 established baselines of spatial language during activities not involving spatial materials. Proportions of spatial words were lower than those in any of the conditions of Experiment 1. In sum, interaction with blocks naturally elicits elevated levels of spatial language, especially in the context of guided play, suggesting simple-to-execute educational interventions.

Spatial skills are a crucial component of human intellect. They allow us to encode information about small and large-scale objects—such as the location of our watch under a book, or which way to turn to reach a destination. They also allow us to mentally transform this information, such as imagining what we might see if approaching an intersection from an alternative direction. Spatial skills provide a foundation for learning in the disciplines of science, technology, engineering, and mathematics (STEM) (Burnett, Lane, & Dratt, 1979; Casey, Nuttall, & Pezaris, 1997; Casey, Nuttall, Pezaris, & Benbow, 1995; Tracy, 1987). For example, mental rotation and spatial visualization are related to geometric problem solving in high school (Battista, 1990; Delgado & Prieto, 2004; Kersh, Casey, & Mercer Young, 2008), to mathematics achievement (Fennema & Tarte, 1985; Guay & McDaniel, 1977; Hegarty & Kozhenikov, 1999), and to success in chemistry (Stieff, 2007; Wu & Sha, 2004).

How do spatial skills develop? One important answer may lie in the relationship between human spatial cognition and the symbol systems we use to describe spatial concepts. In particular, the representational system afforded by spatial language may provide an accessible introduction to spatial concepts, such as the relationship between objects, as illustrated by words like *under* and *next to*. By directing children's attention to spatially relevant aspects of their environment, language highlights patterns that might otherwise go unnoticed, for example, how one block is situated *under* another is a tower. This spatial language offers a categorical label that emphasizes qualitative divisions in what is otherwise continuous space. As such, spatial language might support spatial reasoning ability. The role of vocabulary as a guide for future behavior and learning has already been demonstrated in the area of literacy (Christie & Enz, 1992; Christie & Roskos, 2006). With regard to early spatial development, Casasola (2008) suggests that, as infants acquire spatial terms, they form more perceptually diverse spatial categories. In addition, individual differences in children's spatial language production predicts performance on a variety of spatial skills assessments (Pruden, Levine, & Huttenlocher, 2010). Gentner and colleagues (Gentner, 2003; Gentner & Loewenstein, 2002) suggest that spatial vocabulary may prove central for developing spatial-relational understanding; "...relational language fosters the development of representational structures that facilitate mental processing—that is, that relational language provides tools for thought (p. 316)."

Despite its relevance to the development of spatial skills, little is known about the contexts in which children may be exposed to rich spatial language, or the settings in which they are prone to use spatial language on their own. Research suggests that the amount of exposure to different words

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predicts vocabulary development (Hart & Risley, 1995; Hoff, 2006; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991), especially when the words are used in a way that helps the child understand their meaning (Weizman & Snow, 2001). But when are spatial words used, and in what contexts? Block play is one common spatial activity in which spatial language might naturally occur. Blocks have been frequently mentioned as contributing to the development of spatial skills (Brosnan, 1998; Caldera et al., 1999; Ginsburg, 2007; Ness & Farenga, 2007). During the second and third years of life, children pile blocks on top of one another (Shutts, Ornkloo, von Hofsten, Keen, & Spelke, 2009). As their play becomes more sophisticated, children pay special attention to the colors, shapes, and sizes of blocks. They may also compare the relative sizes of the towers they create (Leeb-Lundberg, 1996). Reifel (1984) suggests that blocks allow children to play directly with spatial concepts, which in turn could assist their developing representations of spatial relationships between objects in the physical world (e.g., into, out, together, on top, beside, etc.). In an analyses of open-ended forms of block play, researchers concluded that the inherent geometric properties of blocks encourage logico-mathematical thinking in young children (Kamii, Miyakawa, & Kato, 2004). A relationship has also been found between 3- and 5- year-olds' block building skill and their spatial visualization abilities (Caldera et al., 1999). Furthermore, Wolfgang, Stannard, and Jones (2003) identified a significant relationship between complex LEGO building during preschool years and later achievement in middle and high school mathematics. Most recently, in an experimental study that incorporated a story-telling context, Casey et al. (2008) concluded that block building interventions have an impact on spatial visualization and block building skills.

Review of the current literature highlights the point that there are several kinds of block play. Children sometimes engage in free play with blocks, but they may also strive to copy a structure depicted on a box or follow step-by-step instructions. Does the context of block play significantly impact the amount of spatial language that children and parents are apt to use in joint play sessions? It seems likely that block play will encourage the use of more spatial language than simple free play, but free play with blocks may still elicit more spatial language than playing with materials that do not involve construction of any kind. To investigate this question, in Experiment 1, we focused on three common contexts of play. In the *free play* condition, parents and children played with blocks without any form of guidance. In the *guided play* condition, the parent and child were given five numbered photographs that pictorially depicted the steps to build a particular final structure. In the *preassembled play* condition, a glued-together model was given to the pair, and the prefabricated structure served as a prop for play.

STUDY 1

Method

Participants

Thirty-six, 3- to 4.5-year-old children (18 females, mean age 46 months, range 36.5–69 months) and 36, 4.5- to 5-year-old children (18 females, mean age 63, range 54–71 months) participated, with either a parent or a guardian. Two of the parents who participated in the study were fathers and 74 were mothers. Data from 10 additional children had to be discarded due to failure to complete the task (8) or experimental error (2). Potential participants were identified through a direct marketing list and were contacted by an introductory letter, followed by a phone call. Additional participants responded to advertisements or heard about the study through word of mouth. As the area in which recruitment was targeted is predominantly middle to upper-middle class Caucasian, the majority of children who participated came from families belonging to this demographic group.

Materials

A set of MegaBloks containing various sized blocks, as well as vehicles and figures, was used. From these blocks, two critical structures could be created (a garage or a helipad). A full set contained 114 building blocks, 8 flat block panels that could create ground surfaces, 2 window-shaped blocks, a lamp-shaped block, a ladder-shaped block, 4 figures depicting different occupations (a firefighter, a pilot, and 2 civilians), and 2 vehicles (a fire truck and a helicopter). A video camera set unobtrusively in the corner of the room, approximately 5 ft from where parent and child were seated, was used to record the session and to later transcribe the footage.

Procedure

The study contained two 10-min phases. Participants were randomly assigned to one of three conditions in Phase 1. In the *free play* condition, parents and children were told to play with the set of blocks as they would at home. In the *guided play* condition, the parent and child were given five numbered photographs depicting the steps to build either the garage or the helipad (much like the instructions one receives for IKEA furniture assembly). In Step 1, the picture illustrated the placement of the board upon which to build. Step 2 portrayed the first ground layer of blocks, and so forth, up to Step 5 which showed the finished structure, complete with placement of the figures around or in the building. Parents and children were encouraged to build the structure using the pictures for guidance. In the *preassembled play* condition, a glued-together model of the garage or the helipad was given to the dyad, as well as the vehicles and figures. No extra blocks were provided for building. The dyad was instructed to play as they naturally would. Thus, all three play conditions in

Phase 1 offered parents and children an opportunity to play with blocks. However, each differed in terms of the structure of the play situation. Children in each of the conditions had access to the same number of blocks, figures, and vehicles. The experimenter left the room during building times.

After 10 min of play, Phase 2 began. In this phase, all dyads were assigned to the guided play condition. The purpose of this manipulation was to assess whether spatial language is affected positively or negatively by prior styles of interaction with block materials. Participants were given a picture of the structure that they had not played with or attempted to build during Phase 1 (e.g., those who had built the heliport were now asked to build a garage). The order of which structure the groups built and played with first was counterbalanced. Parents were told that they could help, but that the goal was for the child to build. After 10 min, the experimenter returned and told the children that they could keep playing or stop.

Coding

All videotaped interactions were transcribed for Phases 1 and 2. The transcripts were analyzed for child and parental spatial language using the spatial categories of the University of Chicago spatial language coding system (Cannon, Levine, & Huttenlocher, 2007). Specifically, coders identified terms and phrases that described the following spatial categories: (1) spatial locations (up, down), (2) deictic terms (here, there), (3) dimension (long, tall), (4) spatial features or properties (curvy, straight), (5) shapes (rectangle, square), and (6) spatial orientations or transformations (“turn it around,” “the man is facing the block”). Coders only identified words that were spatial in context and avoided idioms and/or spatial terms that were used in a metaphorical way (e.g., “that building is *on* fire,” “the doctor performs surgery *on* the patient”). Repetitive statements were only considered once, such that if the parent of child repeated the same exact statement twice in a row, only the first would be included in the analysis.

For each building phase, the total number of individual spatial words (e.g., *down*) and phrases (a collection of words that describe a single spatial meaning, e.g., *in the middle*, *on each side*) were tallied. A ratio of spatial terminology to non-spatial talk was calculated for each parent–child dyad. The ratio is represented as:

$$\frac{\text{Spatial words} + \text{Spatial phrases}}{\text{Spatial words} + \text{Spatial phrases} + \text{Nonspatial ndividual words}}$$

To take into account the variation in verbosity across different pairs, this ratio captures the proportion of total utterances in each phase that were spatial in nature. Spatial words and spatial phrases were independent of one another—no spatial content was counted more than once. Proportions of child and parental spatial language were calculated and averaged separately for Phase 1 and Phase 2.

Reliability

Three independent coders followed the criteria of the coding system and coded transcripts from identical participants (7% of the total transcripts included in the dataset) and were in high agreement ($r = .89$) concerning the proportion of spatial language present in both phases. A third coder second-coded 17% of the 72 transcripts and was in high agreement with both primary coders ($r = .87$ and $r = .95$).

Results and Discussion

As is shown in Table 1, individuals varied a great deal in both verbosity and use of spatial language. To elucidate the degree to which block play in the three play contexts elicited spatial language from parents, a repeated measures ANOVA was performed. Spatial language in both phases (2) was the within-subject variable, and condition (3), sex (2), and age (2) were the between-subjects variables. The dependent variable was the proportion of parent spatial language in Phases 1 and 2. A significant effect was found for condition, $F(2, 60) = 10.62$, $p < .05$, $\eta^2 = .26$, as well as a significant phase by condition interaction $F(2, 60) = 13.99$, $p < .05$, $\eta^2 = .32$. Post hoc comparisons (Tukey HSD) indicated that parents in the guided play condition demonstrated significantly higher proportions of spatial talk than those in the free play (mean difference = .025, $p < .001$), or preassembled conditions (mean difference = .022, $p < .001$). The preassembled and free play conditions showed no significant difference from one another (mean difference = .003, $p = .866$). To clarify the main effect for play condition in Phase 1, independent sample t tests were conducted. Parents in the guided play condition ($M = .096$) demonstrated significantly more spatial language than parents in the free play condition ($M = .057$), $t(46) = -5.454$, $p < .05$, or parents in the preassembled condition ($M = .057$), $t(46) = 5.77$, $p < .05$. No significant differences were found between parents in the free play and preassembled play condition, $t(46) = .062$, $p = .95$.

An additional question was whether children’s spatial language would differ with the condition assigned. An ANOVA analogous to the one above was conducted with the proportions of child spatial language in Phases 1 and 2. A significant main effect was found for condition, $F(2, 60) = 4.65$, $p < .05$, $\eta^2 = 0.90$. Independent sample t tests showed that children in the guided play condition ($M = .067$) demonstrated significantly more spatial language than children in the free play condition ($M = .046$), $t(45) = -2.13$, $p < .05$. Just as with the parents, no significant differences were found between the preassembled ($M = .059$) and free play conditions, $t(46) = -1.86$, $p = .07$. However, children in the guided play condition did not significantly differ in their spatial talk from those in

Table 1

Mean, Standard Deviation, and Range of Total Word and Spatial Word Counts for Parents and Children in Phases 1 and 2, Shown for the Guided, Free Play, and Preassembled Conditions of Study 1

		M (SD)	*Range*
Condition: Guided			
	Parent		
Phase 1	Total words	724(197)	415–1220
	Spatial words	71(32)	27–145
Phase 2	Total words	638(188)	318–1025
	Spatial words	58(22)	24–112
	Child		
Phase 1	Total words	197(91)	32–428
	Spatial words	14(9)	2–38
Phase 2	Total words	234(118)	84–441
	Spatial words	15	2–34
Condition: Free play			
	Parent		
Phase 1	Total words	496(165)	191–899
	Spatial words	29(15)	11–69
Phase 2	Total words	578(188)	180–947
	Spatial words	45(22)	12–95
	Child		
Phase 1	Total words	252(81)	115–403
	Spatial words	12(7)	4–29
Phase 2	Total words	231(81)	88–367
	Spatial words	12(6)	1–26
Condition: Preassembled			
	Parent		
Phase 1	Total words	567(272)	128–1164
	Spatial words	32(16)	7–66
Phase 2	Total words	582(248)	207–1120
	Spatial words	15(7)	3–28
	Child		
Phase 1	Total words	253(95)	68–428
	Spatial words	51(28)	8–102
Phase 2	Total words	240(78)	42–401
	Spatial words	17(8)	2–29

the preassembled condition, $t(45) = .88$, $p = .38$. Post hoc comparisons (Tukey HSD) indicated that children in the free play condition demonstrated significantly lower proportions of spatial talk than those in the preassembled (mean difference $= -.017$, $p = .023$) and guided conditions (mean difference $= -.016$, $p = .033$). The difference between guided play and preassembled conditions was not significant (mean difference $= .0011$, $p = .98$). Overall, the observed differences in child spatial talk indicate the beginnings of a trend similar to that demonstrated by parents, but does not significantly follow through to the assembled and guided play conditions. Perhaps if the parameters of the study had been altered slightly, such that the play session lasted for longer than 10 min, or if the guided condition had contained more steps, children's spatial language would follow the pattern of parents in this respect.

To see if the condition assigned in Phase 1 bore a relationship to the amount of spatial language demonstrated in Phase 2 (in which all dyads engaged in guided play), correlations were computed across each of the three conditions, for both parents and children. For each of the conditions in Phase 1, the proportion of parent spatial language in Phase 1 correlated with the same measure in Phase 2; free play ($r = .62$, $p < .001$), guided ($r = .66$, $p < .001$), and preassembled ($r = .41$, $p < .05$). This relationship was not found for children in any of the conditions (rs $< .15$, ps $> .05$). Proportions of parent and child spatial talk did not correlate in the Phase 1 free play condition ($r = .32$, $p > .05$), or the guided play condition ($r = -.17$, $p > .05$) but did correlate in the preassembled condition ($r = .49$, $p < .05$).

In recognition of the possibility that a particular type of spatial word category could be driving the observed results for both parents and children, separate ANOVAs were conducted to determine whether the use of certain kinds of spatial word categories (as defined by the coding system, such as deictic terms, location terms, or descriptions of orientation and transformation) varied by condition. Spatial word type (6) was the within-subject variable, and condition (3) and sex (2) were the between-subjects variables. The dependent variable was the proportion of spatial language as categorized by the spatial word categories. For parents, a significant effect was found for condition, $F(2, 60) = 20.63$, $p < .001$, $\eta^2 = .385$, as well as a significant phase by condition interaction $F(2, 60) = 3.35$, $p < .001$, $\eta^2 = .09$. Post hoc comparisons (Tukey HSD) confirmed that the instances of the spatial word categories were significantly greater in the guided play condition than the free play (mean difference $= 7.54$, $p < .001$) and preassembled play (mean difference $= 6.50$, $p < .001$) conditions; the preassembled play and guided play conditions did not significantly differ from one another (mean difference $= -1.04$, $p = .70$). For children, a significant phase by condition interaction was found, $F(2, 60) = 10.20$, $p < .001$, $\eta^2 = .236$. Tables 2 and 3 illustrate the means for each spatial category for parents and children, for both Phases 1 and 2. As was found in the analyses of overall proportions of spatial talk, children do not show as dramatic an effect of condition as their parents.

Were children differentially engaged in play during these three conditions? To answer this question, video footage was coded for the amount of time 80% of the subjects spent building, talking about, and generally interacting with the block materials. On average, out of the 10-min session, children spent 9 min, 37 s engaged with the blocks in Phase 1, and 9 min, 25 s in Phase 2. To asses whether condition had an effect on levels on engagement, an ANOVA was conducted with time spent playing in Phases 1 and 2 as the within-subjects variable, gender (2) and condition (3) as the between-subjects variables. No significant differences were found among the conditions assigned in Phase 1 ($M_{\text{free play}} = 9.75$, $M_{\text{guided}} = 9.81$, $M_{\text{preassembled}} = 9.43$), $F(2, 55) = 0.43$, $p = .84$, $\eta^2 = .001$.

In summary, the analyses demonstrate that play context (free, guided, and preassembled) impacts the spatial vocabulary that children are apt to hear. The strength of

Table 2
Means for Spatial Word Categories Demonstrated by Parents in Phases 1 and 2

Spatial word category	*Free play*	*Guided*	*Preassembled*
Phase 1			
Location	13.58	22.88	18.25
Deictic	6.67	17.5	9.58
Dimension	5.33	10.67	1.88
Feature/property	4.17	15.67	5.2
Shape	0.33	4.83	0.75
Orientation/transformation	5.5	9.3	6.17
Phase 2			
Location	17.75	24.17	19.71
Deictic	11.38	14.92	13.13
Dimension	4.71	7.25	5.29
Feature/property	12.58	13.42	13
Shape	1.04	1.79	1.04
Orientation/transformation	4.5	5.5	4.96

the effect of construction contexts on parental talk is further evidenced by the fact that no explicit instructions to use spatial language were given. The guided play context in particular elicited the most spatial language from parents, perhaps because the dyad was most influenced by the shared goal of the condition. For parents, the guided play condition was also shown to elicit significantly higher amounts of spatial words per category. Child data indicated the beginnings of this trend, in that the free play context contained significantly lower proportions of spatial talk; however the guided play and preassembled play conditions did not differ from one another in spatial proportions of speech or spatial word categories.

Study 1 leaves open the question of what baseline levels of spatial language might be present when children and parents interact in situations without blocks or other types of spatial materials. We therefore sought to analyze the language of parents and children during other everyday non-spatial play activities. In order to capture a naturalistic and heterogeneous array of language in diverse non-spatial contexts, Study 2 used the CHILDES database to investigate the quantity of spatial language demonstrated by parents and children in other types of play and daily life activities that do not involve construction.

Table 3
Means for Spatial Word Categories Demonstrated by Children in Phases 1 and 2

Spatial word category	*Free play*	*Guided*	*Preassembled*
Phase 1			
Location	5.29	3.21	9.58
Deictic	3.08	5.63	6.04
Dimension	2.13	3.67	0.46
Feature/property	1.58	1.83	1.33
Shape	0.13	1.33	0.04
Orientation/transformation	1.75	0.75	2.25
Phase 2			
Location	4.52	5.292	6.25
Deictic	3.75	5.3	6.67
Dimension	2.17	2.63	2.42
Feature/property	2.54	2.33	2.88
Shape	0.17	0.38	1.08
Orientation/transformation	1.58	1.08	1.38

STUDY 2

Method

Recruitment Method and Materials

To remain consistent with the methods of Study 1, transcripts from the CHILDES database were selected to fit the following criteria: (1) children were within the age parameters of Study 1 (3 through 5 years of age), (2) the transcribed interaction was restricted to one caregiver speaking to one child (e.g., avoided group dialogue), and (3) the interaction involved task(s) that did not involve play with construction toys. Furthermore, when time information was included, 10-min interactions were used to parallel the methods of Phase 1 in Study 1. If no time information was given, efforts were made to closely match total word counts to those demonstrated in Study 1. Ultimately, the collection of transcripts represented the following activities (which were not mutually exclusive across transcripts): lunch with parent, play with puppets, drawing, playing house, playing store, dressing up, playing “zoo” with animal figurines, pretending to talk on a telephone, playing tea party with dolls, playing with pretend food and kitchen utensils, playing “school,” and throwing a ball.

Participants

Thirty-one transcripts were gathered and analyzed. In keeping with the age groups of Study 1, 14 transcripts were obtained for children approximately between the ages of 3 and 4.5 (6 males, 8 females, mean age 43 months, range 31–43 months) and 17 from children approximately between the ages of 4.5 and 5 (7 males, 10 females, mean age 63 months, range 54–71 months).

Procedure and Coding

Transcripts were analyzed according to the coding system used in Study 1. Two reliable coders from Study 1 calculated the proportions of parent and child spatial language demonstrated in the CHILDES transcripts.

Results

To compare the spatial content of the language that preschool children hear from caregivers when participating in other types of play (CHILDES control) to that of the language elicited when playing with construction toys like blocks, a one-way ANOVA was conducted. As illustrated in Figures 1 and 2, significant differences were found between the spatial language proportions in Study 1 and the proportions calculated from the set of CHILDES transcripts, $F(1, 102) = 55.02$, $p < .001$. A series of independent samples t tests were performed to probe the difference between the block construction play groups and the general play group. It was found that in the three block play contexts, parents used significantly more spatial language than those depicted in the CHILDES transcripts ($M_{\text{CHILDES}} = .03$, $SE = .003$): in the preassembled condition ($M_{\text{preassembled}} = .057$, $SE = 3.32$), $t(53) = 6.29$, $p < .001$, the guided play condition ($M_{\text{guided}} = .096$, $SE = 6.46$), $t(53) = 10.59$, $p < .001$, and the free play condition ($M_{\text{free play}} = .057$, $SE = 3.15$), $t(53) = 5.71$, $p < .001$.

Similarly, children themselves used spatial language more frequently in the conditions of Study 1 than those depicted in the CHILDES transcripts, $F(1, 101) = 23.15$, $p < .001$ (Figure 2). As with parents, independent t-tests revealed that, when broken apart, each block play condition elicited significantly more child language than the selected CHILDES activities ($M_{\text{CHILDES}} = .03$, $SE = .003$): preassembled ($M_{\text{preassembled}} = .059$, $SE = 5.79$), $t(53) = 5.65$, $p < .001$; guided ($M_{\text{guided}} = .067$, $SE = 1.79$), $t(52) = 4.23$, $p < .001$; and free play ($M_{\text{free play}} = .047$, $SE = 4.53$), $t(53) = 3.00$, $p = .005$. These results lead us to conclude that introducing blocks to a play context is likely to elicit conversation containing a host of spatial vocabulary above and beyond what is used in other types of play.

GENERAL DISCUSSION

The purpose of these studies was to explore whether children's learning of spatial language might be enhanced in settings involving play with blocks, paying particular attention to the role of verbal descriptions of spatial concepts. The first study revealed that parents and children do use spatial language in block play, and even more importantly, that different play contexts were more or less supportive of the use of spatial language. In particular, the guided play context in Study 1 promoted more spatial talk from parents than the other two conditions.

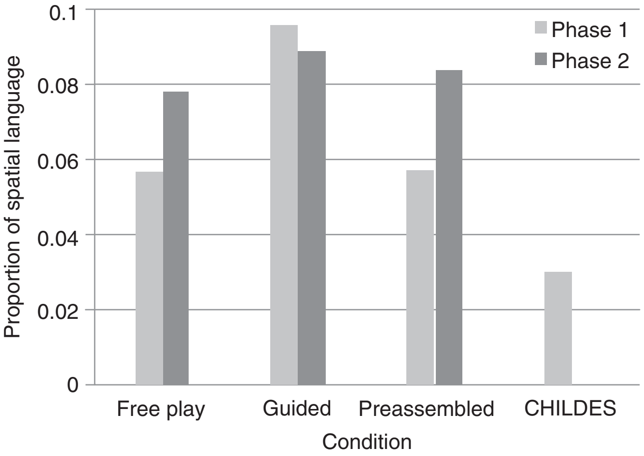

Fig. 1. Proportions of parent spatial language in Phases 1 and 2 as a function of play condition group (Study 1), in comparison to parent spatial language proportions demonstrated in selected CHILDES transcripts (Study 2).

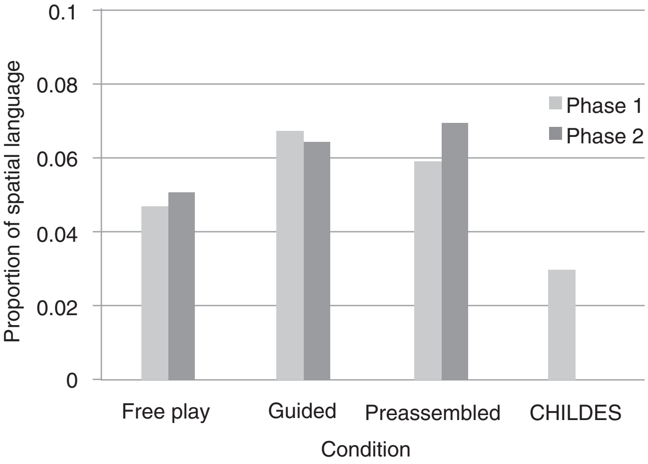

Fig. 2. Proportions of child spatial language in Phases 1 and 2 as a function of play condition group (Study 1), in comparison to child spatial language proportions demonstrated in selected CHILDES transcripts (Study 2).

Child spatial language followed a similar trend, in that children in the guided play condition demonstrated more spatial language than those in the free play condition, but not in the assembled condition. Based upon what was observed in the play conditions, it seems that the preassembled structure afforded play that involved different types of spatial relations apart from those used in construction contexts, for example: "Mommy let's drive the cars *in and out* of the garage," or, "The fireman is climbing all the way *up to the top* of the building." Parents and children often elicited and commented on spatial actions with the figures and vehicles provided. In contrast, in the free play condition, children would put blocks together somewhat randomly and seemed to not pay as much attention to the figures and vehicles. This was also observed in the guided play condition at times. If parents played less of an assertive role, children would sometimes became more absorbed with the activity of building, rather than building in a way that followed the prescribed steps (it should be noted that in the guided play condition, no strict rules were imposed such that the building would have to be finished by the end of the play session.) When children became absorbed with the materials, not as much conversation about spatial configurations was elicited as in the preassembled condition. We hypothesize that stretches of this type of play may have contributed to the lack of a difference between proportions of children's spatial talk in the preassembled and guided play conditions. It may be that with a slightly older age group of children who have a wider range of conversational and block building skills (perhaps 6–7 year olds), the guided play condition would show significantly higher proportions of spatial talk for both parents and children alike.

The second study allowed us to conclude that ordinary, everyday interactions of parents and preschoolers do not necessarily involve spatial talk to as great an extent as play with construction materials. In these forms of play, it is notable that the mean proportions of spatial phrases and words were found to be the same for parents and children alike ($M_{\text{CHILDES}} = .03$). Thus, it seems likely that block play confers an advantage for children's exposure to spatial language and encourages them and their parents to use spatially relevant terms.

These findings hold substantial educational implication for the enhancement of spatial instruction. Many current organizations have recognized the need to bolster this area in the classroom. In 2006, the National Research Council's report entitled *Learning to Think Spatially*, outlined the importance of developing spatial skills not only for success in the STEM disciplines, but also for normal functioning in everyday life. Despite its fundamental role, spatial learning is not specifically addressed in many preschool and kindergarten curriculums (National Research Council, 2006). The Council's report specifically advocated for greater inclusion of direct spatial ability training, and defined spatial ability as the ability to process, manipulate, and visualize spatial information. A recent meta-analysis of the efficacy of such spatial ability training showed that it is malleable and can benefit from training (Hand, Uttal, Marulis, & Newcombe, 2008). As set forth in their Geometry Standards for Pre-K to Grade 2, the National Council of Teachers of Mathematics (2000) highlight the following spatial reasoning objectives: Describing spatial relationships (e.g., the ability to use words such as top and bottom), and creating mental images of geometric shapes.

Blocks may be one such educational tool that provide young children with an accessible and playful introduction to these spatial concepts and abilities. It has been demonstrated that words embedded in playful contexts are learned better and faster (Neuman & Roskos, 1992). The current study indicates that play with blocks in a semi-structured guided play context, in the company of a more experienced partner, is especially beneficial for children's exposure to spatial language. The particular benefits of a guided play approach have additionally been demonstrated in children's learning of the properties of shapes (Fisher et al., 2009). This hearkens back to Vygotsky's classic theory of scaffolded learning within the zone of proximal development, in which a novice's learning is facilitated by an expert instructor (Vygotsky, 1978). Block play in the preschool years may be additionally appropriate as an educational tool in that it coincides with observed trends in language development. It is between the ages of 2 and 5 that children begin to express and understand relational concepts such as big/little, wide/narrow, tall/short, in/on, high/low, and here/there (de Villiers & de Villiers, 1979, 1992). Around the age of 3, children use these terms to make appropriate judgments of function (Gelman & Ebeling, 1989). With the guidance of an adult partner, children will be exposed to new and more sophisticated forms of spatial language to add to their growing lexicons, granting them opportunities to elaborate and expand upon their developing knowledge of spatial relations and corresponding categorical labels.

The fact that no gender differences were found in the current study additionally speaks to the educational validity of blocks as a tool in the classroom. Although prior research has typified a greater male preference for play with blocks (Farrell, 1957; Farwell, 1930; Saracho, 1994, 1995), it seems that girls may be just as motivated to play with construction materials. Indeed, for all of the conditions in the current study, it was found that girls and boys did not differ from one another in the amount of time spent engaging with the blocks. In assessments of competency in block building skills, boys have been shown to have no advantages over girls (see review by Kersh et al., 2008). Thus, teachers may incorporate blocks into their pedagogical techniques without overt concern for alienating female members of the class.

The delivery of spatial language through block play may also prove particularly powerful as an educational tool for children of low-SES (socioeconomic status) households, who may face specific contextual challenges in acquiring language (Case, Griffin, & Kelly, 2001; Whitehurst, 1997). It has been found that although low- and high-SES children start out with the same number of spatial words at 30 months of age, the linear rate of growth of spatial words is slower for low-SES children when compared to middle- and high-SES children (Pruden et al., 2010). Block play may also prove to be a particularly useful and accessible tool in introducing at-risk children to fundamental mathematical concepts (Park, Chae, & Foulks, 2008), and address differences in mathematics achievement scores (Jordan, Huttenlocher, & Levine, 1992; Saxe, Guberman, & Gearhart, 1987).

Blocks offer one play context that may enhance learning. Here, we examined block play between parents and children, and found that, in comparison to many other types of play activities, blocks encourage parents and children to use significantly more spatial terms in conversations with one another. The fact that the guided play condition elicits more spatial language suggests that experimental and educational interventions may follow such a model to increase the frequency of spatial language children hear and come to use on their own. Pre-K and kindergarten teachers may not fully recognize the educational value of block play (National Association for the Education of Young Children [NAEYC] 1997; Park, Chae, & Foulks, 2008; Wellhousen & Keoff, 2000; Zacharos, Koliopoulos, Dokomaki, & Kassoumi, 2007). These finding bear direct relevance to implementation in classrooms, in which a teacher may use goal-directed block play as a means of introducing and acting out spatial concepts and relationships.

A recent meta-analysis (Alfieri, Brooks, Aldrich, & Tenenbaum, 2010) of discovery-based learning speaks to this issue. The authors define discovery learning as occurring when "the learner is not provided with the target information or conceptual understanding and must find it independently and with only the provided materials. . . .there is an opportunity to provide the learners with intensive or conversely, minimal guidance, and both types can take many forms" (p. 2). The guided condition of this study fits within this approach, in which the end product of a complete structure is obtained by sequential stages at which children receive guidance and feedback from their parents as needed. Based upon their findings in the meta-analysis, Alfieri et al. (2010) suggest that pedagogical approaches that employ scaffolded tasks with predefined objectives confer particular benefits for learners. Teachers may adopt this strategy in the context of guided play with blocks, providing children with explanation and support, yet also allowing them the space to build and discover on their own.

Because of the unique language it elicits, playing with blocks may be one of the means by which young children begin to develop the spatial abilities that have been found to be linked to a number of academic achievements later in life (Humphreys, Lubinski, & Yao, 1993; Shea, Lubinski, & Benbow, 2001). These data are among the first to show that naturalistic interactions between parents and children can build a foundation for important spatial concepts and the means of expressing them through language. Future research will further elucidate the way in which block play may be utilized as a mode that fuses together playful learning and spatial education.

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