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ABSTRACT

The purpose of this correlational study was to examine the possible relationships among children's extracurricular toy-playing habits, sex-role orientations, spatial abilities, and science achievement. Data were gathered from 282 Midwestern, suburban, fifth-grade students. It was found that boys had significantly higher spatial skills than girls. No significant differences in spatial ability were found among students with different sex-role orientations. No significant differences in science achievement were found between girls or boys, or among students with the four different sex-role orientations. Students who had high spatial ability also had significantly higher science achievement scores than students with low spatial ability. Femininely-oriented boys who reported low-playing in the two-dimensional, gross-body-movement, and proportional-arrangement toy categories scored significantly higher on the test of science achievement than girls with the same sex-role and toy-playing behavior. (Author)

Toy-Playing Behavior, Sex-Role Orientation, Spatial Ability, and Science Achievement of Fifth Grade Students: Are They Related?

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Abstract

The purpose of this correlational study was to examine the possible relationships among children's extracurricular toy-playing habits, sex-role orientations, spatial abilities, and science achievement. Data were gathered from 282 Midwestern, suburban, fifth-grade students. It was found that boys had significantly higher spatial skills than girls. No significant differences in spatial ability were found among students with different sex-role orientations. No significant differences in science achievement were found between girls or boys, or among students with the four different sex-role orientations. Students who had high spatial ability also had significantly higher science achievement scores than students with low spatial ability. Femininely-oriented boys who reported low-playing in the two-dimensional, gross-body-movement, and proportional-arrangement toy categories scored significantly higher on the test of science achievement than girls with the same sex-role and toy-playing behavior.

Throughout the United States both boys and girls receive the same K-8 science curriculum, yet boys tend to outscore girls in science achievement. The 1971 National Assessment of Educational Progress (NAEP) showed the median male-female difference for all science exercises to increase from 0.5% at age nine to 1.7% at age thirteen (Erickson and Erickson, 1984). In the 1977 NAEP science section, girls averaged between 1.6% and 2.5% below the national mean on items of all cognitive levels. The Second International Science Study - U. S. A., undertaken in 1983, showed the male-female differences in fifth grade to be 6.2% and 6.5% in the ninth grade. In both cases, the males had the higher achievement scores.

Reasons for these sex-related differences in science achievement may be related to three areas: social, educational, and personal. Social factors which have been found to differentially influence attitudes toward science, and ultimately affect one's science achievement, include sex-role models, sex-role stereotyping, and sex-role orientations. Educational factors which have been found to influence science achievement include parent, teacher, and peer expectations, classroom and extracurricular activities. A personal factor which may be related to girls' lower science achievement is spatial ability.

Sherman (1967) long ago suggested that children's sex-typed play behavior, i.e., the tendency for girls to play with one set of toys, while boys tend to play with another set, may contribute to the development of sex-typed spatial abilities. Several researchers have more recently noted that the sex-typed extracurricular activities of children may influence their sex-different science and mathematical achievements (Kelly, 1978; Fox, 1981; Skolnick, Langbort & Day, 1982; Kahle, 1983; Jacobson & Doran, 1985).

A child's sex-role orientation will help determine her/his choice of toys. Because toy preferences and playing habits are often sex-typed (see Tracy, 1987b for a review) and sex-role typed (Tracy, 1987a), it was hypothesized that some children's toy-playing habits (usually masculine) may promote the development of spatial ability (Serbin & Connor, 1977, 1979). In turn, this well-developed spatial ability will have a positive effect upon science achievement scores.

One portion of a child's total cognitive development is measured as her/his spatial abilities. Piaget and Inhelder (1967) suggest that a child's understanding of spatial abilities develops along a three-staged continuum including: (a) preoperational, (b) concrete operational, and (c) formal operational. Interestingly, Piaget did not ever concern his studies with sex differences; however, more recent studies show differences in spatial abilities to be partially dependent upon one's sex and sex-role orientation (Vaught, 1965 and Nash, 1975).

Use of some toys may promote the development of spatial abilities (Serbin and Connor, 1977, 1979). Toys which promote spatial abilities may do so because they provide concrete representations and manipulations of objects which children may be asked to mentally make, usually at school. If children do not have broad enough experiences with these concrete toys while at the elementary school level, their science achievement may be hindered as they are expected, by school teachers, to progress to an increased level of dependence upon spatial abilities in the middle and high school levels.

Limitations

Due to the correlational nature of this study, the results were limited in several ways. Although the degree of the relationships between variables were possible to identify, cause-and-effect relationships could not be made (Glass and Stanley, 1970). There was little control over the independent variables. Thus any interpretation of the data must be made in proper perspective. For example, two interpretations are possible for those students who show significantly higher science avhievement and who report playing with three-dimensional toys more than other children. This study cannot conclude whether students with high science avhievement, and perhaphs a high IQ or above-grade-level reading ability, like to play with some kinds of toys because they are "bright" or that their cognitive development is enhanced because of their play with some kinds of toys. However, the results from this study can be used to suggest further research which can be scrutinized in the future.

Procedure

Suburban, fifth-grade students participated in this investigation. A final sample size of 282 (139 girls and 143 boys) was used in the analysis of the data. Two-way and three-way analyses of variance were used to investigate the relationships of the variables: sex, sex-role, toy-playing behavior, spatial ability, and science achievement.

Four instruments were chosen for this study. Two instruments were well-established and nationally used. Science achievement was measured by the Iowa Tests of Basic Skills, Science subtest. Spatial ability was measured by the Spatial subtest of the Educational Assessment of Ability. The two remaining instruments were partially- and fully-developed by the researcher. Sex-role orientation was measured by a modified version of the Bem Sex-Role Inventory, Short Form. Toy-playing habits were measured by the Tracy Toy and Play Inventory.

Instruments

The original Bem Sex-Role Inventory (Bem, 1981) was designed to implement empirical research on psychological androgyny. The short form contains thirty personality characteristics. Ten of the characteristics are stereotypically masculine, (e.g., ambitious, self-reliant, independent) and ten are stereotypically feminine, (e.g., affectionate, gentle, understanding). Additionally, the Bem Sex-Role Inventory includes ten characteristics that serve as filler items (e.g., truthful, happy, conceited).

The modified Bem Sex-Role Inventory reflected two changes from the original. First, the seven point Likert-type scale was narrowed to a five point scale. Second, very short sentences were used in place of single-word adjectives for each item. For example, "affectionate" became "I am loving toward others" and "independent" became "I like to do things by myself." Although no validation data are available for the modified Bem Sex-Role Inventory, it did evolve after three drafts and reviews.

According to Bem (1981), a split-half median procedure is recommended for scoring the original Bem Sex-Role Inventory. Using this suggestion, the median scores were 2.90 on the masculine characteristics and 3.80 on the feminine characteristics. Students' scores were recoded so that they were placed into one of four categories: undifferentiated (low feminine-low masculine), masculine (high masculine-low feminine), feminine (high feminine-low masculine), or androgynous (high feminine-high masculine).

Students were also administered the researcher-developed, Tracy Toy and Play Inventory (TTPI). The development of this inventory came after four drafts and reviews. Six definitions were developed on the premise that some toys may promote spatial abilities or science achievement. From an original exhaustive list of 102 toys, 69 were successfully placed in the six categories by seven expert judges. Five of the seven judges (72%) had to agree with the placement of each toy in one of the six categories in order for it to be placed on the final draft of the TTPI. Table 1 lists the definitions for the six toy categories and the specific toy and its category.

For the Tracy Toy and Play Inventory, students were to respond on a five-point scale ranging from "Never Played" (1) to "Played Many, Many Times" (5), as to their perception of the time they estimated they had played with each toy. Students were to think of all the times they had played with a toy during their entire lifetime.

The reliability coefficients (a measure of homogeneity within each toy category) for each of the six constructs measured in the Tracy Toy and Play Inventory were: .70 for five two-dimensional items, .72 for nine three-dimensional items, .86 for 21 estimated-movement-with-a-target items, .78 for 14 gross-body-movement items, .85 for 15 proportional-arrangement items, and .76 for five science-activity items. The coefficent range (.70 - .86) indicated that children did not exclusively play with the toys from one category.

Results

The distribution of sex-role orientations is shown in Table 2. There were 38 cross sex-typed subjects. This small number of cross-sex-typed subjects was expected, although it is traditionally believed that there are more cross-sex-typed girls ("Tomboys") than cross-sex-typed boys ("sissies" or "Janegirls").

Using spatial ability (maximum score=15) as the dependent variable, a two-way analysis of variance (ANOVA) yielded a significant difference between girls' (X= 9.87) and boys' (X=11.30) spatial ability scores ($F(1,281)=12.60$, $p < .001$).

However, there was no significant difference among the spatial ability scores of students with different sex-role orientations. The two-way interaction did not reach significance as shown in Table 3.

Using science achievement (range=1.1 (first grade, first month) to 10.9 (tenth grade, ninth month) as the dependent variable, a three-way ANOVA yielded a significant difference between those students with high (X=6.93) and low (X=5.73) spatial ability ($F(1,281)=20.57$, $p < .001$). Science achievement was not significantly different according to sex or sex-role. No two- or three-way interaction reached significance.

A series of two-way ANOVAs were computed. Each ANOVA in the series made use of science achievement as the dependent variable and a toy category (two-dimensional, three-dimensional, estimated-movement-with-a-target, gross-body-movement, proportional-arrangement, and science-activity), sex-role and sex as the dependent variables. The results of the ANOVAs are shown in Table 4.

Post hoc analyses of any group differences using Scheffe multiple comparison methods ($p < .05$) indicated significant differences for two-dimensional toy-playing behavior as follows:

ULB (X=5.61) and FLB (X=8.42)

MLB (X=5.87) and FLB (X=8.42)

ALB (X=6.35) and FLB (X=8.42)

FHB (X=4.88) and FLB (X=8.42)

FLG (X=5.55) and FLB (X=8.42)

The F-ratios for each pairwise contrast are shown in Table 5.

Post hoc analyses of any group differences using Scheffe multiple comparison methods ($p < .05$) indicated significant differences for three-dimensional toy-playing behavior. Four pairs of means reached significance (three pairs at $p < 0.05$ and one pair at $p < 0.10$) after being subjected to the Scheffe method of comparison. The pairs were:

FH (X=7.50) and UH (X=5.64)

FH (X=7.50) and FL (X=5.54)

AL (X=7.02) and FL (X=5.54)

AL (X=7.02) and ML (X=5.61)

The F-ratios for each pairwise contrast are shown in Table 6.

Post hoc analyses of any group differences using Schefee multiple comparison methods indicated significant differences for gross-body-movement toy-playing behavior. Six pairs of means reached significance (five pairs at $p < 0.05$, one pair at $p < 0.10$) after being subjected to the Scheffe method of comparison. The pairs were:

ULB (X=5.52) and FLB (X=8.45)

MLB (X=5.78) and FLB (X=8.45)

ALB (X=6.33) and FLB (X=8.45)

FHB (X=6.03) and FLB (X=8.45)

FLG (X=5.14) and FLB (X=8.45)

FLG (X=5.14) and ALG (X=6.96)

The F-ratios for each pairwise contrast are shown in Table 7.

Post hoc analyses of any group differences using Schefee multiple comparison methods indicated significant differences for proportional-arrangement toy-playing behavior. Nine pairs of means reached significance (seven pairs at p

< 0.05, two pairs at $p < 0.10$) after being subjected to the Scheffe method of comparison. The pairs were:

ULB (X=6.07) and FLB (X=8.34)

MLB (X=5.81) and FLB (X=8.34)

FHB (X=6.17) and FLB (X=8.34)

FLG (X=4.42) and FLB (X=8.34)

FLG (X=4.42) and ALG (X=7.11)

FHG (X=6.41) and FLG (X=4.42)

AHG (X=6.74) and AHB (X=5.46)

MLB (X=5.81) and ALB (X=7.13)

ALB (X=7.13) and AHB (X=5.46)

The F-ratios for each pairwise contrast are shown in Table 8.

Discussion

Spatial Ability- This study measured "mental rotation," a type of spatial ability which required the subject to rotate a two-dimensional figure rapidly and accurately (Linn & Petersen, 1985). Measured at the $p < .05$ level, there was not a statistically significant difference in spatial ability among students with different sex-role-orientations (undifferentiated, masculine, feminine, and androgynous). Other researchers have found sex-role differences in spatial ability. In a spatial perception task and a spatial visualization task, Signorella and Jamison (1978) found that among girls, better performance was associated with a masculine sex-role orientation. Nash (1975) found that children with masculine sex-role orientations had superior spatial visualization skills. There are no reported findings for mental rotation tasks as they relate to sex-role. Thus the relationship between the two variables is unclear.

There was a significant difference among girls' and boys' spatial ability in this study. Boys had significantly higher spatial ability than girls. Within the category of mental rotation tasks, Signorella and Jamison (1978) and Wilson and Vandenberg (1978, cited in Linn & Petersen, p. 1483) found sex differences favoring males.

Although spatial skills have not been experimentally verified as a prerequisite to success in science instruction (Smith & Schroeder, 1981), a "logical relationship between spatial ability and some aspects of academic success exists" (Smith & Schroeder, 1981, p. 705). This study investigated the relationship between spatial ability and one form of academic success, science achievement.

Science Achievement- An important part of this study was the investigation of spatial ability and its relationship to science achievement. Results of this investigation showed a significant difference in the science achievement of students with differing spatial abilities. Those students with high spatial abilities also had high science achievement scores. Because of the correlational nature of this study, no cause and effect relationship can be determined here. It is not possible to determine whether students had high spatial ability as a result of high science achievement or if students had high science achievement as a result of high spatial ability. It may be that students with both high spatial ability and high science achievement have an above average IQ. Any of the three interpretations are possible based on the nature of the analysis of the data.

There was not a significant difference in the science achievement of girls and boys in this study. This finding conflicts with other researchers who have found significant differences in the science achievement of girls and boys (Comber & Keeves, 1973 cited in Erickson & Erickson, 1984; Erickson & Erickson, 1984, Jacobson & Doran, 1985; and Kelly, 1978). The instrument which measured science achievement in this study was not used in any of the aforementioned studies. Perhaps various instruments which measure science achievement are responsible for a portion of the sex-differentiated science scores throughout the educational literature.

No significant differences in the science achievement of students with differing sex-role orientations were found in this study. In the past, no research has been completed which investigated the relationship between these two variables. It was thought that students with a masculine sex-role would have had the opportunity to experience more extracurricular activities which may have promoted spatial ability and/or science achievement. Neither case could be made from the results of this study. However, when examining science achievement and the types of toys with which children played, an unexpected finding surfaced.

Two-dimensional toys- For boys, a feminine sex-role orientation appeared to be related to a high science achievement if the two-dimensional toy-playing behavior was low. Two-dimensional toys tended to be sex-typed for girls (Rheingold & Cook, 1975; and Morey, 1981), and femininely-oriented boys may have been allowed (by significant adults) or have allowed themselves to play with such toys. However, playing with two-dimensional toys (concrete manipulations of two-dimensional objects) may not challenge students who have high science achievement scores. They may be "bored" with these kinds of toys because they have reached a certain "mastery" of them. Thus, students with high science achievement scores may not have the desire to play with two-dimensional toys, rather they spend their time playing with other types of toys or doing other kinds of activities.

Three-dimensional toys- For femininely-oriented girls and boys, increased three-dimensional toy-playing behavior may be related to increased science achievement. Three-dimensional toys tended to be sex-typed for boys (Blomberg, 1981; Benbow, 1986; Rheingold & Cook, 1975; Feldstein and Feldstein, 1982). Thus masculinely- and femininely-oriented students who have been allowed (by significant adults) or have allowed themselves to play with such toys at a rate higher than a median playing rate, may be engaging in challenging activities. These challenging types of activities (concrete manipulations of three-dimensional objects which require the user to plan, visualize, coordinate complex operations to produce a desired result, and think strategically) may be related to the types of activities needed to reach high levels of science achievement. Since androgynous students' science achievement was above the mean regardless of three-dimensional toy-playing habits, they may not depend on three-dimensional toy-playing for gaining experience in science achievement.

Estimated-movement-with-a-target toys- It was thought that these toys would have provided students with activities which made use of space and required them to estimate the movement of an object so that it would strike a target. These types of activities may be related to the physical sciences (Jacobson & Doran, 1985), but in this study, no significant relationships resulted. With the advent of Title IX, both girls and boys engage in the majority of estimated-movement-with-a-target toys. These toys would not be considered sex-typed in the 1980s. Neither high nor low estimated-movement-with-a-target toy-playing habits were significantly related to science achievement as measured in this study.

Gross-body-movement toys- For boys, a feminine sex-role appeared to be related to a high science achievement if the gross-body-movement toy-playing behavior was low. Gross-body-movement toys did not tend to be sex-typed. Femininely-oriented boys may have been allowed (by significant adults) or have allowed themselves to play with such toys. However, playing with gross-body-movement toys (making use of space in a gross fashion) may not challenge students who have high science achievement and spatial ability scores. They may be "bored" with these kinds of toys because they have reached a certain "mastery" of them. Thus, students with high science achievement scores may not have the desire to play with gross-body-movement toys, rather they spend their time playing with other types of toys (maybe three-dimensional toys) or doing other activities such as reading and/or watching science-related television shows, thus increasing their science information levels.

For girls, a feminine sex-role orientation and low gross-body-movement toy-playing behavior was related to a science achievement which was significantly lower than boys with the same sex-role and playing behavior. These low science achieving girls may benefit from increasing their gross-body-movement activities until they reach a level of "mastery" of such activities. Once a level of "mastery" is reached, they could engage in activities (the results of this study suggest spending time playing with three-dimensional toys during play time) in which the low playing feminine boys participate. Androgynous students may not depend on gross-body-movement toy-playing for gaining experience in science achievement.

<u>Proportional-arrangement toys</u>- Femininely-oriented boys who reported high proportional-arrangement playing behaviors had significantly lower science achievement, compared to femininely-oriented boys with low proportional-arrangement toy-playing behavior. Proportional-arrangement toys tended to be sex-typed for girls (Rheingold & Cook, 1975; and Morey, 1981) and

femininely-oriented boys may have been allowed (by significant adults) or have allowed themselves to play with such toys. However, playing with proportional-arrangement toys (many "domestic" items) may not challenge students who have high science achievement and spatial ability scores, thus they may not have the desire to play with such toys; rather, they spend their time playing with other types of toys (maybe three-dimensional toys) or doing other activities such as reading and/or watching science-related television shows.

For girls, a feminine sex-role orientation and low proportional-arrangement toy-playing behavior was related to a science achievement which was significantly lower than boys with the same sex-role and playing behavior. These low science achieving girls may benefit from increasing their proportional-arrangement activities until they reach a level of "mastery" of such activities. Once a level of "mastery" is reached, they could engage in activities (the results of this study suggest spending time playing with three-dimensional toys during play time) in which the low playing feminine boys participate. Androgynous students may not depend on gross-body-movement toy-playing for gaining experience in science achievement.

Science-activity toys- It was thought that these toys would have provided students with activities which were directly related to science achievement. These types of toys may be related to the physical sciences (Jacobson & Doran, 1985), but in this study, no significant relationships resulted. These toys would be considered sex-typed. Neither high nor low science-activity toy-playing habits were significantly related to science achievement as measured in this study. However, high science-activity toy-playing approached significance (p = .08) and was related to high science achievement.

Recommendations

The results and conclusions of this study are relevant to classroom teachers, parents, university teacher educators, child and educational psychologists. Femininely-oriented boys who reported low-playing behaviors in all toy categories except three-dimensional toys, scored very well on the test of science achievement used in this study. This is a cross-sex-typed group. Historically, this group has not received wide acceptance from parents, teachers, and/or peers. Even in this decade, parents, teachers (Schlosser & Algozzine, 1980) and peers (Bridges & Del-Ciampo, 1981, and Sigelman, 1984) have been reluctant to accept cross-sex-typed boys with the same level of acceptance afforded masculinely-oriented boys. Negative feedback (in the form of pressure to conform to a masculine sex-role, i.e, not to act "like a girl or sissy") directed toward this group may be unfounded.

Historically, femininely-oriented girls were thought to be well-adjusted people. Parents, teachers (Schlosser & Algozzine, 1980) and peers (Bridges & Del-Ciampo, 1981 and Sigelman, 1984) tend to offer little negative feedback to girls who behave within the traditional set of feminine behaviors. Even so, femininely-oriented girls who reported low-playing behavior in all toy categories had very poor science achievement scores. The attitudes and behaviors which teachers and parents stress for girls may be intellectually stifling. Promoting androgyny in our girls may provide them with more opportunities for intellectual stimulation and development.

A summary of recommendations for students' toy-playing behaviors appears in Table 9. If high-playing behavior was significantly associated with high science achievement for girls or boys, then a recommendation to increase that toy-playing behavior was made for tha. group. If low-playing behavior was significantly associated with high science achievement, then a recommendation to decrease that toy-playing behavior was made for that group. If high-playing behavior was significantly associated with low science achievement, then a recommendation to decrease that toy-playing behavior was made for that group. If low-playing behavior was significantly associated with low science achievement, then a recommendation to increase that toy-playing behavior was made for that group.

Future experimental research (with increased toy-playing as a treatment) should examine the variables investigated in this study. Naturalistic studies should examine the relationship of sex-role orientation to science achievement and spatial ability. With new insights into these areas, parents, teachers, university instructors, educational and child psychologists may help to lessen the gap between girls' and boys' science achievements throughout school.

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Table 1

Toys and Their Category Definitions for the Tracy Toy and Play Inventory

Toys	Category Definition
Stickers Magnetic Alphabet Board Chalkboard Jigsaw Puzzles Spirograph	These toys require the user to make TWO-DIMENSIONAL (2D) representations or manipulations of reality either with or without directions. Jigsaw Puzzles and Magnetic Alphabet Boards are examples of Two-Dimensional toys.
Tinker Toys Erector Sets Wooden/Plastic Blocks Rubix Cube Airplane Models Model Cars Ship Models Lego Blocks Playdoh	These toys require the user to make THREE-DIMENSIONAL (3D) manipulations of the pieces either with or without directions. Model building and Lego Blocks are examples of Three-Dimensional toys.

Table 1 (cont'd)

Toys	Category Definition
Ping Pong Equipment Soccer Equipment Yard Darts/ Wall Darts Basketball Equipment Boomerang Video Games Baseball/Softball Equipment Football Equipment Tetherball Equipment Marbles Tennis Equipment Miniature Golfing Equipment Bowling Equipment Kickball Equipment Pool (billiards)	These toys require the user to manipulate, or <u>ESTIMATE</u> the <u>MOVEMENT</u> of, an object so that it hits another <u>TARGET</u> object (EMT) which is associated with the activity. The target may be still or moving. There may be gross- and fine body movements associated with these toys. Video Games and Croquet Equipment are examples of Estimated-Movement-with-a-Target toys.

Table 1 (cont'd)

Toys	Category Definition
Croquet Equipment	
Horseshoes Set	
Volleyball Equipment	
Baton	
Frisbee	
Badminton Equipment	
Ice Skates/	These toys require the user to make GROSS-BODY
Roller Skates	(GB) movements in order to accomplish the task for
Skateboard	which the toy was intended. No concern for a
Big Wheel	"target" (other than a self-imposed bodily
Bicycle/Tricycle	destination) is inherent in the related activity.
Jump Rope	These toys actually become an extension of the
Pogo Stick	users' own bodies. Ice Skates/Roller Skates and
Wagon	a Sled are examples of gross-body-movement toys.
Swing	
Skis	
Canoe	
Teeter-totter	
Stilts	
Row Boat	

Table 1 (cont'd)

Toys	Category Definition
Toy Tea Sets Toy Cars/Tracks Dress-Up Vanity Toy Farm Set Toy City Set Toy Zoo Set Electric Racecars Toy Cash Register Toy Picnic Set Toy Garage Electric Train Toy House Cleaning Set Dollhouse Medical Kit Toy Kitchen Items	These toys are played with and placed in PROPORTIONAL(P) arrangements or orientations along with other objects of the same scale. Electric Train Sets and Toy Zoo Sets are examples of Proportional-Arrangement toys.
Telescope Microscope Chemistry Set Rockets Electrical Kit	These toys are realistic enough to be included in an elementary classroom for the purpose of completing SCIENCE ACTIVITIES (SA). Microscopes and Electrical Kits are examples of Science Activity toys.

Table 2

Distribution of Sex-Role Orientations by Sex

	Sex	
Sex-Role	Girls	Boys
Undifferentiated	25	33
Masculine	17	55
Feminine	35	21
Androgynous	62	34

Table 3

Two-way ANOVA: Spatial Ability by Sex-Role and Sex

Source	S.S.	df	M.S.	F	Sig. of F
Main Effects	177.13	4	44.28	3.29	.01
SXRL	32.95	3	10.98	.82	.49
SEX	169.54	1	169.54	12.60	.00
Two-Way Int.					
SXRL SEX	69.56	3	23.19	1.72	.16
Explained	246.68	7	35.24	2.62	.01
Residual	3687.23	274	13.46		
Total	3933.91	281	14.00		

Note. SXRL = Sex-Role

Table 4

ANOVA F-Ratios: Science Achievement by Toy-Playing Categories, Sex-Role and Sex

	F(1,281)	F(7,274)	F(3,278)	F(15,266)
One-way				
2D	.54			
3D	.83			
EMT	.20			
GB	.42			
P	.35			
SA	3.16			
Two-way				
2D xSXRL		2.16		
3D xSXRL		4.03**		
EMTxSXRL		.90		
GB xSXRL		1.17		
P xSXRL		2.17		
SA xSXRL		.98		
2D xSEX			2.02	
3D xSEX			.28	
EMTxSEX			2.54	
GB xSEX			.82	
P xSEX			4.10*	
SA xSEX			.51	
Three-way				
2D xSXRLxSEX				3.16*
3D xSXRLxSEX				2.07
EMTxSXRLxSEX				.49
GB xSXRLxSEX				3.01*
P xSXRLxSEX				2.79*
SA xSXRLxSEX				.26

Note. * $p < .05$

** $p < .01$

Table 5

Scheffe Multiple Comparisons for Significant Three-Way Interaction in ANOVA: Science Achievement by Two-Dimensional Toy-Playing, Sex-Role and Sex

	F-ratio							
	UHB	ULB	MHB	MLB	FHB	FLB	AHB	ALB
UHB	-	1.05	.13	-	1.26	-	.41	-
ULB		-	-	.07	-	4.57**	-	.39
MHB			-	.22	.67	-	.07	-
MLB				-	-	4.67**	-	.21
FHB					-	3.56**	.38	-
FLB						-	-	2.39**
AHB							-	.04
ALB								-
UHG	.13	-	-	-	-	-	-	-
ULG	-	.07	-	-	-	-	-	-
MHG	-	-	.01	-	-	-	-	-
MLG	-	-	-	.07	-	-	-	-
FHG	-	-	-	-	.56	-	-	-
FLG	-	-	-	-	-	3.90**	-	-
AHG	-	-	-	-	-	-	.43	-
ALG	-	-	-	-	-	-	-	.12

Note. U = Undifferentiated; H = High Two-D
M = Masculine; L = Low Two-D
F = Feminine; B = Boys
A = Androgynous; G = Girls
.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 5 (cont'd)

	F-ratio							
	UHG	ULG	MHG	MLG	FHG	FLG	AHG	ALG
UHG	–	.11	.46	–	.03	–	.09	–
ULG		–	–	.08	–	.08	–	.39
MHG			–	.21	.01	–	.12	–
MLG				–	–	.00	–	.62
FHG					–	.26	.41	–
FLG						–	–	.80
AHG							–	.01
ALG								–

<u>Note</u>. U = Undifferentiated H = High Two-D
M = Masculine L = Low Two-D
F = Feminine B = Boys
A = Androgynous G = Girls
.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 6

Scheffe Multiple Comparisons for Significant Two-Way Interaction in ANOVA: Science Achievement by Three-Dimensional Toy-Playing, Sex-Role and Sex

	F-ratio							
	UH	UL	MH	ML	FH	FL	AH	AL
UH	–	.33	.67	–	2.03*	–	.50	–
UL		–	–	.37	–	.39	–	.51
MH			–	1.08	.69	–	.05	–
ML				–	–	.01	–	2.31**
FH					–	2.82**	1.31	–
FL						–	–	2.06**
AH							–	.65
AL								–

Note. U = Undifferentiated H = High Three-D
M = Masculine L = Low Three-D
F = Feminine
A = Androgynous
.95 F (7,267) > 2.03 ** .90 F (7,267) > 1.73 *

Table 7

Scheffe Multiple Comparisons for Significant Three-Way Interaction in ANOVA: Science Achievement by Gross-Body-Movement Toy-Playing, Sex-Role and Sex

	F-ratio							
	UHB	ULB	MHB	MLB	FHB	FLB	AHB	ALB
UHB	–	1.17	.26	–	.35	–	.35	–
ULB		–	–	.06	–	4.27**	–	.37
MHB			–	.25	.03	–	.01	–
MLB				–	–	3.55**	–	.18
FHB					–	2.03**	.01	–
FLB						–	–	1.73**
AHB							–	.01
ALB								–
UHG	.26	–	–	–	–	–	–	–
ULG	–	.26	–	–	–	–	–	–
MHG	–	–	.01	–	–	–	–	–
MLG	–	–	–	.02	–	–	–	–
FHG	–	–	–	–	.04	–	–	–
FLG	–	–	–	–	–	4.22**	–	–
AHG	–	–	–	–	–	–	.36	–
ALG	–	–	–	–	–	–	–	.20

Note. U = Undifferentiated H = High Gross-Body
M = Masculine L = Low Gross-Body
F = Feminine B = Boys
A = Androgynous G = Girls

.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 7 (cont'd)

	F-ratio							
	UHG	ULG	MHG	MLG	FHG	FLG	AHG	ALG
UHG	–	.00	.04	–	.02	–	.21	–
ULG		–	–	.15	–	.49	–	.47
MHG			–	.24	.01	–	.03	–
MLG				–	–	.07	–	.92
FHG					–	.76	.24	–
FLG						–	–	1.68*
AHG							–	.02
ALG								–

Note. U = Undifferentiated H = High Gross-Body
M = Masculine L = Low Gross-Body
F = Feminine B = Boys
A = Androgynous G = Girls
.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 8

Scheffe Multiple Comparisons for Significant Three-Way Interaction in ANOVA: Science Achievement by Proportional-Arrangement Toy-Playing, Sex-Role and Sex

	F-ratio							
	UHB	ULB	MHB	MLB	FHB	FLB	AHB	ALB
UHB	–	.00	.27	–	.00	–	.20	–
ULB		–	–	.08	–	2.90**	–	.78
MHB			–	.73	.22	–	.98	–
MLB				–	–	4.36**	–	1.51*
FHB					–	1.79**	.23	–
FLB						–	–	.71
AHB							–	1.71**
ALB								–
UHG	.01	–	–	–	–	–	–	–
ULG	–	.00	–	–	–	–	–	–
MHG	–	–	.28	–	–	–	–	–
MLG	–	–	–	.00	–	–	–	–
FHG	–	–	–	–	.03	–	–	–
FLG	–	–	–	–	–	5.46**	–	–
AHG	–	–	–	–	–	–	1.52*	–
ALG	–	–	–	–	–	–	–	.00

Note. U = Undifferentiated H = High Pro-Arr
M = Masculine L = Low Pro-Arr
F = Feminine B = Boys
A = Androgynous G = Girls
.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 8 (cont'd)

	F-ratio							
	UHG	ULG	MHG	MLG	FHG	FLG	AHG	ALG
UHG	–	.02	.02	–	.01	–	.13	–
ULG		–	–	.03	–	1.10	–	.75
MHG			–	.02	.07	–	.25	–
MLG				–	–	.59	–	.74
FHG					–	1.88**	.14	–
FLG						–	–	3.17**
AHG							–	.14
ALG								–

<u>Note</u>. U = Undifferentiated H = High Pro-Arr
M = Masculine L = Low Pro-Arr
F = Feminine B = Boys
A = Androgynous G = Girls
.95 F (15,259) > 1.69 ** .90 F (15,259) > 1.50 *

Table 9

Toy-Playing Recommendations as Related to Science Achievement

	Type of Toy					
	Two-D	Three-D	Est-M	Gro-B	Pro-A	Sc-A
			Girls			
Undif.	nr	nr	nr	nr	nr	nr
Masc.	nr	++	nr	nr	nr	nr
Fem.	++	++	nr	++	++	nr
Androg.	nr	nr	nr	nr	nr	nr
			Boys			
Undif.	++	--	nr	++	nr	nr
Masc.	++	++	nr	++	nr	nr
Fem.	--	++	nr	--	--	nr
Androg.	++	nr	nr	++	nr	nr

Note. Undif. = Undifferentiated
Masc. = Masculine
Fem. = Feminine
Androg.= Androgynous
Two-D = Two-Dimensional Toys
Three-D= Three-Dimensional Toys
Est-M = Estimated-Movement-with-a-Target Toys
Gro-B = Gross-Body-Movement Toys
Pro-A = Proportional-Arrangement Toys
++ = increase toy-playing behavior
nr = no recommendation
-- = decrease toy-playing