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Children's Play Preferences, Construction Play with Blocks, and Visual-spatial Skills: Are they Related?

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Fifty-one preschoolers' play preferences, skills at assembling block structures, and spatial abilities were recorded in this study. There were no sex differences in children's visual-spatial skills, and play with art materials and children's free and structured play with blocks were related to spatial visualisation. Two patterns emerged from the findings: (1) activity and

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performance representing skills in spatial visualisation and visual-motor co-ordination; and (2) creativity, or the ability to break set and to produce varied solutions using visual materials. Future research might examine the extent to which children's play activities and experiences predict these types of skills.

It is widely recognised that play, a spontaneous, self-guided activity, provides children opportunities to learn and practise important cognitive and social skills. Visual-spatial skill is one area of cognitive ability that has frequently been associated with sex differences (Huttenlocher & Levine, 1993) and with particular play preferences (Tracy, 1987). Interest in the determinants of visual-spatial skills has been stimulated by consistent findings that spatial abilities are related to math and science achievement (Casey, Pezaris, & Nuttall, 1992; Tracy, 1990) and that males tend to perform better than females on most visual-spatial tasks, at least by adolescence (Burns & Reynolds, 1988; Geary, Gilger, & Elliott-Miller, 1992; Harris, 1981; Maccoby & Jacklin, 1974; McGee, 1979; Tracy, 1990), as early as middle childhood (Johnson & Meade, 1987; Kerns & Berenbaum, 1991) and even preschool (Huttenlocher & Levine, 1993).

Spatial abilities, according to Linn and Petersen (1985) involve more than one component. In a meta-analysis of studies investigating sex differences in spatial abilities, they identified three primary components: (1) spatial perception, or determining spatial relations of objects with respect to one's own body orientation; (2) mental rotation, or identifying a model in a different orientation; and (3) spatial visualisation, which involves multistep mental manipulations of spatially presented information. Linn and Petersen (1985) found that the magnitude of sex differences in visual-spatial skills is largest for mental rotation, medium for spatial perception, and smallest for spatial visualisation tasks. These findings have been further replicated with more recent studies in a meta-analysis by Voyer, Voyer, and Bryden (1995). Voyer et al. (1995) further discovered that effect sizes in sex differences found in the literature vary as a function of partitioning of data (differences more marked in older ages) and some aspect of how the tests were administered or scored (individually vs. in group).

The origin of this sex difference remains a source of considerable debate. Both genetic and hormonal explanations have been proposed (Casey & Brabeck, 1989; Kimura & Hampson, 1994; Lewis & Harris, 1988; McGee, 1979; Newcombe & Bandura, 1983; Resnick, Gottesman, Berenbaum, & Bouchard, 1986; Voyer & Bryden, 1990). For example, females with congenital adrenal hyperplasia (CAH) (Resnick et al., 1986) and right-handed females with nonright-handed relatives (Casey &

Brabeck, 1989) demonstrate high levels of spatial ability as compared to their female counterparts.

On the other hand, some investigators have stressed the importance of environmental factors such as sex-typed play activities in the development of visual-spatial skills (Newcombe, 1982; Sherman, 1967). This view emphasises socialisation differences in childhood (Fagot, 1977, 1978). There is evidence that boys play more often than girls with blocks and other toys that provide practice with two- and three-dimensional manipulations and transformations (Tracy, 1987), and this "practice deficit" may contribute to girls' poorer performance on visual-spatial tasks. A meta-analysis in the role of experience in spatial skills performance by Baenninger and Newcombe (1989) found that for both males and females, participation in spatial activities is related to spatial ability. This relationship, however, accounts for only 9% of the variance in spatial skills. The present study was designed to further investigate the link between play preferences in the classroom, ability at block play and visual-spatial skills of girls and boys in the preschool age when sex differences are lowest.

Spatial Abilities and Play Activities

Correlational studies have shown that participating in spatial activities such as ball playing and playing with "manipulative" toys are positively related to preschoolers' visual-spatial skills. Preschoolers who frequently engaged in "masculine" play activities have been shown to perform better on the Preschool Embedded Figures Test (PEFT) (spatial visualisation) than those who spent less time in masculine activities (Fagot & Littman, 1976). After coding preschoolers' free play preferences as either masculine or feminine, Connor and Serbin (1977) found that boys' preferences for masculine activities was positively related to their performance on the PEFT, but not to their performance on the Block Design subtest of the Wechsler Preschool and Primary Scale of Intelligence (spatial visualisation with mental rotation component). In contrast, activity choices were not related to girls' performance on these spatial tasks. A replication study with a larger sample, however, demonstrated that preschoolers of both sexes who were rated as frequently engaging in masculine activities performed better on the Block Design task than did those identified as "high feminine" children (Serbin & Connor, 1979).

Anthropological studies conducted in Kenya also provide support for the hypothesis that engaging in spatial activities enhances performance on spatial tasks (Munroe & Munroe, 1971; Nerlove, Munroe, & Munroe, 1971). Children who had more experience exploring the physical environment away from their home performed better on the Copying

Blocks subtest of the Stanford–Binet than did children who stayed close to home.

In addition to these correlational studies, several experimental studies have demonstrated that visual spatial skills can be learned through training and practice and will generalise to a related task (Connor, Schackman, & Serbin, 1978; Connor, Serbin, & Schackman, 1977; Matthews, 1987). To determine if male superiority on visual-spatial tests is a direct result of masculine play experiences, Sprafkin, Serbin, Denier, and Connor (1983) randomly assigned preschoolers to a training session during which they were exposed to masculine toys (e.g. blocks and tinker toys). Children exhibiting high or low rates of male-preferred selections in free play were equally represented in both training and control conditions. Two training sessions over a six-week period consisted of three phases: (1) children were instructed about how the materials may be used and shown relevant features (e.g. number of sides); (2) children were encouraged to make various structures out of the materials; and (3) children played with the materials on their own during a free play session. Performance on the Block Design subtest of the WPPSI and the Punched Holes Test was significantly greater at post-test for children in the training condition, whereas pre- and post-test scores did not differ for the control group, thus providing evidence for a causal relation between play with construction toys and spatial visualisation task performance.

To date, however, there are no studies in which children's structured and unstructured play with blocks and similar manipulative toys has been observed closely enough to determine the mechanisms by which such play might enhance visual-spatial skills. The present study examines the role of preschoolers' play preferences and behaviour as correlates of two types of visual-spatial skills. This study goes beyond other research in that it includes in-depth observation of children's involvement and skill in complex block play—both structured and unstructured. Children's spontaneous levels of interest, creativity and complexity of play was assessed during a free play session with blocks. Children's skills in block construction and visualisation were assessed in a structured block modelling task. Two types of visual-spatial skills were assessed using standardised tests which measured the spatial visualisation component of spatial skills and perceptual field independence or ability to break set. Spatial visualisation was selected for two reasons: (1) tests which can be used with preschoolers assess only spatial visualisation as the other two components appear at later ages (Voyer et al., 1995); and (2) these tests do not demonstrate consistent sex differences, thus, within-gender differences can be more readily investigated. Although performance on embedded figures involves some visual-spatial ability, it also measures field independence or ability to break set, both of which are components of nonverbal creativity. Finally, verbal skills were assessed to control for individual differences in verbal skills.

The goals of this study were twofold: (1) to investigate the relation between preschoolers' play preference in a classroom setting and their performance on standardised visual-spatial tasks; and (2) to analyse their free and structured play with blocks and its relation to spatial skill performance. The following hypotheses were tested in this project: (a) Children's play preferences in preschool, particularly play with manipulative toys, will be related to their visual spatial skills as assessed by standardised tests; (b) Children's play with blocks (involvement and complexity of free play with blocks; and complexity and correctness of structured/modelling block play) will be related to their visual-spatial skills as assessed by standardised tests.

METHOD

Participants

Sixty children attending nine university-affiliated preschool classrooms participated in this study. The children ranged in age from 47 to 69 months ($M = 56.5$ months). Data from nine of the children are not included in this report because the children did not complete all measures due to moves from the area during the study. The final sample thus consisted of 26 girls and 25 boys. There was no difference in the ages of the two sexes (girls $M = 56.3$ months, boys $M = 56.7$ months, $t < 1.0$, n.s.). Most of the children were from middle class homes, and they were predominantly European-American in ethnic background.

Procedures and Measures

Play Preferences. The toy and play activity preferences of the children were measured using a play preference teacher rating form completed by the lead teacher in each child's classroom. The form consisted of a listing of 18 play activities typically observed in preschool classrooms. Teachers reported how frequently each child chose each of the activities during free play periods using a 5-point Likert-type scale ranging from "almost always" to "almost never". Twelve of the 18 activities were selected to represent three categories of play: art (easel painting, using magic markers, crayons and colouring books, and cutting paper); fantasy play (playing house, playing hospital, giving a puppet show, and playing grocery store); and manipulative toy play (jigsaw puzzles, parquetry blocks, Lego, and blocks). Scores on these subsets were summed to obtain a preference rating for each child in each category.

Observations of Block Play

On two occasions, children were taken to a playroom where they were videotaped at play with standard preschool wooden blocks.

Unstructured Block Play. During the first block play session, children were presented with a large box filled with 70 blocks comprising a variety of shapes and were asked to "Build the best thing you can with these blocks". No other instructions were given, and the adult, who remained in the room to monitor the child and the video camera, was involved in paperwork and instructed to minimise interaction with the child. The unstructured block play sessions lasted approximately 15 minutes, but could be terminated earlier if the child wished.

The videotapes of the unstructured block play sessions were later coded for the complexity and competency of children's use of blocks and their degree of interest and involvement. The total time children spent in play was also recorded. Two observers scored the tapes and both scored 12 of the tapes for reliability. The coding definitions and inter-observer agreements for each coding category are shown in Table 1.

Structured Block Play. On a different day, children were taken to the same playroom and shown a complex block model, illustrated in Fig. 1, which they were asked to duplicate, using the box of blocks that had been provided for unstructured play. Again, the adult remained in the room and videotaped the session but engaged in minimal interaction. The structured block play sessions lasted approximately 15 minutes and could be terminated earlier by the child.

The videotapes of the structured block play sessions were coded for accuracy by the same two coders who scored the unstructured play sessions. Each child received a score for each block placed: a correct placement received a score of 2, a placement that was approximately correct a score of 1, and an incorrect placement a score of 0. The child's total score was used as the primary measure of accuracy; scores could range from 0 to 86.

In addition, the block model was partitioned into six sections, and the correct placement of sections with regard to the entire model was scored from slides taken of the child's final structure. For each section of the model, a child received a score of 3 for placement between the correct two adjacent sections, a score of 2 for correct placement next to one adjoining section, a score of 1 for placement of the section in the approximately correct position in the structure, or a score of 0 if the section was not constructed or placed entirely incorrectly. A child's total score on this scale could range from 0 to 18. The number of sections that were correctly

TABLE 1
Unstructured Block Play Codes and Inter-observer Agreements

Building strategies		
Symmetrical placements	Placing the same shaped block in a design, such as at both ends of a long block, or recreating the same structure a second time	80
Rotations/flips	Rotating or turning blocks for the purpose of making interfaces, symmetrical placements, or alignment	67
Adjustments	Moving a previously placed block to another location on the structure	78
Trial placements	Manipulating a new block as if to place it on the structure, actually touching the block to the structure, but not actually placing the block; or completely removing a previously placed block	81
Saves	Child acts to prevent a collapse	96
Interfaces	Placement of two complementary blocks together, such as combining an arch with a semicircle or two ramps together to form a rectangle	?94
Collapses	Block or structure falls or is moved out of place	99
Types of blocks used		
Total blocks	Total number of different blocks placed	98
Different shapes used	Total number of different block shapes	96
Unique shapes	Number of unusually-shaped blocks used	96
Number of structures	Number of different constructions built	100
Number of different block forms	Of 16 possible types of constructions (e.g. stacks, arches, enclosures)	91
Quality of play ratings (agreement within 1 scale point)		
Interest/involvement		90
Amount of planning in construction		70
Complexity of final structure		67

constructed was also counted. Finally, children's efforts to rebuild collapsed portions of the structure were counted. Inter-observer agreement, calculated on 25% of the structured block play sessions, averaged 85% accuracy of individual block placements.

Standardised Tests

Visual-spatial skills were evaluated using three different standardised measures. Children's verbal skills were also evaluated in order to control for general intellectual ability. Each test was administered on a separate day in a testing room near the child's preschool classroom. The order in which tests were administered was varied randomly.

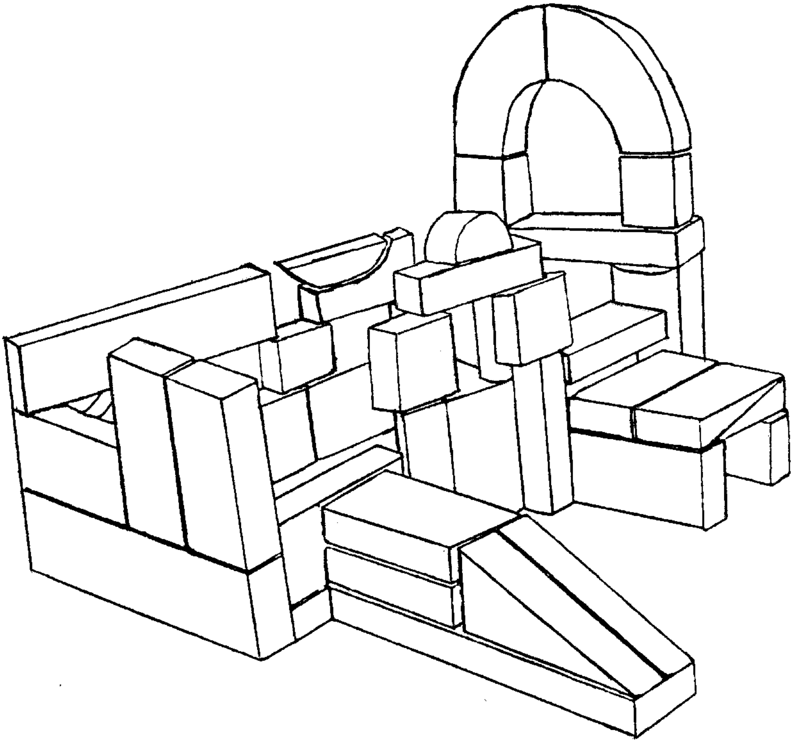

FIG. 1. Block model.

Block Design. The Block Design (BD) subtest from the Wechsler Preschool and Primary Scale of Intelligence (WPPSI; Wechsler, 1967) and the Wechsler Intelligence Scale for Children–Revised (WISC-R; Wechsler, 1974) were administered to measure the children's ability to analyse and reproduce abstract forms. These tests assess spatial visualisation, but also contain some mental rotation components. The WPPSI Block Design subtest uses flat (two-dimensional) red and white blocks and consists of 10 items in which the child is asked to reproduce either a model constructed by the examiner or a pictured design. The 11-item WISC-R Block Design subtest uses red and white cubes and children are asked to reproduce patterns of increasing complexity. All children began the block design tasks with the first WPPSI item and continued until they had 2 consecutive failures. Both the WPPSI and the WISC-R tasks were used to ensure that all children reached a ceiling of performance. The highest possible score on the combined tests was 44. The block design subtests from the WPPSI and

WISC-R are highly reliable, with test-retest correlations reported at .82 and .85, respectively (Wechsler, 1967, 1974).

Enbedded Figures Test. The Children's Embedded Figures Test (CEFT; Karp & Konstadt, 1971) was administered to assess children's ability to abstract a geometric figure embedded within a more complex picture. This test also measures spatial visualisation. The test consists of 11 items in which children locate a triangle of specific size and 14 items in which children locate a 5-sided "house"; each series is preceded by two practice trials. Children were given a laminated paper shape to place on the embedded shape in the picture. The test was discontinued when children failed 5 consecutive items. The highest possible score was 25.

Test-retest reliability for the CEFT has been reported to range from .83 to .90 (Karp & Kondstadt, 1971). Construct validity has been evaluated with older children through correlations with scores on the adult version of the Embedded Figures Test ($r = .85$ for 11-year-old children) and with visual-spatial subtests of the WISC (statistically significant r-values ranging from .32 to .49; Witkin, Oltman, Raskin, & Karp, 1971).

Copying Blocks. The block portion of the Copying subscale from the *Stanford–Binet Intelligence Scale*, 4th edition (Thorndike, Hagen, & Sattler, 1986) was used to measure visual-motor ability (CB). The CB contains aspects of spatial visualisation as well as mental rotation. The test consists of 12 items in which children are asked to reproduced three-dimensional structures using solid colour cubes. The test is discontinued after 4 consecutive failures, and the highest possible score was 12. Test-retest reliability for the entire copying subtest (which includes paper-and-pencil tasks that were not administered in the present study) is reported at .87 (Thorndike et al., 1986).

Peabody Picture Vocabulary Test–Revised. The Peabody Picture Vocabulary Test–Revised (PPVT-R; Dunn & Dunn, 1981) was used to measure the verbal abilities of the children. The test consisted of 175 items that assessed the child's receptive vocabulary. The children were shown groups of four pictures and then were instructed to show what was asked. The reliabilities for the test range from .71 to .89 (Dunn & Dunn, 1981). The children's scores on this measure did not differ by gender. Males and females scored similarly on their verbal abilities (male: $M = 55.43$, SD = 20.57; female: $M = 58.35$, SD = 17.53).

RESULTS

Preliminary Analyses

All scores were submitted to multivariate analysis of covariance (MANCOVA) in order to test for sex differences in play activities, unstructured and structured block play, and standardised test. Verbal ability (score on the PPVT-R) was used as the covariate in all analyses.

Play preferences. A 2 (sex)×2 (age) multivariate analysis of covariance (MANCOVA) controlling for score on the PPVT was carried out to test for sex differences in children's play preferences as rated by their preschool teachers. Girls and boys were rated as having significantly different preferences [$F(3, 52) = 19.43, P < .001$]. Univariate tests indicate significant sex differences in fantasy [boys $M = 2.38$, SD = .52; girls $M = 2.98$, SD = .63, $F(1, 54) = 20.64, P < .001$] and manipulative toy play [girls $M = 2.40$, SD = .52; boys $M = 3.23$, SD = .50, $F(1, 54) = 36.79, P < .001$], but no difference in preference for art activities [girls $M = 2.20$, SD = .46; boys $M = 2.40$, SD = .45, $F(1, 54) = 3.49$, n.s.].

Unstructured block play. Separate MANCOVAs with the score on the PPVT as a covariate were used to test for sex differences in building strategies, types of blocks used, quality of construction play, and time spent in free block play (see Table 2). Boys and girls differed only on the set of variables describing number and types of blocks used [$F(5, 42) = 2.77, P < .05$]. Univariate results indicated that girls were more likely than boys to use the "unique" or unusual-shaped blocks, and boys were more likely than girls to build more than one structure during their free block play time. There were no overall differences between boys and girls in the frequency with which they used building strategies [$F(7, 40) = 1.12$, n.s.], the qualitative ratings of their play [$F(3, 44) = 1.61$, n.s.], or the amount of time spent in block play [$F(1, 46) = 2.89$, n.s.].

Structured block play. A MANCOVA was run controlling for the score on the PPVT on the set of structured block play variables that measured the accuracy with which children reproduced the block model. No sex differences were found [$F(5, 41) = 1.41$, n.s.] (Correct blocks, girls $M = 42.23$, SD = 25.12, boys $M = 38.58$, SD = 25.08; correct sections, girls $M = 8.42$, SD = 6.37, boys $M = 8.08$, SD = 7.14; number of sections completed, girls $M = 4.12$, SD = 1.95, boys $M = 3.50$, SD = 2.15; rebuilds, girls $M = 1.50$, SD = 2.00, boys $M = 1.38$, SD = 1.93.)

TABLE 2
Means for Unstructured Block Play Variables for Girls and Boys

	Girls		Boys		
	M	*SD*	*M*	*SD*	*F*
Building strategies					1.63
Symmetrical placements	3.8	3.1	1.8	2.7	–
Rotation/flips	1.5	2.0	0.6	1.0	–
Adjustments	5.7	3.7	6.0	3.6	–
Trial placements	3.1	2.6	2.6	3.3	–
Saves	5.9	3.6	7.8	6.2	–
Collapses	7.0	5.3	5.3	3.6	–
Interfaces	1.8	1.9	1.3	2.4	–
Types of blocks used					3.26*
Total blocks	58.9	19.3	51.2	23.7	1.61
Different shapes	8.9	1.9	8.3	2.5	0.96
Unique shapes	4.7	2.4	3.1	2.3	5.63*
No. of structures	1.1	0.3	1.5	0.9	5.15*
No. of block forms	7.8	1.8	6.9	2.4	2.40
Quality of play ratings					
Interest	3.7	1.1	3.4	1.2	–
Planning	3.3	1.2	2.8	1.5	–
Complexity	3.1	1.3	2.7	1.4	–
Time spent in play (min)	16.4	0.7	15.5	2.6	2.76

*$P < .05$.

Spatial tests. A MANCOVA with the score on the PPVT as a covariate was carried out to test for sex differences in children's performance on the three spatial tasks presented to them. There were no overall differences between boys and girls [$F(3, 52) = 0.86$, n.s.]. (Block Design, girls $M = 18.41$, SD = 13.04, boys $M = 19.39$, SD = 13.63; Copying Blocks, girls $M = 8.06$, SD = 2.47, boys $M = 7.36$, SD = 2.70; Embedded Figures, girls $M = 8.84$, SD = 4.88, boys $M = 9.29$, SD = 5.77.)

Play Preferences, Block Play, and Spatial Skills

Variables used in analyses. A series of regression analyses was carried out to examine associations among children's play preferences, their skill at unstructured and structured block play, and their performance on spatial tasks. Because a large number of variables was obtained from the unstructured play session, factor analysis was used to create clusters of variables representing dimensions of children's play behaviour. As shown in Table 3, three factors were found to account for more than 50% of the

TABLE 3
Factor Loadings of Variables from the Unstructured Block Play Session

Factor 1 *Complexity of Play*		*Factor 2* *Interest/Involvement*		*Factor 3* *No. and Variety of Blocks*	
Interfaces	.89	No. block forms	.76	Shapes	.85
Rotations/flip	.78	Complexity rating	.76	Unique shapes	.81
Symmetric placements	.44	Rebuilds	.69	No. of block	.78
		Planning rating	.52		
		Interest rating	.50		

variance. The first factor, labelled *complexity of play*, included use of block interfaces, rotating, and flipping blocks before placing them in a structure, and symmetrical placements of blocks. A second factor, labelled *interest/involvement*, included total number of structural forms used, the qualitative ratings of children's play, and the number of times children rebuilt structures that collapsed. The third factor, labelled *number and variety of blocks used*, included the number of differently shaped blocks children used, use of unique-shaped blocks, and the total number of blocks used. A composite variable was used in the regression equations to index each of these components of children's free block play.

Performance on spatial tasks (dependent variable) was measured by the childrens' performance on replicating a block model (number of correct block placements and number of correct completions of model sections); and on standardised subscales (block design, copying blocks, and embedded figures).

For each set of analyses, age was entered first into the regression equation. Predictor variables were then entered as a block to evaluate the significance of the relation for each set of variables. Each analysis with a statistically significant R-squared was followed up by a series of hierarchical analyses in which each independent variable was entered individually, in a stepwise fashion, to evaluate the increase in R-squared attributable to each variable.

Play preferences and block play. The first set of regression analyses examined the associations among children's play preferences and the sets of variables used as indices of skill at unstructured and structured block play, and the relation between unstructured and structured play with blocks. Significant results are shown in Table 4. Children's play preferences showed no relation to the unstructured block play variables: complexity of play, [$F(4, 46) = 1.51$]; quantity and variety of blocks used [$F(4, 46) = 0.86$]. Preference for art activities and the complexity of play

TABLE 4
Preschoolers' Play Preferences and Free Block Play behaviour as Predictors of Skill at Copying

	Accuracy Blocks		*Accuracy Sections*	
Dependent Variables:	*Beta*	R^2	*Beta*	R^2
Age	.37***	.13	.31**	.10
Play preferences				
Art	.26*	.19	.36***	.22
Manipulative	n.s.		n.s.	
Fantasy	n.s.		n.s.	
Unstructured block play				
Complexity of play	.29**	.22	.23*	.16
Interest/involvement	n.s.		n.s.	
Quantity and variety	n.s.		n.s.	

*$P < .10$; **$P < .05$; ***$P < .01$.

of children's free play with blocks predicted their accuracy in structured block play.

Play preferences and spatial skills. The results of the regression analyses examining the role of play preferences in spatial test performance are shown in Table 5. A preference for play with art materials was associated with high performance on the BD test, and a trend toward a relation between art and the CB test was found. A preference for fantasy play was significantly associated with performance on the CB test. Manipulative toy play preference was not related to performance on any of the spatial tests.

Block play and spatial skills. The results of the analyses relating children's skill at block play and their performance on visual-spatial tests are shown in Table 6. The free block play variable indexing complexity of

TABLE 5
Preschoolers' Play Preferences as Predictors of Spatial Skills

	Block Design		*Copying Blocks*		*Embedded Figures*	
Dependent Variables:	*Beta*	R^2	*Beta*	R^2	*Beta*	R^2
Age	.45***	.21	.47***	.22	.46***	.21
Art	.33**	.31	.23*	.26	n.s.	
Fantasy	n.s.		.34**	.28	n.s.	
Manipulative	n.s.		n.s.		n.s.	

*$P < .10$; **$P < .05$; ***$P < .01$.

TABLE 6
Preschoolers' Free Block Play and Skill at Copying a Block Model as Predictors of Spatial Skills

	Block Design		*Copying Blocks*		*Embedded Figures*	
Dependent Variables:	*Beta*	R^2	*Beta*	R^2	*Beta*	R^2
Age	.45***	.21	.47***	.27	.46***	.21
Free block play						
Complexity of play	.33***	.32	n.s.		.24*	.27
Interest/involvement	n.s.		n.s.		.39***	.38
Number and variety	n.s.		n.s.		n.s.	
Structured block play						
Accuracy: Blocks	.45***	.38	.37***	.34	n.s.	
Accuracy: Sections	n.s.		n.s.		n.s.	

*$P < .10$; **$P < .05$; ***$P < .01$.

play was a significant predictor of scores on the BD test and marginally related to performance on the CEFT. The variable indexing interest and involvement in free block play predicted CEFT scores. None of the unstructured block play variables was related to the CB task, but accuracy of block placement during the structured block play session was strongly related to performance on the BD and CB tests. Accuracy in reproducing the block model did not relate to the CEFT test.

DISCUSSION

The two main purposes of this study were to examine the relation between preschoolers' play preferences in a classroom setting and performance on visual-spatial tasks, and the relation of play with blocks and to visual-spatial skills. Previous research has typically found a difference between girls and boys, favouring boys, in spatial ability. This difference has been attributed in part to differences in play experiences of girls and boys. This study examined the play preferences and spatial skills of preschoolers in an effort to provide further understanding of the role of experience in this sex difference and in individual differences in visual spatial skills within sexes.

There were few differences between girls and boys on the measures used. Boys were rated as preferring manipulative toys more than girls did. During play with blocks, girls and boys differed only on two dimensions. Girls used more unique shapes in their structures and boys built more structures, but these aspects of their play were not associated with visual-spatial skills. Girls and boys did not differ in performance on any of the visual-spatial tests. These findings are consistent with previous research suggesting that girls and boys play with different toys, and that children's spatial skills do not differ by gender in the preschool years, at least as measured by psychometric tests; thus, further assessing the antecedents of spatial skills in future research seems warranted.

The prediction that children's play with manipulative toys would be related to their spatial abilities was not supported. Play with manipulative toys was not related to any of the measures of spatial skills either during block play or in the standardised tests. This finding is in contrast to Connor and Serbin's (1977) finding that play in masculine activities, which included manipulative toys, was positively related to spatial ability, but is consistent with Newcombe's (1993) results showing that play with masculine toys was not related to spatial ability. The Newcombe study and the present investigation used different methods of classifying toys than Connor and Serbin's study did. Connor and Serbin classified their toys by sex stereotype; Newcombe classified toys and play activities as spatial, nonspatial, and rated by sex stereotype; the present study classified toys by ability requirements. Perhaps if individual types of toys and activities are compared individually across studies, more similarities will be found.

Play with art materials, reproduction of a complex block structure, and performance on tests of spatial visualisation were interrelated. Although art was not expected to predict spatial skills, this finding is consistent with Newcombe's (1993) investigation showing that participation in sex-neutral activities, including art, was positively related to spatial ability. As art is generally considered sex-neutral, sex stereotyping of the play activity does not appear to be a relevant mediator of its associations with spatial skills.

The common elements in art, reproducing a block structure, and the two tests of spatial visualisation appear to be skills in analysing, visualising, and visual-motor co-ordination. Engaging in art activities may provide preschoolers with an opportunity to practise analysing visually and reproducing objects, which is a skill required by the block design test (BD), and experience with the visual-motor co-ordination needed for the copying blocks test (CB). These findings are consistent with the notion that practice with art materials develops eye-hand co-ordination and the ability to observe the environment in more detail and thus to be better at reproducing observable designs.

Children's performance with the blocks in free play and their interest and involvement predicted performance on the embedded figures test, but not the tests of spatial visualisation. Performance on the CEFT requires the ability to abstract figure from ground, to break set, and to be field-independent. Children who created a variety of block forms, who demonstrated planning and interest in building their free play structure appear to have been practising skills involved in breaking set and fluent production required to find the embedded shape in the CEFT. The common skills in these activities are those often defined as creativity.

Even the patterns that were demonstrated here do not, of course, demonstrate a causal relation. They are consistent with the hypothesis that experience in play activities influences children's visual-spatial skills, but an alternative interpretation is equally plausible. Individual differences in visual-spatial ability or in breaking set that contribute to the observed correlations could result from genetic differences or early experience, or both. None the less, it is important to understand how such skills are manifested in play, and how different aspects of play and performance are configured.

In summary, the hypothesis that preference for manipulative play activities predicts visual-spatial ability was not supported. Instead, two patterns emerged. One of these appears to indicate a configuration of activity and performance representing skills in spatial visualisation and visual-motor co-ordination. It consists of preference for art activities, skill at reproducing a complex block model, and skill on two tests of spatial visualisation. The second appears to represent some components of creativity—ability to break set and to produce varied solutions using visual materials. It is represented by interest and involvement in free play block construction, complex and varied structures in free play, and skill on an embedded figures task that requires the child to break set and do perceptual reorganisation of a visual stimulus. Future research might profitably examine the extent to which children's play activities and experiences predict or enhance these two types of skills.

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