REVISIONS/REPORTS

Social Forces Shape Math Attitudes and Performance

Jacquelynne S. Eccles and Janis E. Jacobs

Debate has continued throughout the last decade over the existence and possible causes of differences between males' and females' mathematical skills. Several observations recur as the focus of this controversy. First, adolescent boys have been found to score higher than girls on standardized mathematics achievement tests.[1] Second, males are more likely than females to engage in a variety of optional activities related to mathematics, from technical hobbies to careers in which math skills play an important role.[2] Third, adolescent males typically perform better than their female

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1. See, e.g., Lynn Fox, Linda A. Brody, and Dianne Tobin, eds., *Women and the Mathematical Mystique* (Baltimore, Md.: Johns Hopkins University Press, 1980).

2. See, e.g., Lucy Sells, "The Mathematics Filter and the Education of Women and Minorities," and Dianne Tobin and Lynn Fox, "Career Interests and Career Education: A Key to Change," in Fox, Brody, and Tobin, eds., pp. 66–75, and 179–92, respectively; George Dunteman, Joseph A. Wisenbaker, and Mary Ellen Taylor, *Race and Sex Differences in College Science Program Participation* (Research Triangle Park, N.C.: Research Triangle Institute, 1979).

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counterparts on spatial-visualization tests.[3] Researchers have attributed these differences to a variety of hereditary and environmental factors without reaching a consensus about their origins.

A significant addition to this controversy came in a 1980 *Science* article by Camilla Benbow and Julian Stanley. Within a sample of highly gifted seventh- and eighth-grade children, the authors found that, on the average, boys scored higher than girls on the College Board's Scholastic Aptitude Test for Mathematics (SAT-M).[4] This difference was especially marked at the extreme upper end of the distribution. These data extend a pattern of commonly found sex differences to a select population of junior high school students and thus are neither surprising nor particularly novel.[5] What is novel, however, is Benbow and Stanley's interpretation of their data. They argue that "superior male mathematical ability" is the best explanation for the sex differences, since the boys and girls in their sample had essentially identical mathematics training prior to the seventh grade. Furthermore, they suggest that "superior male mathematical ability" is the probable cause of general sex differences in both mathematical achievement and attitudes toward math. These conclusions have sparked renewed controversy in the scientific community and a disturbing response in the mass media. This article questions Benbow and Stanley's underlying assumptions and presents data counter to their conclusions.

Benbow and Stanley base their argument on the following suppositions: (*a*) students' scores on the SAT-M are primarily a measure of their mathematical aptitude; (*b*) students who have taken similar formal educational courses in mathematics have had similar experiences with the discipline; and (*c*) a demonstrated sex difference in mathematical reasoning supports the conclusion that "less well-developed mathematical reasoning contributes to girls' taking fewer mathematics courses and achieving less than boys."[6] In her rebuttal to Benbow and Stanley, Alice Schafer concluded that taking the SAT-M as a measure of mathematical aptitude is unjustifiable. Moreover, Warner Slack and Douglas Porter and Rex Jackson have pointed out that the SAT measures acquired intellec-

3. See, e.g., Michelle Wittig and Anne Peterson, eds., *Sex-related Differences in Cognitive Functioning* (New York: Academic Press, 1979).

4. Camilla P. Benbow and Julian C. Stanley, "Sex Differences in Mathematical Ability: Fact or Artifact?" *Science*, no. 210 (December 1980), pp. 1262–64, esp. p. 1262.

5. Portions of these results have been reported in other sources. See, e.g., Lynn Fox and Sanford Cohn, "Sex Differences in the Development of Precocious Mathematical Talent," in Fox, Brody, and Tobin, eds., pp. 94–112, esp. p. 94; Lynn Fox and Daniel Keating, eds., *Intellectual Talent: Research and Development* (Baltimore, Md.: Johns Hopkins University Press, 1976). The reported pattern of sex differences, in fact, forms part of the collection of results researchers are now seeking to explain.

6. Benbow and Stanley, pp. 1264, 1262.

tual skills.[7] Thus, one must question Benbow and Stanley's assumption that the SAT-M measures mathematical aptitude. Furthermore, performance on timed tests is influenced by a wide variety of motivational and affective factors such as test anxiety, risk-taking preferences, cognitive style, and confidence in one's abilities. Since males and females differ on some of these factors, it is quite possible that the sex differences reported by Benbow and Stanley reflect these noncognitive differences rather than, or in addition to, true aptitudinal differences.

The authors' assumption that the boys and girls in their sample had equivalent mathematical experiences is also problematic. Assessing students' mathematical experiences is extremely difficult. Counting the number of mathematics courses the children have taken is only one possible method, feasible only if the sample is in secondary school. The fact that all the children in Benbow and Stanley's sample had completed the sixth grade does not support the inference that these students had equivalent formal educational experiences with mathematics. Concluding that their informal experiences were equivalent is even more suspect.

To justify such inferences one would need to develop appropriate measures of the quantity and quality of elementary school children's mathematical experiences and then test for sex differences on these measures. Using one such strategy, Gaea Leinhardt, Andria Seewald, and Mary Engel observed the formal teaching practices of thirty-three second-grade teachers and found that teachers spent relatively more time teaching mathematics to boys than to girls. Based on their results, in fact, boys may receive as much as thirty-six more hours of formal mathematics instruction than do girls by the time the children reach the seventh grade. Both Helen Astin and Lynn Fox and her colleagues have investigated participation in less formal activities related to mathematics. According to their studies, boys are more likely than girls to have informal, mathematically related experiences such as playing with scientific toys, participating in mathematical games, and reading mathematics books.[8] Thus, Benbow and Stanley's assumption that their boys and girls have had equivalent

7. Alice Schafer, "Sex and Mathematics," *Science*, no. 211 (January 1981), p. 392; Warner Slack and Douglas Porter, "Training, Validity, and the Issue of Aptitude: A Reply to Jackson," *Harvard Educational Review* 50, no. 3 (1980): 392–401. Rex Jackson, "The Scholastic Aptitude Test: A Response to Slack and Porter's 'Critical Appraisal,'" ibid., 50, no. 3 (1980): 382–91, esp. 382.

8. Gaea Leinhardt, Andria Seewald, and Mary Engel, "Learning What's Taught: Sex Differences in Instruction," *Journal of Educational Psychology* 71, no. 3 (1979): 432–39, esp. 432; Helene Astin, "Sex Differences in Mathematical and Scientific Precocity," in *Mathematical Talent: Discovery, Description, and Development*, ed. Julian Stanley, Daniel Keating, and Lynn Fox (Baltimore, Md.: Johns Hopkins University Press, 1974), pp. 70–86, esp. p. 70; Fox and Cohn, p. 94.

mathematical experiences is questionable, precluding definitive conclusions regarding the origin of observed differences on SAT-M scores.[9]

Benbow and Stanley's assumption that their data contribute new insights into the origins of sex differences in mathematical achievement and attitudes is also suspect. The authors in no way establish the power of SAT-M scores to predict a student's subsequent achievement in, attitudes toward, or course enrollment in mathematics. Other investigators have suggested that the link, if any, is weak. For example, Slack and Porter concluded that the SAT-M score is a poorer predictor of a student's mathematics achievement in college than either high school grades or a score on the SAT Mathematical Achievement test. In addition, in a follow-up of the 1976 cohort of Benbow and Stanley's sample, Lynn Fox and Sanford Cohn found no relation between the girls' SAT-M scores and their subsequent educational acceleration. Finally, Laurie Steel and Lori Wise found that although mathematical ability is a significant predictor of subsequent mathematics achievement and course enrollment, it does not account for the sex differences in either high school seniors' mathematics grades or their high school mathematics enrollment patterns.[10] Apparently variations in mathematical reasoning ability contribute little to variations in subsequent course-taking patterns among either the group of gifted girls studied by Benbow and Stanley or more representative samples of mathematically competent high school students.

Predictors of Math Achievement and Math Participation

What does predict the course-taking plans and achievement patterns of mathematically competent (as distinguished from gifted) junior high school students? Contrary to Benbow and Stanley's conclusion, our data suggest that social and attitudinal factors have a greater influence on junior and senior high school students' grades and enrollment in mathematics courses than do variations in mathematical aptitude. Further, our data suggest that sex differences in mathematical achievement and attitudes are largely due to sex differences in math anxiety; the gender-stereotyped beliefs of parents, especially mothers; and the value students attach to mathematics.

9. It is possible that sex differences in innate mathematical aptitude account for boys' greater interest in mathematically related activities. But it is impossible to discern the cause and effect relations among innate aptitude, interest, and subsequent skill without extensive longitudinal testing. Our critical point here is that one cannot assume equivalent mathematical experiences in a population of seventh-grade girls and boys.

10. Slack and Porter; Fox and Cohn, p. 94; Laurie Steel and Lori Wise, "Origins of Sex Differences in High School Math Achievement and Participation" (paper presented at the American Educational Research Association, San Francisco, March 1979).

Our conclusions are based on a two-year longitudinal study of 250 average and above-average students in the seventh through ninth grades, their parents, and their mathematics teachers. We gave questionnaires to the students in two successive years and examined their mathematics course grades and scores on a standardized achievement test (either the Michigan Educational Assessment Program or the California Achievement Test) for each year of the study. We also gathered questionnaire data from both parents and teachers.

We created our scales by applying exploratory factor analysis to the information in the student and parent questionnaires. Factor analysis is a statistical procedure whereby items are grouped together according to the similarity of respondents' answers. For example, because mothers and fathers gave similar estimates of their children's mathematical abilities, we grouped all questions regarding these estimates in one scale rather than analyzing those questions individually.[11]

Four parent factors emerged: mothers' estimates of the difficulty of mathematics for their children, fathers' estimates of the difficulty of mathematics for their children, both parents' estimates of their children's mathematical abilities, and both parents' estimates of the importance of enrolling in mathematics courses. Three student factors emerged: students' estimates of their own mathematical abilities, their estimates of the difficulty of mathematics, and their rating of the value of mathematics courses. We created three additional scales: one reflecting teachers' estimates of each student's mathematical ability, one reflecting each student's math anxiety, and one reflecting mathematical aptitude/achievement based on each student's previous year's mathematics grade and most recent score on a standardized test of math achievement.

We assume, based on arguments by Slack and Porter and others,[12] that the latter composite score is at least as good an estimate of mathematical aptitude as is the SAT-M score. To the extent that mathematics achievement scores reflect mathematical aptitude, this measure provides an estimate of individual differences in mathematical aptitude. Moreover, given that this score summarizes the performance information provided to students, parents, and teachers, it is also an indicator of the objective performance differences on which children, parents, and teachers base their estimates of an individual student's math potential and ability.

We entered each of these scores, along with the student's sex, into a multiple regression, recursive path analysis (see fig. 1). The total sample

11. See Karl Joreskog and Dan Sorbon, eds., *Advances in Factor Analyses and Structural Equation Models* (Cambridge, Mass.: ABT Books, 1979). Factor loadings can be obtained from the authors.

12. Slack and Porter, p. 392.

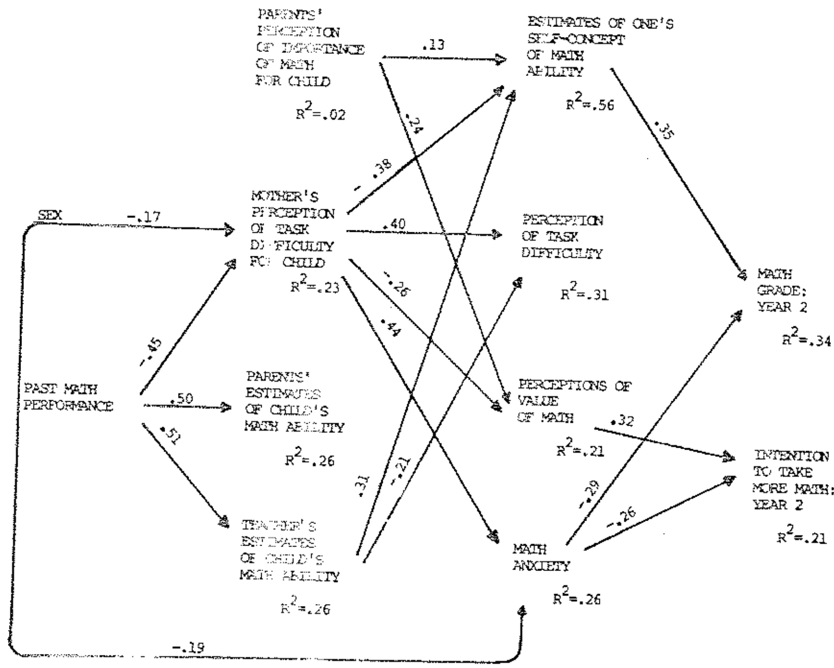

FIG. 1.—Longitudinal influences on students' mathematics course grades and future course enrollment plans.

size was 164 students, their parents, and their mathematics teachers. Path analysis is a statistical procedure used to assess the direct and indirect relations among a set of scales or variables. It allows us to estimate how strong the influence of one variable is on other variables. For example, it enables an estimate of the extent to which students' grades in sixth-grade mathematics courses influence their parents' estimates of their children's mathematical ability one year later. Path analysis also allows us to test predictions that students' grades in mathematics have an indirect, rather than direct, effect on their confidence in their own abilities and that parents' interpretations of the students' grades mediate this indirect effect.

Recursive path analysis estimates the direction of effects in only one direction; in figure 1, this direction is always left to right.[13] Only statistically significant paths are depicted in this chart. To make it easier to interpret the direction of impact of these paths, we placed our scales in

13. We did not test for effects in the reverse direction, and we did not test for relationships between variables within a given column. We believe such effects exist but did not test for them in this analysis.

four columns, left to right, representing the chronological sequence in which we collected the data. Variables in the column on the far left reflect scales of students' mathematical performance prior to entry into our study, as well as their sex. Variables in the second column are parent and teacher scales gathered in the first year of our study.[14] With the exception of math anxiety, the variables in the third column are student attitudinal scales based on questionnaires distributed in the first year of our research; math anxiety is a student belief scale gathered in the second year. Variables in the fourth column on the far right represent students' grades and course-taking plans gathered during the study's second year. We estimated all possible paths across columns.[15]

Standardized column-wise multiple regression equation procedures were used to estimate path coefficients. At each step, each of the variables in one column was regressed on the set of all variables in the columns to the left. This procedure yields standardized path coefficients, reflecting the relative predictive power of each variable in comparison to all other variables. These coefficients, printed on each path, can vary from -1 to $+1$.

A high path coefficient (either positive or negative) reflects a relatively strong relationship. A positive path coefficient means that high scores on the variable to the left predict high scores on the variable to the right. Conversely, a negative path coefficient means that low scores on the variable to the left predict high scores on the variable to the right. We entered sex as a dummy variable, with females equal to 1 and males equal to 2. Thus, the two weak negative path coefficients on the paths leading from the sex variable indicate that females have slightly higher scores on the two related variables; that is, females have slightly higher math anxiety scores, and girls' mothers rate mathematics as slightly more difficult for their children than do boys' mothers.[16]

We used t-tests to calculate the significance of each path coefficient. The R^2 value printed below each scale represents the percent of variance in a measure that is explained by the variables to its left. A large R^2 value

14. Fathers' estimates of the difficulty of mathematics for their children did not contribute to the prediction of students' mathematics achievement or their course enrollment plans. Including these estimates in the analysis reduced the sample size considerably. Thus this variable is omitted from all our analyses reported here. Fathers' effects in this data set appear to be redundant with, but less powerful than, mothers' effects.

15. Using variables from different years strengthens our conclusions about the direction in which the variables in the columns affect each other but does not rule out the possibility that effects can occur in the opposite direction as well.

16. Specification of the path model, i.e., assignment of variables to particular columns, was based on the theoretical model in Jacquelynne Eccles (Parsons) et al., "Expectations, Values, and Academic Behaviors," in *Achievement and Achievement Motivation*, ed. Janet Spence (San Francisco: W. H. Freeman & Co., 1983), pp. 75–146.

indicates that we can predict more about that variable using the variables to its left than we can predict about variables with lower R^2 values.

Grades and plans to continue taking mathematics are predicted most directly by the students' beliefs listed in the third column: their estimates of their mathematical abilities, their perceptions of the value of mathematics courses, and their levels of math anxiety. These student beliefs, in turn, are related most strongly to the students' mothers' beliefs concerning the difficulty of mathematics for their children. Parents' estimates of the importance of mathematics courses for their children and teachers' estimates of each student's mathematical ability also predict some of the students' beliefs.

What does this analysis tell us about boys' and girls' attitudes toward mathematics and their enrollment decisions? To answer this question we need to consider the results of the path analysis in conjunction with the pattern of correlations between the important variables. A correlation is a statistical coefficient (signified by an r value) that indicates the strength of the relationship between two variables; it does not take into account any other variables or possible mediating effects. Like standardized path coefficients, correlation coefficients can range from -1 to $+1$; the higher the number (either positive or negative), the stronger the relationship between the two variables. The closer the coefficient is to zero, the weaker the relationship. A correlation coefficient of zero indicates no relationship between the two variables. In the discussion that follows, we will include the relevant correlation coefficients whenever they aid the interpretation of the path analysis and enhance our understanding of boys' and girls' attitudes toward mathematics.

The path analysis suggests that a student's performance in mathematics has an indirect effect on that student's attitudes toward mathematics and subsequent mathematics grades. While past mathematics aptitude/achievement scores are related both to a child's subsequent mathematics grades ($r = .40$) and course enrollment plans ($r = .17$) these relationships appear to be mediated by mothers' and teachers' beliefs, by students' estimates of their mathematical abilities, and by students' beliefs about the value of mathematics. Thus, students' grades appear to affect subsequent mathematics performance and course-taking plans only to the extent that these grades influence both parents' confidence in their children's ability to learn mathematics and students' own beliefs, motivation, and math anxiety. Furthermore, the influence of past grades on students' beliefs appears to be mediated by the parents' interpretation of these grades. Finally, when one compares the correlations between girls' and boys' estimates of the value of mathematics and objective indicators of their mathematical ability, an interesting difference emerges. Boys' estimates of the value of mathematics are related to their past performance in mathematics ($r = .33$) and to both their teachers' and parents' estimates of their mathematical ability ($r = .33$, $r = .28$). In contrast, girls' estimates of the value of mathematics are not related to any of these measures ($r = .06$, $r = .03$, and $r = .06$, respectively). Thus, a student's mathematical aptitude, as measured in this study, can serve only as an indirect predictor of that child's attitudes toward mathematics, future mathematics achievement, and course-enrollment plans. Social and attitudinal factors appear to have much stronger direct effects on these beliefs and plans, especially among girls.

Math anxiety also appears to be an important predictor of both subsequent mathematics grades and course-taking plans, and girls report higher levels of this anxiety than do boys. These results are especially interesting in light of three additional relations. First, in this sample of mathematically competent students, math anxiety is only weakly related to the students' previous performance in mathematics ($r = -.17$). Consequently, the individual variations in math anxiety are not primarily a consequence of objective differences in performance. Second, math anxiety has a stronger and more direct relation to mathematics grades and to students' future plans for taking math courses than does our mathematical aptitude/achievement score. Third, math anxiety is directly and strongly influenced by social factors, in particular by mothers' beliefs about the difficulty of the subject for their children. Thus, math anxiety appears to be a key social/attitudinal variable that might account for sex differences in achievement and enrollment in mathematics courses. Furthermore, given the common finding that anxiety has a debilitating effect on children's scores on standardized achievement tests,[17] one must ask whether the sex differences in math anxiety are strong enough to explain most of the variance in the SAT-M scores that Benbow and Stanley attribute to superior male mathematical ability.

The results of our path analysis also point out parents' importance as central socializers of sex differences in mathematical achievement and attitudes. While teachers' beliefs are predictive of students' beliefs, teachers in our study estimated that boys and girls had similar mathematical ability. In addition, the impact of teachers' beliefs is not as large as that of parents' beliefs and does not have a direct effect on students' plans to continue taking mathematics. These data suggest that parents' gender-stereotyped beliefs are a key cause of sex differences in students' attitudes toward mathematics.

17. Kennedy Hill, "The Relation of Evaluative Practices to Test Anxiety and Achievement Motivation," *Educator* 19, no. 15 (1977): 15–22; Diane Ruble and Anne Boggiano, "Optimizing Motivation in an Achievement Context," in *Advances in Special Education*, ed. Barbara Keogh (Greenwich, Conn.: JAI Press, 1980), pp. 183–238.

Although it could be argued that parents' gender-stereotyped beliefs about the difficulty of mathematics for their children are veridical, reflecting a real sex difference in children's behaviors, the following additional results suggest that this is not the case. First, girls and boys in this sample had equivalent mathematics grades and standardized math test scores at the start of the study. Second, when asked how much math homework they do, the boys and girls reported equivalent amounts. Third, the teachers' estimates of these girls' and boys' mathematical abilities did not differ. And finally, mothers who endorsed the gender stereotype that boys do better than girls in advanced high school mathematics courses thought that math was harder for their daughters than did the mothers who believed that girls and boys can do equally well in advanced math courses. Thus, the gender stereotypes evident in mothers' and fathers' beliefs do not appear to be grounded in reality. The extent to which they reflect a "real" sex difference in mathematical aptitude remains to be demonstrated.

Thus, Benbow and Stanley's conclusion that sex differences in attitudes toward and achievement in mathematics may result from "superior male mathematical ability" is premature at best. Although the authors may favor a biological explanation, their data do not provide a test of that hypothesis.

Further, one must be concerned about the effect their conclusion may have on girls' future mathematical achievement and attitudes. This concern is especially justified given the distortion of Benbow and Stanley's findings by the popular media (see fig. 2) and the strong influence parental beliefs about mathematical ability have in shaping girls' attitudes toward math and their actual achievement. This is not to say that we should rule out the possibility of biological influences on mathematics competence. Biological processes may be important. But the nature, the magnitude, and the malleability of these factors are not yet understood. Our data suggest that, at present, social factors are a major cause of sex differences in both mathematics performance and attitudes toward math in the population at large. And, as noted above, the extensive and biased coverage of the Benbow and Stanley article in the mass media may have provided yet one more social force discouraging female participation in mathematics-related courses and career fields. This is the issue we will now address.

Impact of Media Coverage

Since we were in the midst of a longitudinal study of the socialization of girls' and boys' attitudes toward math when the Benbow and Stanley story broke, we were in a unique position to assess the impact of the media

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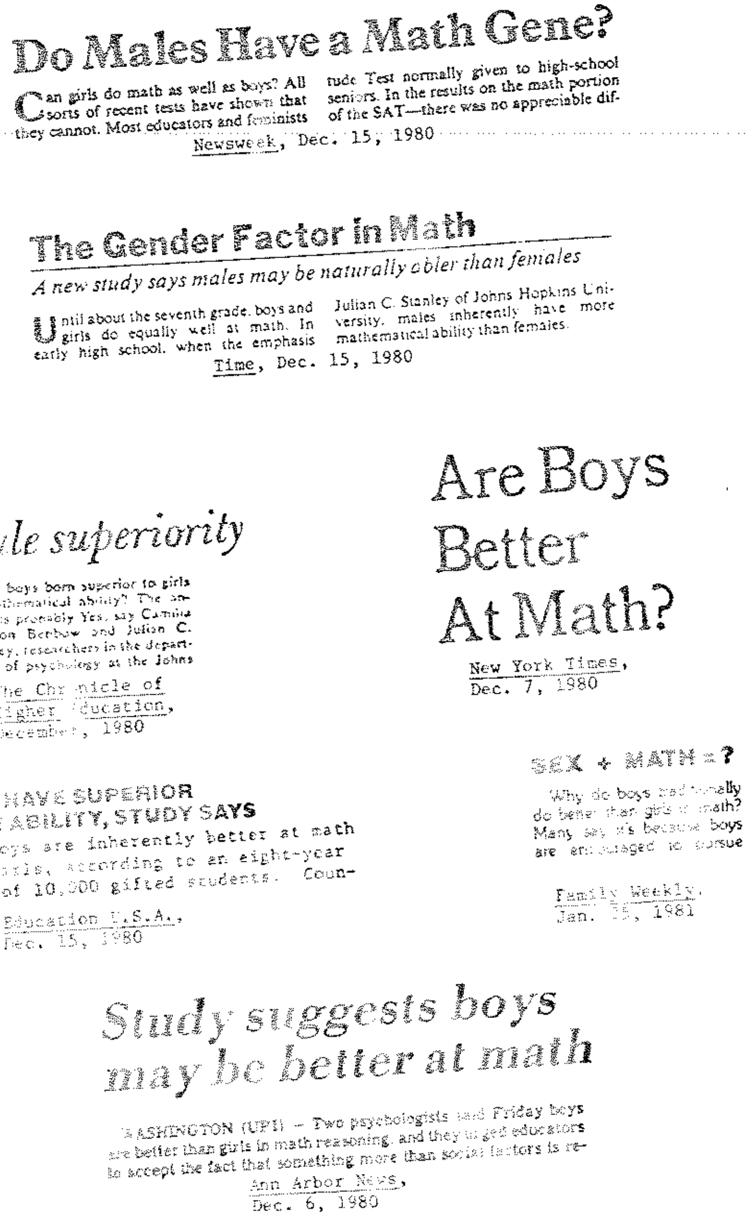

Do Males Have a Math Gene?

Can girls do math as well as boys? All sorts of recent tests have shown that they cannot. Most educators and feminists ... tude Test normally given to high-school seniors. In the results on the math portion of the SAT—there was no appreciable dif-

Newsweek, Dec. 15, 1980

The Gender Factor in Math

A new study says males may be naturally abler than females

Until about the seventh grade, boys and girls do equally well at math. In early high school, when the emphasis ... Julian C. Stanley of Johns Hopkins University, males inherently have more mathematical ability than females.

Time, Dec. 15, 1980

Male superiority

Are boys born superior to girls in mathematical ability? The answer is probably Yes, say Camilla Persson Benbow and Julian C. Stanley, researchers in the department of psychology at the Johns

The Chronicle of Higher Education, December, 1980

Are Boys Better At Math?

New York Times, Dec. 7, 1980

BOYS HAVE SUPERIOR MATH ABILITY, STUDY SAYS

Boys are inherently better at math than girls, according to an eight-year study of 10,000 gifted students. Coun-

Education U.S.A., Dec. 15, 1980

SEX + MATH = ?

Why do boys traditionally do better than girls in math? Many say it's because boys are encouraged to pursue

Family Weekly, Jan. 25, 1981

Study suggests boys may be better at math

WASHINGTON (UPI) — Two psychologists said Friday boys are better than girls in math reasoning, and they urged educators to accept the fact that something more than social factors is re-

Ann Arbor News, Dec. 6, 1980

Fig. 2.—News report headlines of Benbow and Stanley's *Science* article

campaign on parents' stereotypes and beliefs regarding their children's mathematical ability.[18]

We sent the parents in our sample a questionnaire similar to our original one about three months after the research report appeared in *Science*. We added a question, placed on the last page of the form, which described the media coverage of the research and asked if parents had heard about it. Approximately one-quarter of the responding parents (57 out of 200) said yes. While most of these had read about the study in either a magazine or a newspaper, many indicated that they had heard about the report from several sources. We compared the responses of parents who had read the media reports (referred to as the misinformed group) to the responses of those who had not (referred to as the uninformed group).[19]

We first assessed the impact of the media exposure on parents' attitudes about their children's mathematical abilities. The result was different for mothers and fathers. Compared to estimates made by uninformed mothers of girls, responses by misinformed mothers of girls indicated that they felt their daughters had less mathematical ability, would have less success in future math courses, would find mathematics more difficult, and would have to work harder in order to do well in math courses. In addition, the misinformed mothers of girls thought that mathematics was much more difficult for their daughters than did the misinformed mothers of boys. In contrast, uninformed mothers of both girls and boys had similar beliefs about their children's mathematical abilities.

Fathers responded quite differently. Generally, the fathers of girls felt that their daughters had slightly less mathematical ability than did the fathers of sons. However, misinformed fathers of girls were more positive about their daughters' mathematical abilities after reading the media coverage than they had been before reading the reports. In contrast, uninformed fathers of girls had come to feel that their daughters had less mathematical ability than they had estimated one year earlier.

We next assessed the impact of the media reports on parents' stereotypes regarding the utility of mathematics for boys and girls in general. We also asked parents how useful they felt the study of mathematics was for their child. In response to the first question, both misinformed and uninformed mothers felt that math was more useful for males than for females, regardless of the sex of their child. In addition,

18. For more details, see Janis Jacobs and Jacquelynne Eccles, "Gender Differences in Math Ability: The Impact of Media Reports on Parents," *Educational Researcher* 14, no. 3 (1985): 20–25.

19. In order to test the hypothesis that parents in the misinformed group and those in the uninformed group may have had significant differences unrelated to their media exposure, analyses of variance were performed on all pretest variables including the two groups' demographic and attitudinal variables. The parents were similar on all of these measures.

the mothers' beliefs had become more gender-stereotyped in the year following our first survey. They now rated math as even more useful for males in their adult lives than they had earlier.

A slightly different pattern emerged for fathers. When fathers were talking about their own children, fathers of sons rated mathematics as more useful for their child than fathers of daughters. In addition, misinformed fathers of sons felt that math was more useful for their sons than did the uninformed fathers of sons. When asked about the usefulness of math for males in general, the misinformed fathers of sons stood out from the other parent groups even more distinctly: they thought mathematics was *much* more important for males than for females. It appears that exposure to the media coverage increased the gender-stereotyped attitudes of fathers of sons.

In summary, media reports of the Benbow and Stanley article did appear to change parents' attitudes. The effect, however, depended on both the sex of the parent and the sex of the child. Misinformed mothers had their gender-stereotypic beliefs confirmed regarding the difficulty of math for females and its comparative ease for males. In contrast, misinformed fathers of girls became more confident in their daughters' mathematical abilities. Unfortunately, while the misinformed fathers of girls came to the defense of their daughters' math abilities, misinformed fathers of boys responded quite differently. They became even more convinced than their uninformed counterparts of the validity of the broader gender stereotypes regarding mathematics abilities. They felt that females in general do not perform as well as males in advanced math classes and that mathematics is more useful to males than to females.

These findings are not surprising. We know that the salience of any event determines how it will be interpreted and remembered. We would expect parents of mathematically able daughters to interpret the news of superior male mathematical ability very differently from parents with sons, and mothers to interpret it differently from fathers. In this case, it appears that exposure to media reports confirmed mothers' beliefs that their daughters are not as able in mathematics as are their sons, while it put fathers of girls in a position of challenging the "evidence" on behalf of their daughters. For fathers the opposite happened for variables measuring general gender stereotyped beliefs. Fathers of sons had their gender-stereotyped beliefs confirmed and strengthened although their beliefs about their own children did not change.

Conclusions

Our research suggests that sex differences in students' attitudes toward mathematics and in plans to continue taking math courses are influenced substantially by their parents' perceptions of the difficulty of mathematics for their child and by their own attitudes about the value of mathematics. Furthermore, parents' beliefs, especially mothers' beliefs, appear to have a greater influence on students' attitudes than do students' mathematics grades. Doris Entwisle and D. P. Baker recently reported a similar result for children in grades one through three.[20] Although the girls and boys in their study had received similar grades in mathematics and similar scores on a math aptitude measure, the boys had higher expectations for their mathematics performance than did the girls. This sex difference seemed to stem from the different expectations parents held for their sons and for their daughters. Finally, our results suggest that media reports attributing sex differences in mathematics to innate or biological factors have a negative impact on mothers' confidence in their daughters' math abilities.

Even though parents in general held stereotypic beliefs, many parents of daughters spoke of the need to change stereotypic views of women and mathematics. One mother summed up this position succinctly when she said, "For whatever reason, boys in general *seem* to pick up math concepts with more ease and less methodical study. There are exceptions, however, and I would not want *my* daughter to feel she could not do equally well in math as her brothers." She continued, "Perhaps society has encouraged boys in math more than girls. I hope it is changing."

We too hope it will change but fear that change will be very slow, especially given the prevailing biases that influence what is spotlighted and what is ignored in national news coverage. In the meantime, we, as feminists, parents, and teachers, need to do all we can to support and encourage girls in their efforts to develop interests in math and science. In this area, passive nondiscrimination is simply not an adequate intervention strategy.

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20. Doris Entwisle and D. P. Baker, "Gender and Young Children's Expectations for Performance," *Developmental Psychology* 19, no. 2 (1983): 200–214, esp. 200.