Why Do Boys Do Better in *Math?*

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IT FLIES IN THE FACE OF POLITICAL correctness, but, like it or not, the facts speak for themselves. Men are better than women when it comes to math and science. Yes, there are exceptions, the Madame Curies of the world, but the naked facts are these: Men receive three of every four doctoral degrees awarded in the mathematical sciences and two of every three degrees earned nationwide in science and engineering.

The pattern is established well before college. Studies of youngsters in the eighth to 12th grades show boys outscoring girls by a ratio of 7-to-1 at the highest levels in math and science tests. And it goes on. Boys beat girls by 50 to 60 points on the Scholastic Assessment Test (SAT) and by a whopping 80 points in the math portion of the Graduate Record Examination (GRE). Ninety-six percent of all perfect scores received on the math-SAT are earned by males.

So what gives? Any self-respecting '90s woman will tell you she's every bit as smart as that man over there, yet few are living up to it, math- and science-wise. Are women really equal in this arena? Or are men somehow biologically, innately superior?

Few questions divide educators like this one. Most will tell you women are equally capable of sophisticated mathematical and scientific thought. If they don't succeed at the level men do, it's because parents and teachers—society as a whole—haven't encouraged them. In effect, America is socializing its daughters to fail, resulting in a narrower range of opportunities.

But others take the more controversial view that male mathematical superiority is largely biological. This approach is grounded in the belief that the male brain architecture gives boys an edge in visuospatial cognition, which enhances some forms of mathematical thinking.

Among the advocates of this position is MU's David Geary, associate professor of experimental psychology and author of the 1994 book, *Children's Mathematical Development*. Geary studies individual, developmental, cross-cultural and gender differences in numerical skills. His work won an Excellence in Intelligence Research Award from the Mensa Education and Research Foundation in 1992.

"It's simply wrong to argue that sex-based differences in mathematical achievement are solely socialized," Geary says. "People like to believe that because socialization is controllable. The notion is comforting, but that doesn't mean it's statistically valid."

Geary doesn't suggest boys have a "math gene" that predisposes them to outperform girls. Instead, he says, "The male advantage in mathematical problem-solving is a combination of cognitive, psychosocial and biological factors."

The biological edge, Geary says, is related to visuospatial cognition. He defines the term as the type of thinking that allows a person to navigate three-


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dimensional space. This advantage gives boys an intuitive understanding of some mathematical concepts, Euclidean geometry for example, that girls just don't have to the same degree.

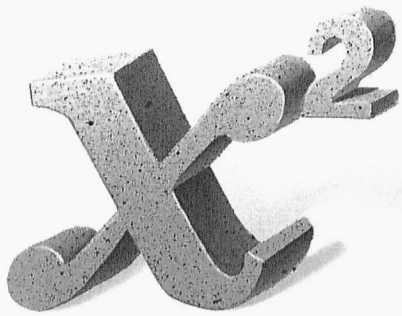
"There is a strong biological foundation for male-female differences in spatial abilities and navigational skills," Geary says. "This is true for most mammals. And though the definitive study of brain structure and math skills hasn't been done, there are sex differences in the functional organization of the left and right hemispheres of the brain that account for this superiority in visuospatial abilities."

The biological explanation is reinforced, Geary says, by research in laboratory animals and humans showing that females with unusually high levels of male hormones have better spatial skills than normal females, even their own sisters.

But suggest the biology theory to Jack Price, president of the National Council of Teachers of Mathematics, and he responds with a Bronx cheer.

"Girls in this country have been socialized not to do well in math," says Price, who also is co-director of the Center for Education and Equity in Mathematics, Science and Technology at California Polytechnic. "The only place heredity and biology figure in is in the attitudes of the home. Often a girl's parents don't feel she should be going into math or science, and they don't encourage her. But when stereotypes are broken and broken early, we do find women going into non-traditional occupations."

Price does acknowledge, however, that boys and girls learn differently. Take mathematical word problems, for example. Boys, he says, favor deductive reasoning, or a top-down kind of thinking in



which they read the problem, identify the relevant principle and then hunt a solution. Girls, meanwhile, tend to use inductive thinking, or a bottom-up strategy, in which they try to establish a pattern before seeking a solution. The public schools have taught math and science as deductive processes, giving boys the advantage, Price says.

Rich Lapan, MU associate professor of educational and counseling psychology, agrees with Price. Lapan says inequities won't go away without deliberate, educational intervention. Specifically, girls in grades six to nine need to be taught about the importance of math and science education.

"Girls don't get into math and science because they don't see these subjects as relevant to their future. They still experience a conflict about pursuing traditionally male careers. As a consequence, girls are much more likely than boys to close off a number of options prematurely. We need to help our daughters understand that it's OK to be smart, that being smart will not diminish their attractiveness or femininity."

Claude Steele, a professor of social psychology at Stanford University, has studied this phenomenon, this automatic ruling out of life's possibilities, calling it "stereotype vulnerability." He believes it is equally damaging to blacks and women.

"When anxiety occurs on a chronic basis, what a person can do to protect himself or herself from that anxiety is to stop caring about that domain," Steele told the *Chronicle of Higher Education*.

Lapan, the father of three daughters, is directing some of his professional efforts toward helping girls overcome this negative self-image. Last year, he and his associates spent time in seventh-grade classrooms throughout Columbia, asking students to weigh various jobs in terms of interest and their confidence in themselves to do the work. His preliminary findings were similar to national data showing that only about 10 percent of female students believe themselves capable of working in computer services (median salary $30,000), for example, whereas 75 percent feel qualified to do recreation work (median salary $16,000). That raises another reason to care about this issue: Recent labor economics studies have demonstrated that gender differences in math ability are related to gender differences in earnings and status in the workplace.

"Women tend to underestimate their abilities, and as a consequence they make choices by default and for not-very-good reasons," Lapan says. He cites a 1984 study of female graduate students at Stanford University that found even this group of capable, intelligent women to be insecure about their math and science abilities and preparedness, despite the fact that their test scores were comparable to, or better than, those of their male counterparts.

"Sexual stereotyping starts so early.

"Girls don't get into math and science because they don't see these subjects as relevant to their future."—Rich Lapan

It's hard to believe until you become a parent yourself. But certainly by the seventh grade we found that girls already have started limiting their choices and career options."

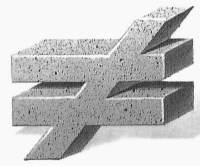
Lapan also found that seventh-grade girls continue to perceive people in the math and science professions as nerdy, or uncool. MU mathematics Professor John Beem says this stereotype persists even at the university level.

"Two big attitudes work against us," says Beem. "First, there's the 'math brain' thing. Students seem to think you've either got it, or you don't. But I've always found the so-called math brains simply are the ones who spend more time on their homework."

The second misperception is that math doesn't matter to one's future. "And of course that isn't true," Beem says. "So many disciplines—pharmacology, business, computer science, medical school—require a knowledge of advanced mathematics. Students who think it doesn't matter are crossing a lot off. They're really hurting themselves."

A number of initiatives are under way at Mizzou to try to correct these inequities and attitudes. Beem is one of five MU faculty collaborating on a three-year, $1 million National Science Foundation project to revise Missouri's middle-school math curriculum. The new way of teaching will focus on problem solving and "number sense" rather than on computation skills.

"Now, 70 percent of the curriculum these kids are exposed to is material they've had before," says project leader Barbara Reys, associate professor of curriculum and instruction. "Students get bored and turn away from math at a time



when they're beginning to make important career decisions."

Lapan and Reys are part of MU's Mathematics, Science and Technology Initiative, or MST, launched in 1994 with a combination of University funding, corporate financing and federal grant support. Faculty aim to improve the teaching and learning of mathematics and science, particularly through the use of interactive technology.

Another MST team is working with a local high school to better understand the ways learning occurs in a unique environment. Every spring, students take part in a six-day mock space shuttle mission in which they use math and science skills acquired during the previous year. They actually live in a 51-foot "shuttle," working with the same instructional manuals NASA astronauts and physicists use.

Also to interest young people in things scientific, MU publishes *Mizzou Magic*, a science magazine for middle-school and junior-high age readers, and co-hosts a math and science summer camp for middle-school girls and their teachers. The girls engage in experiments and meet women who have established successful math and science careers. Their teachers, meanwhile, receive training on gender equity issues as they affect the classroom.

MU's Southwestern Bell Science Education Center in the College of Education is developing new techniques to enhance the quality of math and science education throughout the state. This past fall, the center hosted workshops for 50 elementary and secondary teachers to consider new curriculum guidelines for science education. Kindergarten through high-school educators wanting to talk over new ideas about teaching science are encouraged to call 1-800-HELPSCI.

Although there are conflicting opinions as to why boys outdo girls in math and science, all parties agree on one point: Math and science education in the United States must improve. U.S. children consistently score lower than children from other counties, particularly Asian nations, in tests of mathematical achievement.

"It's very clear that in the industrialized world, American children are among the most poorly educated in mathematics," says Geary, noting the disparity appears before the end of the first grade and widens as the child's education progresses. "High-school math in this country is junior-high math in those countries."

Although he doubts we'll ever see the day America's engineers are 50 percent female, he endorses intervention that will convince our children that a good math education has value for everyone, not only the nerds.

Says Lapan: "Eventually, I hope all our kids will feel they have choices that are free and open. I hope we will have a generation of women who will be more knowledgeable about themselves and the world of work, and I hope they'll find jobs that encourage and support them."