Journal of Educational Psychology
1979, Vol. 71, No. 2, 242-249

Predicting Mathematics Performance in High School Girls and Boys

Julia Sherman
WRI of Wisconsin, Inc., Madison, Wisconsin

Ninth-grade scores for 157 females and 148 males for three cognitive tests (Test of Academic Progress, Quick Word Test, and Space Relations Test of the Differential Aptitude Tests) and the eight Fennema-Sherman Mathematics Attitudes Scales were used to predict mathematics performance: grades in a second, third, and fourth year of theoretical math (latter, females only, $n = 30$) and scores of senior girls on the Mental Arithmetic Problems test ($n = 85$). Using multiple regression, ninth-grade scores significantly predicted mathematics performance 1-3 years later. Spatial visualization was an important variable, significantly predicting geometry grade for girls, but not for boys. Aside from math achievement, spatial visualization was the only other variable with a significant weight in predicting mathematical problem-solving scores for girls over a 3-year period.

In recent years increasing attention has focused on the importance of mathematics to the educational and career development of females (Astin, 1968; Astin & Myint, 1971; Carnegie Commission on Higher Education, 1973; Fox, Fennema, & Sherman, 1977; Goldman & Hewitt, 1976). A variety of cognitive and affective variables have shown significant concurrent relationships with mathematics achievement for both high school girls and boys. These factors have included general intelligence and/or verbal skill; spatial visualization; Confidence in Learning Mathematics; perceived attitude of Mother, Father, and Teacher toward one as a learner of mathematics; perceived Usefulness of Mathematics; Effectance Motivation in Mathematics (a kind of joy in problem solving); and for girls only, the extent to which mathematics is perceived as a sex-neutral, rather than a male, domain (Fennema & Sherman, 1977). With the last exception, correlations between math achievement and these variables have been similar for the two sexes in Grades 9-11, but in Grade 12, correlations for affective variables have been higher for girls.

Insofar as these variables have been studied by others, the results have been consistent (Aiken, 1971, 1972, 1973, 1974, 1976; Dwyer, 1974; Schildkamp-Kündiger, 1974; see also literature reviews in Fennema & Sherman, 1976, 1977). However, two results were particularly noteworthy (Fennema & Sherman, 1977). For both sexes, the correlation of spatial visualization with mathematics achievement (.48) was as high as the correlation between verbal skill as measured by vocabulary and mathematics achievement. While this finding was expected (Sherman, 1967), the importance of spatial visualization to mathematics performance has not always been appreciated (Very, 1967). Second, while several affective factors correlated with mathematics achievement, Confidence in Learning Mathematics correlated nearly as highly (.41) with mathematics achievement as did vocabulary and spatial visualization. The

This research was supported in part by a grant from the National Institute of Education. The opinions herein do not necessarily reflect the position or policy of the National Institute of Education, and no official endorsement should be inferred.

I wish to thank Kit Turen for assistance in collecting the data, Jim Allen for work in analyzing the data, Jess Frank for statistical advice, and Jeanne Gomoll for typing the manuscript. I am especially grateful to the students, parents, and school personnel who made this study possible.

Requests for reprints should be sent to Julia Sherman, 3917 Plymouth Circle, Madison, Wisconsin 53705.

influence of sex role[1] pressures on girls' mathematics performance was difficult to demonstrate, but some effects were shown.

Of even greater interest than demonstration of relationships with concurrent mathematics achievement is the prediction of future performance. Can cognitive and affective variables measured in the ninth grade predict mathematics performance in the tenth, eleventh, and twelfth grades? Will the relationships remain the same for the two sexes? Will spatial visualization predict mathematics performance? Will confidence (or indeed any other affective variable) predict future mathematics performance?

A further question of interest is the prediction of mathematical problem-solving skill. Will the same variables relating to and predicting mathematics achievement also predict mathematical problem solving? Mathematical problem solving can be defined as solving a problem involving mathematical ideas when one does not possess a standard solution, a skill thought to be particularly "problematic" for females (Maccoby & Jacklin, 1974). Finally, while previous research with this data set dealt with variables singly, the present study uses multivariate statistical techniques.

Briefly, the study reported here used data obtained from subjects in the ninth grade in 1975 to predict their grades in theoretical math courses in the tenth and eleventh grades (females and males) and in the twelfth grade (females only). In addition, the ninth-grade data were used to predict performance on a mathematical problem-solving test administered to a sample of twelfth-grade girls.

Method

Subjects

The subject pool consisted of students previously tested (in 1975) when they were in the ninth grade (Fennema & Sherman, 1977). These subjects were representatively selected by algebra class from all the public high schools (four) in a medium-sized midwestern city. Nearly all subjects were white; socioeconomic status ranged from lower class to upper middle class. In the 1977–1978 school year, an attempt was made to locate these students at the same high school. Of the original 413 students, 331 were located and agreed to participate in the study. Very few students refused to cooperate. Cognitive scores of the original group and the final group were similar. Subjects for the tenth-year analysis consisted of that portion of the sample who took geometry. Subjects for the eleventh- and twelfth-year analyses similarly represented portions of the sample who continued to a third or fourth year of theoretical math, respectively. Subjects for the problem-solving regression consisted of those girls from the sample who were enrolled in a fourth year of theoretical math (n = 30) plus approximately equal samples of girls who attempted two (or one) and three years of theoretical mathematics. These last two samples were selected so that they were not significantly different from the girls in a fourth year of theoretical math in either vocabulary (Borgatta & Corsini, 1964) or spatial visualization (Bennett, Seashore, & Wesman, 1973) as measured in the ninth grade. (The group was constituted in this way to facilitate comparison of attitudes among intellectually equivalent groups of subjects, data not reported here.)

Measures

The dependent variables included grades in Years 10, 11, and 12 and score on a math problem-solving test. Grades in theoretical math courses in the tenth, eleventh, and twelfth years were obtained (10th year, geometry; 11th year, Algebra–trigonometry or Precalculus; 12th year, Advanced Algebra, Calculus, Trigonometry, or Advanced Mathematics). Mathematical problem solving was measured by Mental Arithmetic Problems, Form AA, a test derived from the French kit of tests (Stafford, 1965). The test consists of 26 word problems. The task is to select the correct answer from nine choices. The test's reliability was .61 as measured by the Kuder–Richardson-21 formula (n = 85). From Grade 9 to 12, the stability coefficient for the same test form was .64 (n = 38). Three items were altered to make the test more even in sex-typed content; for example, *Juan* was changed to *Jane, football games* to *swimming matches*. A sample item from the test follows:

"How many pencils can you buy for 50 cents if they are 2 for 5 cents?" The answer choices were: ?, 2, 5, 10, 20, 25, 100, 125, 250.

The independent variables included three cognitive measures and eight affective measures. General intelligence and verbal skill were measured by the Quick Word Test, a vocabulary test which correlated .85 with Full-Scale Wechsler Bellevue IQ scores (Borgatta & Corsini, 1964). Spatial visualization was measured by the Space Relations Test of the Differential Aptitude Test (Bennett et al., 1973). Math achievement at the ninth-year level was measured by the Test of Academic Progress (Scannell, 1972). Eight affective variables

[1] The words *sex role* and *role* have been used because they are the most widely accepted terms. I am in agreement, however, with the growing dissatisfaction with the precision and appropriateness of these terms.

were measured by the Fennema–Sherman Mathematics Attitudes Scales, which consist of 5-point Likert-type scales of high reliability. Each scale has 12 items. The scales are Confidence in Learning Mathematics; perceived Usefulness of Mathematics; perceived attitudes of Mother, Father, and Teacher toward one as a learner of mathematics; Attitude toward Success in Mathematics; Mathematics as a Male Domain (ranging from low score, male, to high score, sex-neutral); and Effectance Motivation in Mathematics, a sort of joy in problem solving. Items on the Math as a Male Domain scale concern opinions that females cannot do math as well as males and/or that females who do well in math are peculiar or masculine. Fuller descriptions of the rationale of the scales and definitions of the concepts, the items, and relevant statistics can be found in Fennema and Sherman (1976). Low scores represent attitudes less favorable to learning math, though not necessarily for Math as a Male Domain for males.

Procedure

In 1975 subjects were tested in their own classrooms by trained male and female examiners during four classroom periods of subsequent weeks. Responses were recorded on National Computer Service answer sheets, which were scanned and scored by the Wisconsin State Testing Service and put on computer tape. In 1977–1978, subsequent grades were recorded, and the sample of senior girls was given the Mental Arithmetic Problems test at their own schools, sometimes individually and sometimes in small groups, depending on requirements of the school. Since, unlike the original testing procedure, answers had to be recorded on answer sheets, testing time was extended from 15 to 17 minutes. The grades and test scores were merged with the earlier data and analyzed by multiple regression techniques.

Results

The *n*s, means, and standard deviations for each variable for the analyses predicting grades in the tenth, eleventh, and twelfth years and predicting mathematical problem solving are given in Table 1. Except for the dependent variables, values given are as they were assessed in the ninth grade. Scores of subjects generally became higher (more favorable) as the groups became progressively more select, with one important exception. In ninth grade, girls subsequently enrolled in a fourth year of theoretical math showed *less* positive attitudes toward success in mathematics and stereotyped mathematics *more* as a male domain than did the overall groups of girls with two or three years of theoretical math.[2]

The raw score correlations between the dependent variables and each of the independent variables are presented in Table 2. For females in the tenth year, significant correlations were obtained for 10 of the 11 variables, compared with only 4 significant correlations for males. The following correlations were significantly higher for females than for males: math achievement, Math as a Male Domain, and Usefulness of Mathematics. (Except for the Father scale, all the rest of the differences between the correlations for the two sexes have a probability <.10, two-tailed test.)

For the eleventh year, many fewer significant correlations were found. For females, the ninth-grade affective variables related better to eleventh-grade performance than the cognitive variables. Significant correlations for females were found for Confidence in Learning Mathematics, Usefulness of Mathematics, and Effectance Motivation in Mathematics; for males, math achievement and Effectance Motivation. The correlations were not significantly different between the sexes.

For the sample of girls enrolled in twelfth-year theoretical math, ninth-year scores correlated significantly with twelfth-year mathematics grade for the following variables: math achievement, spatial visualization, and Effectance Motivation. For the broader sample of senior girls, significant correlations with mathematical problem solving (assessed in the twelfth year) were found for math achievement, Quick Word Test, spatial visualization, Confidence in Learning Mathematics, and perceived attitudes of Mother, Father, and Teacher toward one as a learner of mathematics.

In general, mathematics achievement showed significant correlations with dependent variables in five of six analyses, while spatial visualization, Confidence in Learning Mathematics, and Effectance Motivation in Mathematics showed significant relationships in four of six analyses. Also, relationships tended to be higher for females than for males.

The results of multiple regression analyses predicting tenth-year grade (geometry) and

[2] A complete discussion of the meaning of this finding is beyond the scope of this article, and it will be discussed in the context of interview material.

eleventh-year grade (third year of theoretical math) for females, males, and both sexes combined are presented in Table 3. Also presented are the results for females of the multiple regression analyses predicting twelfth-year grade and mathematical problem-solving scores.

The multiple correlation coefficients predicting geometry grade from ninth-year variables were significant for each sex and for both sexes combined. For females, mathematics achievement, Quick Word Test, spatial visualization, and Confidence in Learning Mathematics significantly predicted geometry grade; for males, mathematics achievement and Usefulness of Mathematics, weighted negatively, predicted geometry grade. An overall test of the difference between the sexes in regression coefficients was significant, $F(10, \infty) = 1.88$, $p < .05$. Considering only comparisons in which at least one of the standardized regression coefficients was significantly different from zero, the following coefficients

Table 1
Means and Standard Deviations for All Variables for All Analyses

Independent variable	Possible range	Analysis: 10th year Female	10th year Male	11th year Female	11th year Male	12th year[a]	Problem solving[a]
Math Achievement	0–48						
M		23.75	25.76	25.80	27.21	29.03	27.06
SD		7.61	7.36	7.46	6.99	7.98	7.19
Vocabulary	0–100						
M		57.65	59.85	61.12	61.25	64.57	65.04
SD		13.56	12.36	11.72	12.58	10.90	9.87
Spatial Visualization	0–60						
M		36.38	37.47	39.06	38.43	41.83	41.02
SD		9.80	10.23	8.47	10.36	8.48	7.81
Confidence in Learning Math	12–60						
M		43.28	44.76	45.26	46.40	48.37	43.66
SD		9.03	8.45	8.38	7.49	5.34	10.03
Mother	12–60						
M		44.29	46.45	45.89	47.01	46.23	45.48
SD		7.57	6.18	7.57	6.53	8.09	7.67
Father	12–60						
M		45.27	46.68	46.53	47.90	46.47	45.72
SD		7.55	6.90	7.81	6.49	9.18	8.12
Attitude toward Success in Math	12–60						
M		47.13	46.85	47.29	46.84	46.53	47.61
SD		6.66	6.10	6.59	5.88	6.37	6.25
Teacher	12–60						
M		42.55	43.41	44.42	44.02	44.80	43.39
SD		6.84	6.32	6.67	6.48	5.62	7.26
Math as Male Domain	12–60						
M		53.47	45.68	53.74	45.31	52.87	54.47
SD		5.63	7.91	5.78	8.20	5.71	5.12
Usefulness of Mathematics	12–60						
M		45.87	47.45	48.18	48.02	49.67	46.28
SD		8.83	7.68	7.71	7.45	6.49	8.90
Effectance Motivation in Math	12–60						
M		38.85	38.77	40.71	40.27	43.90	40.48
SD		9.00	7.70	8.29	7.38	6.25	8.26
Dependent variables[b]							
M		2.68	2.90	2.52	2.57	2.83	14.54
SD		1.14	1.06	.96	1.06	1.05	3.96
n		157	148	85	109	30	85

[a] Females only.
[b] Scores for grades in Years 10, 11, and 12 (possible range, 0–4) and for problem solving (possible range, 1–26).

Table 2
Correlations Between Dependent Variables and Independent Variables

Independent variable	Grade in 10 Female	Grade in 10 Male	Grade in 11 Female	Grade in 11 Male	Grade in 12[a]	Problem solving[a]
Math Achievement	.58**	.30**	.21	.21*	.51**	.57**
Vocabulary	.48**	.31**	.11	.14	−.02	.27*
Spatial Visualization	.44**	.26**	.16	.09	.44*	.33**
Confidence in Learning Math	.39**	.19*	.29**	.15	.28	.34**
Mother	.26**	.07	.11	.05	.36	.24*
Father	.23**	.13	.13	.09	.10	.26*
Attitude toward Success in Math	.13	−.07	.18	.08	−.06	−.03
Teacher	.36**	.15	.20	.16	.25	.37**
Math as Male Domain	.21**	−.05	.17	.14	.12	−.02
Usefulness of Mathematics	.25**	−.08	.23*	.09	.12	.16
Effectance Motivation in Math	.29**	.09	.31**	.19*	.39*	.13
n	157	148	85	109	30	85

[a] Females only.
* $p < .05$. ** $p < .01$.

were significantly higher for females: mathematics achievement, spatial visualization, and Confidence in Learning Mathematics. Usefulness was a significantly greater negative predictive factor for males than for females.

The multiple correlation coefficients for females and males predicting eleventh-year grades in mathematics were not significant; however the multiple correlation coefficient for both sexes combined was statistically significant. The highest standardized regression coefficient for both sexes was not a cognitive variable; rather, it was Effectance Motivation in Mathematics. No overall difference between the sexes was found in the standardized regression coefficients.

The multiple correlation coefficient predicting twelfth-year grade was not statistically significant ($p < .07$). One standardized regression coefficient, Attitude toward Success in Mathematics, was a significant negative predictor of twelfth-year grade. Among these 30 girls, the more they had

Table 3
Multiple Correlation Coefficients and Standardized Regression Coefficients Predicting Grades in 10th, 11th, and 12th Years and Mental Arithmetic Problems Test

Independent variable	Grade in 10 Female	Grade in 10 Male	Grade in 10 Both	Grade in 11 Female	Grade in 11 Male	Grade in 11 Both	Grade in 12[a]	Problem solving[a]
Math Achievement	.26**	.11	.18**	.09	.15	.13	.35	.42**
Vocabulary	.25**	.23**	.25**	.05	.04	.04	−.17	.07
Spatial Visualization	.21**	.12	.19**	.11	.03	.05	.03	.20*
Confidence in Learning Math	.22**	.09	.15*	.18	.02	.09	.06	.07
Mother	−.06	.06	.01	−.15	−.13	−.13	.25	.13
Father	−.03	.04	−.01	−.02	.04	.04	.21	−.03
Attitude toward Success in Math	.07	−.07	.01	.08	−.01	.03	−.56*	.01
Teacher	.13	.18	.12	.00	.03	.01	.34	.21
Math as Male Domain	.00	−.09	−.06	.02	.14	.06	.11	−.16
Usefulness of Mathematics	−.01	−.25*	−.11	.05	−.06	.00	−.51	−.09
Effectance Motivation in Math	−.01	−.02	.00	.21	.16	.17	.44	−.11
Multiple Correlation Coefficient	.69**	.46**	.56**	.41	.30	.32*	.75	.65**
n	157	148	305	85	109	194	30	85

[a] Females only.
* $p < .05$. ** $p < .01$.

"feared" success in mathematics as a ninth grader, the higher was their grade in mathematics in the twelfth year.

Mathematical problem solving was predicted at a statistically significant level by the ninth-grade variables, with math achievement and spatial visualization both being significant predictors.

In general, as in the case of the raw score correlations, the best ninth-grade predictor of future math performance was mathematics achievement. After geometry, neither vocabulary nor spatial visualization significantly predicted mathematics performance as measured by grade. However, spatial visualization did significantly predict girls' mathematical problem-solving scores in the senior year. Affective variables generally showed less predictive power.

Discussion

Perhaps some cautions regarding interpretation of the data are in order. In interpreting Tables 2 and 3, especially in comparing predictive power across years and types of dependent variables, the following comments should be kept in mind. The samples used to predict grades were smaller, more select, and homogeneous from the tenth to the twelfth years. The homogeneity would tend to shrink the size of correlations, and the smaller sample sizes would make it more difficult for a given result to reach statistical significance. In the eleventh and twelfth years the dependent variable was not the same for all subjects, since ninth-year scores were used to predict grades in one of several possible mathematics courses. This could have the effect of lowering predictive power. (The dependent variable for the tenth year was geometry grade for all subjects.) Note also that the twelfth-year regression for mathematical problem-solving test scores was based on more heterogeneous subjects than the twelfth (or eleventh) year regressions for grades.

However, ninth-grade cognitive and affective data did successfully predict later mathematics performance. As is commonly the case, when pitted against cognitive variables as in the regression analyses, affective variables were not generally very effective as predictors of performance. Perhaps more interesting is the fact that they showed as much predictive power as they did. Effectance Motivation in Mathematics, for example, had the highest standardized regression weight predicting eleventh-year mathematics grades for both girls and boys, and Confidence was a significant predictor of geometry grade for girls and both sexes together.

At first glance it is difficult to understand the significant negative weight of Usefulness of Mathematics in predicting the geometry grade of boys. A possible explanation is as follows: Geometry, to a greater extent than other high school math courses, tends to emphasize formal proofs and deemphasize applications. Therefore, it is not surprising that the Usefulness of Math scale should take a negative weight when used with math achievement in an equation to predict geometry grades. This explanation, however, does not explain why boys showed this reaction significantly more than girls.

An explanation which better fits the data rests upon the assumption that mathematics is seen as more crucially useful to males than to females. This fact is well documented (Fennema & Sherman, 1977). Thus poorer male math students may have expressed their dilemma (needing to achieve but not being able) by emphasizing their awareness of the usefulness of mathematics as they marked the scale. Instances in which *lower* achieving boys considered math as more useful than higher achieving boys have occurred in other data (Sherman & Fennema, 1977). Thus the negative weight may be due to the fact that the poorer students rated math as more useful.

A similar explanation may apply for the significant negative weight of Attitude toward Success in Mathematics measured in the ninth grade predicting twelfth-year grade in mathematics for girls. The motive to avoid success was hypothesized as operating especially among capable women with a strong achievement orientation (Horner, 1972). In essence, they are the ones who need to worry about it. In comparing other samples of girls scoring above the median in math achievement (Test of Academic

Progress) with those below the median, the better achievers were *not* more "fearful of success" (Sherman & Fennema, 1977). However, merely being above the median may not have been a sufficient index of intellect and achievement orientation to affect Attitude toward Success. As previously noted, in this sample, girls who continued to a fourth year of theoretical math were less positive toward success in mathematics than the general group of girls. In other words, the girls who were potentially the best performers in mathematics worried the most about success in mathematics. The high negative weight of Attitude toward Success becomes understandable in this context.

The sex-related differences in the standardized regression coefficients and correlations relating cognitive and affective variables and geometry grade contrast with the similarity for the two sexes of the concurrent correlations previously reported between these variables and performance on a math achievement test for Grades 9–11, though not for Grade 12 (Fennema & Sherman, 1977). In Grade 12, there was a similar tendency for affective variables to correlate higher with math achievement for girls than for boys. The difference between results of the present study and the previous study can be accounted for by a drop in the size of the male correlations. It is not clear why this should be the case.

Not surprisingly, in the multiple regression analyses, math achievement was the strongest predictor of future math performance. Grades, for example, also tend to be a strong predictor (Aiken, 1973).[3] More interesting is the fact that spatial visualization was a significant predictor both for geometry performance for girls and both sexes combined and for mathematical problem solving for senior girls. Spatial visualization was a significantly better predictor of geometry grade for girls than for boys. In contrast, verbal skill as measured by vocabulary did not predict geometry grade much better for girls than did spatial visualization; it did not predict differently for the two sexes, nor did it significantly predict girls' mathematical problem solving in the twelfth grade.

It had been hypothesized that because of sociocultural "roles" prescribed for the two sexes, females more often than males fail to have the requisite experiences to develop their spatial skills maximally and that this in turn might have unexpected ramifications in girls' mathematics learning (Sherman, 1967). A thorough discussion of this hypothesis is beyond the scope of this article, but some confirmation for the importance of spatial visualization to female mathematics performance may be seen in the present findings. In addition, results of discriminant analyses showed that among the factors differentiating the ninth-grade scores of this same subject pool as to whether they later took two, three, or four years of theoretical math, spatial visualization had the highest weight for females and the lowest weight for males (Sherman, Note 1).

It has now become clear that an X-linked genetic factor is not responsible for differences sometimes observed between groups of males and females in their spatial or mathematical performance (Sherman, 1978). These findings and the increasing weight of evidence pointing to the importance of spatial visualization to mathematics performance underscore the need for a better understanding of the development of spatial visualization and its relationship to education and female development. Further research is needed in this area and in delineating how sociocultural factors influence cognitive development of spatial and mathematical skills.

---

[3] Grade in ninth year was not included among the predicting variables even though it is a powerful predictor because the emphasis in this research was not on prediction of grade for practical purposes, but on understanding variables influencing math performance. Grade is a powerful, complex, "dirty" predictor, which works well for practical purposes but poorly for improving theoretical understanding.

Reference Note

1. Sherman, J. *Girls' and boys' enrollment in theoretical math courses: A longitudinal study.* Manuscript submitted for publication, 1978.

References

Aiken, L. R. Verbal factors in mathematics learning: A review of research. *Journal for Research in*

Mathematics Education, 1971, *2*, 304–313.

Aiken, L. R. Research on attitudes toward mathematics. *Arithmetic Teacher*, 1972, *19*, 229–234.

Aiken, L. R. Ability and creativity in mathematics. *Review of Educational Research*, 1973, *43*, 405–432.

Aiken, L. R. Two scales of attitude toward mathematics. *Journal for Research in Mathematics Education*, 1974, *5*, 67–71.

Aiken, L. R. Update on attitudes and other affective variables in learning mathematics. *Review of Educational Research*, 1976, *46*, 293–311.

Astin, H. S. Career development of girls during the high school years. *Journal of Counseling Psychology*, 1968; *15*, 536–540.

Astin, H. S., & Myint, T. Career development and stability of young women during the post high school years. *Journal of Counseling Psychology*, 1971, *19*, 369–394.

Bennett, G. K., Seashore, H. G., & Wesman, A. G. *Differential Aptitude Tests, Forms S and T* (4th ed.). New York: Psychological Corporation, 1973.

Borgatta, E. F., & Corsini, R. J. *Quick Word Test, Manual*. New York: Harcourt, Brace, 1964.

Carnegie Commission on Higher Education. *Opportunities for women in higher education*. New York: McGraw-Hill, 1973.

Dwyer, C. A. Influence of children's sex role standards on reading and arithmetic achievement. *Journal of Educational Psychology*, 1974, *66*, 811–816.

Fennema, E., & Sherman, J. Fennema–Sherman Mathematics Attitudes Scales. JSAS *Catalog of Selected Documents in Psychology*, 1976, *6*, 31. (Ms. No. 1225)

Fennema, E., & Sherman, J. Sex-related differences in mathematics achievement, spatial visualization and affective factors. *American Educational Research Journal*, 1977, *14*, 51–71.

Fox, L. H., Fennema, E., & Sherman, J. *Women and mathematics: Research perspectives for change*. Washington, D.C.: U.S. Government Printing Office, 1977.

Goldman, R. D., & Hewitt, B. N. The Scholastic Aptitude Test "explains" why college men major in science more often than college women. *Journal of Counseling Psychology*, 1976, *23*, 50–54.

Horner, M. S. Toward an understanding of achievement-related conflicts in women (In M. Mednick & S. Tangri (Eds.), *New perspectives on women*). *Journal of Social Issues*, 1972, *28*, 157–175.

Maccoby, E. E., & Jacklin, C. N. *Psychology of sex differences*. Palo Alto, Calif.: Stanford University Press, 1974.

Scannell, D. P. *Test of Academic Progress, Manual, Form S*. Boston: Houghton Mifflin, 1972.

Schildkamp-Kündiger, E. *Studien zur lehrforschung: Frauenrolle und mathematikleistung*. Düsseldorf: Schwann, 1974.

Sherman, J. Problem of sex differences in space perception and aspects of intellectual functioning. *Psychological Review*, 1967, *74*, 290–299.

Sherman, J. *Sex-related cognitive differences: An essay on theory and evidence*. Springfield, Ill.: Charles C Thomas, 1978.

Sherman, J., & Fennema, E. The study of mathematics by high school girls and boys: Related variables. *American Educational Research Journal*, 1977, *14*, 159–168.

Stafford, R. E. *Mental Arithmetic Problems* (Form AA). New York: Vocational and Educational Guidance Associates, 1965.

Very, P. S. Differential factor structures in mathematical ability. *Genetic Psychology Monographs*, 1967, *75*, 169–207.

Received July 17, 1978 ■