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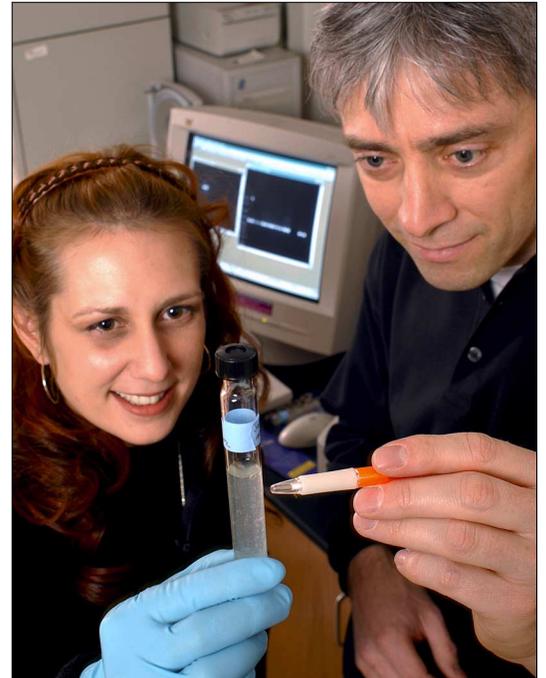
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## Gender and Learning

*Are there innate differences between the sexes?*

**H**arvard President Lawrence Summers ignited a firestorm recently when he suggested more men than women are scientists because of differences between males and females in “intrinsic aptitude.” Many scientists — both men and women — expressed outrage at Summers’ remarks and blamed any lag in math among girls mainly on discrimination and socialization. They point out that girls have closed the gap in average scores on most standardized math tests in elementary and high school. Today women constitute almost half of college math majors and more than half of biology majors. But Summers’ supporters say he courageously raised a legitimate question for scientific inquiry. Indeed, in recent years some researchers have been pursuing a scientific explanation for the discrepancies in math and science aptitude and achievement among boys and girls and have found differences, including biological ones.



*Kirsti Ritalabti, a postdoctoral fellow at Georgia Institute of Technology, examines unusual microorganisms that research team leader Frank Löffler thinks may help to clean up polluted environments.*

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Cover: Kirsti Ritalahti, a postdoctoral fellow at Georgia Institute of Technology, examines unusual microorganisms that research team leader Frank Löffler thinks may clean up polluted environments. Today women constitute almost half of college math majors and more than half the biology majors. (Georgia Institute of Technology/Gary Meek)

# Gender and Learning

BY SARAH GLAZER

## THE ISSUES

Harvard President Larry Summers recently confronted one of academia's most controversial questions: Why do so few women hold tenured faculty positions in science and engineering?

But his attempt at an answer reignited a long-simmering debate among researchers about how well women perform in math and science compared with men.

In speaking to a group of economists in January, Summers said the imbalance might be due mainly to "issues of intrinsic aptitude."<sup>1</sup>

Summers' suggestion that women are biologically inferior in math infuriated many female scientists. Some asserted that the other two factors he mentioned were far more important in keeping women out of science: sex discrimination and the way girls are taught to view math as male territory.

Women's-rights groups fault male hiring committees' bias against women and the lack of family-friendly policies for keeping the growing number of women with science degrees from attaining comparable numbers of faculty positions. For instance, while women now earn 31 percent of chemistry PhDs and 27 percent of math doctorates they hold only 12 percent of chemistry faculty positions and 8 percent of math positions at the nation's research institutions.<sup>2</sup> Harvard, for instance, has no females on its senior math faculty.

A "steel ceiling" keeps women's participation trapped at less than 20 percent of engineering, computer science and physics careers, where these social barriers are particularly steep, women's



Getty Images/Jodi Hilton

*Harvard students and other supporters protest on Feb. 22, 2005, against remarks by Harvard President Lawrence Summers suggesting more men than women are scientists and engineers because of differences in "intrinsic aptitude." While many scientists criticized Summers, his supporters say he courageously raised a legitimate question for scientific inquiry. On May 16, Summers pledged \$50 million to aid and recruit female faculty.*

activists contend. But skeptics say gut female preferences, rooted in evolutionary biology, are more influential in steering women away from those fields.

"I'm not saying there aren't any biological, innate differences," says Sue Rosser, a biologist and dean at the Georgia Institute of Technology. "I'm saying there are also these overwhelming social differences, and those are the things you can do something about."

But Linda Chavez, president of the Center for Equal Opportunity, an anti-affirmative action think tank, insists boys simply are hard-wired for math and girls aren't. Summers was "just articulating what most researchers in this area believe," she said, "that biology plays a bigger role in explaining these differences than socialization does."<sup>3</sup>

Researchers have been vigorously debating how big a gender gap there

really is in math aptitude. In fact, they find that a gap shows up mainly among the top scorers on high-stakes math exams like the SAT. On most other standardized elementary and high school tests, the difference between boys' and girls' average scores has diminished to a negligible level in recent years. And there's no consensus as to how much biology contributes to the difference.

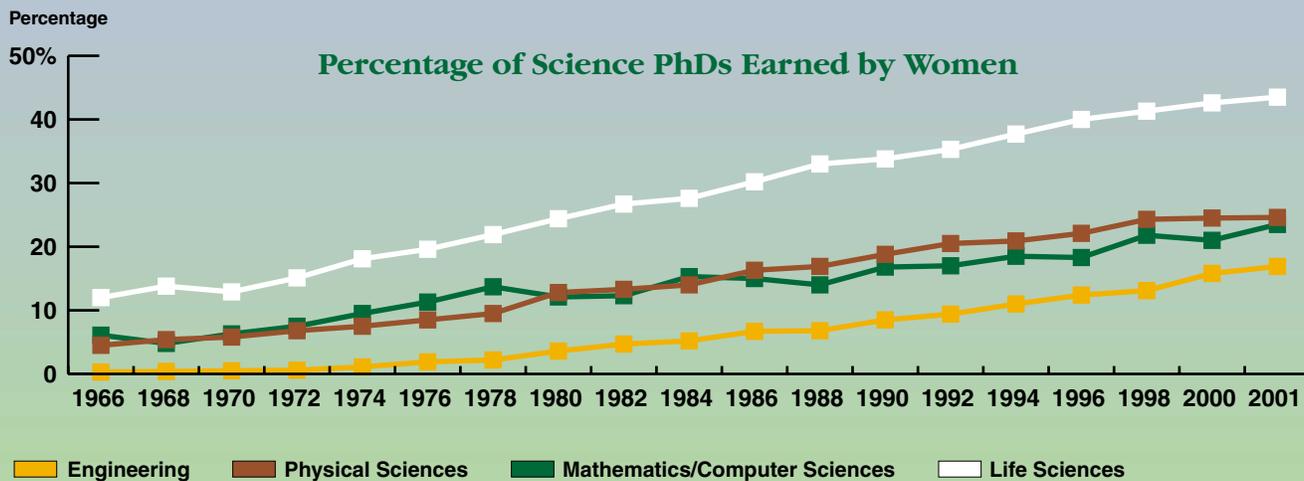
Yet there are intriguing differences in how boys and girls learn, and those differences may be hard-wired, says Leonard Sax, a family physician in Poolesville, Md., and author of the 2005 book *Why Gender Matters*. "Boys enjoy plugging numbers into equations; girls are much more interested in knowing why," he says. One study found girls get turned off by physics classes that teach rote formulas; they're more engaged when teachers explore the explanations for physical laws.<sup>4</sup>

Some differences are well established. Girls do better on tests of content learned in class and score much higher on reading and writing tests than boys. Boys score higher on standardized tests with math and science problems not directly tied to their school curriculum. On tests of spatial awareness, boys do better on tests that involve navigation through space. Girls are better at remembering objects and landmarks.<sup>5</sup>

Studies also show differences in brain structure and hormonal levels that appear to influence spatial reasoning. But the implications of these differences for real-world math and science achievement remain unclear. "There is evidence that male and female brains differ anatomically in subtle ways, but no one knows how (or even if) these anatomical differences relate to cognitive performance,"

## PhDs for Women Increased Steadily

The percentage of science PhDs awarded to women steadily increased from 1966 to 2001, with women making dramatic gains in engineering. In life sciences, women now earn nearly half the PhDs awarded.



Source: National Science Foundation, "Science and Engineering Degrees, 1966-2001," [www.nsf.gov](http://www.nsf.gov).

the journal *Nature Neuroscience* declared.<sup>6</sup>

For example, college men and women of equal math ability use different parts of the brain when taking the Math SAT, according to a brain imaging study by Richard J. Haier, a psychologist at the University of California, Irvine.<sup>7</sup> "There are lots and lots of studies that show differences in the brain between men and women. What those differences mean — [that] gets a little controversial," Haier says.<sup>8</sup>

In 1992, a report on math and science education galvanized national attention. "How Schools Shortchange Girls" said girls took fewer advanced math and science classes than boys and received less attention from teachers in class, leading to poorer performance in those subjects.<sup>9</sup>

By the time the American Association of University Women (AAUW) released the report, however, the much-publicized gender gap already was closing. Indeed, gender differences on standardized math tests in elementary and high school have been small since

1990, according to the Department of Education.<sup>10</sup> Moreover, the 1970s gap in average math scores on standardized tests that favored 17-year-old boys had disappeared by 1999, and the science gap also had declined.<sup>11</sup>

In fact, girls now receive better math and science grades than boys — right up through college.<sup>12</sup> Today they constitute more than half the biology majors, almost half the math majors and half of medical school enrollments. Girls take more high school classes than boys in chemistry, biology and most types of math. Although more boys take advanced classes in physics and advanced calculus, the differences appear to be shrinking rapidly. (See graph, p. 452.)

Some experts contend that the dramatic speed with which girls have closed the average-score gap in math is proof that the original deficiency was caused by socialization. "If there had been some math gene, things wouldn't have changed quite as fast," says Susan Bailey McGee, executive director of the Wellesley Centers for Women at Wellesley College and prin-

cipal author of the AAUW report.

Still, relatively few women enter the fields of physics or computer science. Some believe a "steel ceiling" has kept women below 20 percent of engineers in recent years. "There's a lot of stereotyping that goes on about what's appropriate for girls and boys," as evidenced by the far lower number of girls taking courses in those subjects, McGee says. When predominantly male university departments are making hiring and promotion decisions in those fields, she contends, "it's an unconscious bias to favor someone most like themselves."

It is unclear how big a role anti-female bias plays, but a recent study of the nation's top 50 research universities found that in most science disciplines "qualified female candidates exist, but they are not being hired" as faculty.<sup>13</sup> Last year, the Government Accountability Office (GAO) complained that federal agencies handing out billions of dollars in science grants were not doing enough to ensure universities receiving the grants are not discriminating against women.<sup>14</sup>

At the heart of the current controversy is a serious societal implication — that the failure of an institution like Harvard to tenure even one woman mathematician can be blamed on the lack of top-flight women mathematicians, which in turn can be blamed on too few top female minds in math. As evidence of intrinsic aptitude differences, Summers pointed out that more boys than girls receive top scores on standardized math tests. For example, last year boys outnumbered girls 2-to-1 among 12th-graders scoring 750-800 on the Math SAT, according to The College Board. Harvard scientists-to-be are drawn from those making scores at least that high, if not higher, and the ratio of men to women increases as the score rises, some argue.

“When we’re talking about the pipeline for MIT and Harvard, we’re talking about the exceptional high school graduate — not the average high school graduate,” says Linda Gottfredson, a professor of education at the University of Delaware, who sides with those arguing that biology is playing a strong role in weighting the pool of top scientists toward males.

But some experts say — and at least one judge has agreed — that girls may not do as well as boys on the Math SAT because it is biased in favor of boys. (See story, p. 456.) In any case, very high standardized math scores are actually poor predictors of who goes on to science majors or careers, particularly for girls, according to the sociologists whose data Summers cited. Twelfth-graders who continue in science actually come from the top quarter, where women are better represented, rather than the top 5 percent, where boys outnumber girls 2-to-1, according to Kimberlee Shauman, a sociologist at the University of California, Davis, who calls Summers’ use of her data on gender differences “naive.”<sup>15</sup>

“What it takes to be a successful scientist is much more than math achievement,” she says. “We need

## Few Women PhDs Hold Faculty Positions

*The pool of potential female candidates for faculty positions is plentiful, but faculty search committees and chairs say they receive few applications from women PhDs. Recent female PhDs say they do not perceive the academic environment as desirable and so they do not apply for faculty positions. For example, while women have earned 31 percent of the chemistry doctorates awarded in recent years at the top 50 U.S. research institutions, they held only 12 percent of the chemistry faculty positions. Similarly, 27 percent had math PhDs, but only 8.3 percent of math faculties were women.*

### Percentage of Female PhDs and Female Faculty

Discipline	PhDs (1993-2002)	All Faculty Ranks
Chemistry (2003)	31.3%	12.1%
Math	27.2	8.3
Computer Science	20.5	10.6
Astronomy (2004)	20.6	12.6
Physics	13.3	6.6
Chemical Engineering	22.3	10.5
Civil Engineering	18.7	9.8
Electrical Engineering	11.5	6.5
Mechanical Engineering	10.4	6.7
Economics	29.3	11.5
Political Science	36.6	23.5
Sociology	58.9	35.8
Psychology	66.1	33.5
Biological Sciences	44.7	20.2

Source: Nelson, Donna, “A National Analysis of Diversity in Science and Engineering Faculties at Research Universities,” Jan. 6, 2005.

people who are creative, who have good communication skills, are good managers. Some of these skills — like communication — are more likely to be found among women.”

Gottfredson argues that the large numbers of women who recently have been going into “life sciences” like biology and medicine — rather than “hard sciences” like physics and engineering — demonstrate that biological, evolutionary differences rather than discrimination are keeping women out. “Women have moved up in massive numbers, but they’ve picked their

fields,” she says. “And some of the reason for the choice is basically different wiring of men and women in terms of their gut preferences.” Studies frequently find, for example, that girls are more interested in people and living organisms; boys more interested in things and mechanics.

But, Shauman objects, “It’s a huge leap to say that is based on a biological difference. There’s no gene or complex of genes or hormone levels linked to this desire to work with people vs. things.”

*Continued on p. 451*

## Harvard Pledges \$50 Million to Aid Women

Harvard President Lawrence Summers' announcement on May 16 committing Harvard to spending \$50 million for recruiting women faculty and improving the campus climate for women capped four months of apologies.

Indeed, when Summers warned women students in April about the sex bias they're likely to face in science, he seemed the polar opposite of the man who in January had questioned girls' "intrinsic aptitude" in math.

At a Harvard conference on women in science organized by female science majors, he said professors should be aware of how influential they can be in discouraging female students. (Women at Harvard drop plans to major in science at a far higher rate than males.) To show he shared their pain, Summers described how he was made to feel inadequate in college physics: After giving the wrong answer to a problem, the instructor stared at him "with a certain stunned belief that I could be so stupid."<sup>1</sup>

So-One Hwang, a senior linguistics major, was one of several female students who think Summers' remarks rang true. "I feel embarrassed to admit I didn't pursue physics or math because I didn't want to deal with the sociological factors," she says. She cited anxiety about attaining success in the male-dominated sciences and male classmates who exclude females from study groups or treat them with disdain.

Undergraduates aren't the only women who feel this way, according to a task force that recommended numerous changes to retain women in science. "In some departments, women graduate and postdoctoral fellows report hearing disrespectful criticisms of their abilities from male colleagues and a lack of a supportive environment," the report said.

On May 16, the science task force and another on women faculty — both appointed by Summers in the wake of the controversy over his remarks — made several recommendations, including gender-bias training for graduate students who teach science to undergraduates, increased financial support for faculty child care and an automatic tenure extension during maternity or parental leave. Summers said he would institute some of the recommendations immediately, including hiring a senior vice provost for diversity charged with intensifying the search for women faculty.

Many of the task force recommendations are aimed at countering factors frequently cited as driving women from science: the lack of mentoring, informal job networking and female social support. According to Mariangela Lisanti, president of the undergraduate group Women in Science at Harvard-Radcliffe, her group asked for an on-campus summer dorm so women working in labs could live and eat with fellow researchers, a central place to find

information about research internships and informal study centers where students could ask successful undergraduates questions about homework in difficult introductory science courses. These changes also will be implemented immediately, Summers said.

Summers "saw how what we said could be behind why women are leaving science," says Lisanti, a senior majoring in physics.

On Summers' watch, offers of tenure-track jobs to women have fallen precipitously to 4 out of 32 tenure offers last year in the Faculty of Arts and Sciences. Earlier task forces' recommendations aimed at retaining women have been implemented only "spottily," according to Harvard professor of natural sciences Barbara J. Grosz, chair of the Task Force on Women in Science and Engineering. Grosz chaired a task force in 1991 and again in the late '90s. Only some departments followed their recommendations for senior faculty mentors for junior women faculty, she says.

As for the most recent report, Grosz says, "There's a higher probability these recommendations will be put into effect and sustained over the long term because we built in mechanisms for monitoring, data collection and reporting that weren't present in the previous panel's recommendation in 1991."

For example, she says, information on recruiting and hiring will have to be reported to the new senior vice provost, and mentoring plans will become a required part of junior faculty reviews. Grosz says her task force wanted to "plug the leak" at each stage where women are known to leave science — from the first two years of college, when students get discouraged by difficult courses, to postdoctoral years when women often feel isolated in labs. Several measures are focused on helping women in childbearing years to keep their careers on track, such as a fund to pay for child care so junior faculty can travel to

conferences, "which is where you get known," Grosz says.

Some skeptics say the \$5 million a year over 10 years pledged by Summers is just a drop in the bucket considering Harvard's operating budget of about \$2.5 billion a year. Grosz acknowledges some recommendations like subsidized child care will cost much more. "Five million dollars per year will not cover everything," she says, "but it's a significant contribution from Harvard's center — right upfront — that says they're behind this."

Some advocates hope the current pressure to implement change will have national implications. As Harvard goes, so goes the world, many faculty believe.

As for Summers' apparent turnaround, Lisanti says, "The proof is going to be in the action."



Getty Images/Jodi Hilton

*Harvard President Lawrence Summers drew intense criticism as well as support for questioning girls' "intrinsic aptitude" in math.*

<sup>1</sup> Marcella Bombardieri, "Summers Displays New Understanding of Women's Careers," *The Boston Globe*, April 8, 2005.

Continued from p. 449

Others suggest the demands of motherhood may explain why many promising female PhDs leave science. Junior faculty must produce sufficient publications to make tenure in their 30s, the prime child-bearing years. Married women with children under 6 are half as likely to enter a tenure-track position as married men with a child the same age, according to a University of California study.<sup>16</sup> Many universities are experimenting with family-friendly policies like tenure extensions to ease the burden on young faculty mothers.

On May 16, Harvard's embattled president pledged to spend at least \$50 million to carry out task force recommendations aimed at improving the climate for women in science at Harvard as well as recruiting and retaining more women faculty.

And on May 18, *The New York Times* reported a recent study of the University of California — the nation's largest public university system — shows women's participation in some faculty departments has even decreased.<sup>17</sup>

As the debate over gender and learning continues, here are some of the issues being debated in academia, government and the press:

### ***Is there really a gender gap in math and science?***

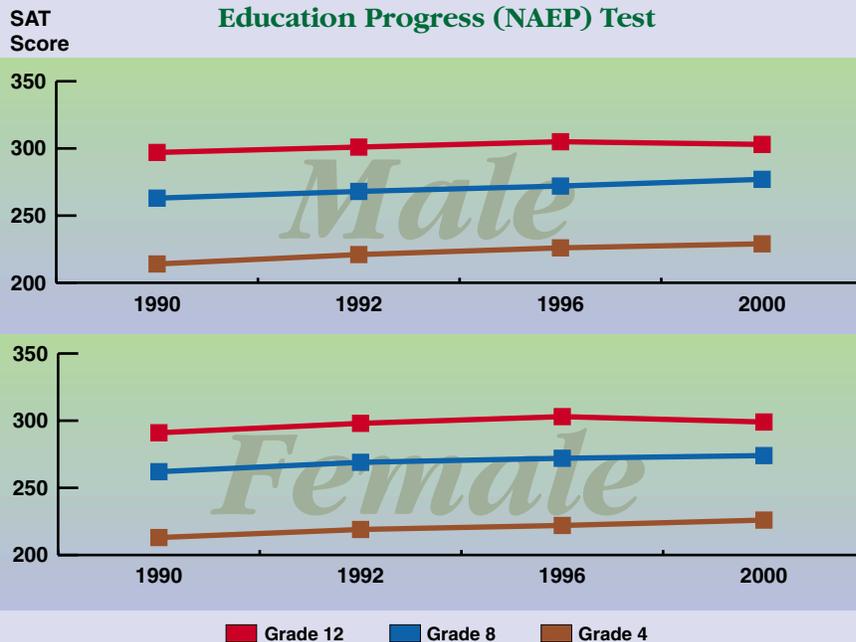
In 1992, following the AAUW's headline-making report, states passed a flurry of laws designed to counter the perceived bias against females in the classroom, and a flood of books and articles lamented how girls' self-esteem was being crushed.<sup>18</sup>

But by 1992, in fact, girls had already closed the gap on most measures. Two years earlier, more female high school graduates than boys had taken first- and second-year algebra and geometry, according to a Department of Education report. Also in 1990, more female high school students than males had taken biology and chemistry. By 1994, physics was the only science course with high-

## **Boys Maintain Slight Edge in Math Scores**

*Boys' scores on the mathematics portion of the national assessment test — given in grades 4, 8 and 12 — have been slightly higher than girls' scores during the past decade. However, scores for both males and females increased.*

### **Average Math Scores on National Assessment of Education Progress (NAEP) Test**



Source: National Center for Education Statistics, National Assessment of Education Progress (NAEP) mathematics scores

er male enrollment. Citing these statistics, Diane Ravitch, a professor of education at New York University and former Education Department official in the first George Bush administration, said in 1998 that the AAUW had ginned up a "phony crisis."<sup>19</sup>

The AAUW authors now concede their report was based on outdated statistics. "The data we had access to was late 1980s data," explains lead author McGee. In her defense, the report noted the math gap was shrinking — a finding generally overlooked in the bad-news-for-girls press coverage. But she adds, "The real issue was how girls felt about pursuing those subjects and whether they felt it was something to pursue as a career."

The AAUW report also had argued that adolescent girls suffered from low

self-esteem and received less attention from teachers than boys, which further discouraged them from pursuing math and science. That conclusion and the negative implications that AAUW drew were disputed by Ravitch (who suggested teachers were reprimanding boys when they called on them) and by American Enterprise Institute scholar Christina Hoff Sommers, who questioned the validity of the data in her 2000 book *The War Against Boys*. Psychologist Judith Kleinfeld also pointed out that boys did far worse on standardized tests of reading and writing and got lower grades in school — trends that remain true today.<sup>20</sup>

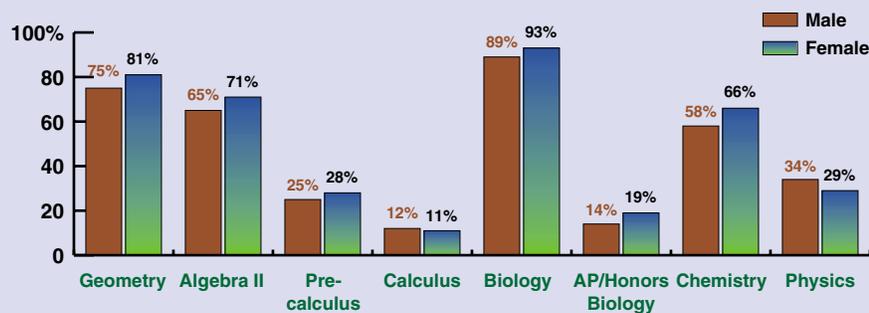
Indeed, today a growing number of researchers contend boys are the ones who are shortchanged — judg-

## More Girls Take Advanced Math and Science

*Higher percentages of females took advanced math and science courses than males among students who graduated from high school in 2000. However, higher percentages of males enrolled in calculus and physics.*

### Percentages of High School Graduates Taking Math and Science Courses

(from the Class of 2000)



Source: National Center for Education Statistics

ing by the larger proportion of boys in special-education classes and the declining proportion attending college. Women now make up 56 percent of students enrolled in college; By 2012, the Department of Education projects they will account for about 60 percent of bachelor's degrees.<sup>21</sup>

"Maybe we should be worried about boys having a much higher rate of dropout," says Diane Halpern, a professor of psychology at Claremont McKenna College in Claremont, Calif. "Girls are learning math and science in school very well," she says, based on their grades and tests on content learned in school. Boys, meanwhile, score better, on average, on math tests on content they have not learned, she notes, including the SAT.

"Who's winning," Halpern says, "depends on what side [of the gender fence] you're standing on."

Today girls receive better grades than boys in math and science through high school, have closed the gap on average scores on most standardized math tests and take more advanced high school classes than boys in almost

every category except physics and high-level calculus. In college they constitute nearly half the math majors and more than half the biology majors.

"In terms of course-taking and achievement, the gap is pretty well gone," agrees Patricia B. Campbell, a coauthor of the AAUW report, who recently revisited the gender-gap statistics. She found few gender differences in the math courses girls and boys take in high school until they reach Advanced Placement (AP) courses; about the same number of boys and girls are taking four or more years of high school math.<sup>22</sup>

Girls make up the majority of those taking AP exams and — stunningly — 57 percent of those taking the first-level calculus exam. "You have to get to the second level of calculus [known as BC] before you find any meaningful sex difference, and then it's a small percent of the population," notes Campbell. (Girls accounted for 39 percent of those taking the BC test.) In science, boys still make up the majority of students taking AP chemistry and higher-level physics.

Although Campbell concedes that "in the last 20 years there has been a tremendous decline in the gap," she worries that the decline "hasn't had the impact we would have expected" in all scientific and technical fields.

Specifically, Campbell cites computer science and engineering, where she says women's gains have stagnated. Less than 20 percent of girls take AP exams in computer science, and a low percentage take any computer science classes. Girls are less likely to have career aspirations in computer science and engineering. Among those taking the ACT (the college admissions equivalent of the SAT taken more commonly in the Midwest) or the SAT in 2001, only 2 percent of girls were planning to major in either field. By contrast, 9 percent of boys cited computer science, and 11 percent chose engineering as their majors of choice.<sup>23</sup>

At the college level, the disparity is most striking in engineering, physics and computer science, where women earned less than 20 percent of the bachelor's degrees, a gender gap that has changed little since 1989.<sup>24</sup> Considering girls' equally strong math and science preparation in high school, Campbell suggests, "Our perceptions [of what girls can do] don't seem to have kept pace with reality."

But vocational expert Gottfredson questions whether girls' relative lack of interest in those fields is really a problem. She says female clustering around the biological sciences represents females' natural inclination toward people and living organisms in contrast to boys' interests in mechanical things. Even within engineering, she notes, women have gravitated into sub-fields like biomedical engineering rather than mechanical or electrical engineering. "Why do we need equal proportions of men and women in every profession?" she has asked.<sup>25</sup>

Still, with women now accounting for half of all college majors in science and technology, the percentage of those pursuing advanced degrees

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and moving into academic jobs remains low. Only 19.5 percent of science and engineering faculty at four-year colleges and universities are women, with only 10 percent making full professor, according to the National Science Foundation.<sup>26</sup>

Even in a field like biology, where women have outnumbered men earning PhDs for several years, women make up only 30 percent (white males still make up more than half) of the assistant professors — the first rung on the academic employment ladder.<sup>27</sup> In almost every scientific field, women's participation decreases as they progress from PhD to graduate assistant to assistant professor to tenured associate and then full professor.

Summers' explanation for this trend focused on gender differences in high-stakes standardized test scores, as has most of the debate about gender differences.

While the average math and science score-gap on the closely monitored National Assessment of Educational Progress (NAEP) has either disappeared or dropped to a few points favoring males, females still score on average 36 points lower than males on high-stakes tests like the Math SAT and lower on the quantitative part of the Graduate Record Exam, a graduate school admissions test.<sup>28</sup>

Generally, more boys than girls receive top scores on such tests. For example, in 2004 about twice as many boys as girls scored at least 750 on the Math SAT — a test some claim is biased in favor of boys. (See sidebar, p. 456.)

Most girls and boys overlap somewhere around the average when it comes to math test scores. However, boys are more variable — more boys than girls are seriously disabled in math, and more are in the top 5 percent of scorers, a fact Summers highlighted. As the University of California's Haier explains, "The average boy can't do high-level math." Statistically, by the same logic, neither can the average girl.

### ***Are there "innate differences" between males and females in math and science aptitude?***

The fact that more boys than girls make top scores on standardized math tests is often invoked as evidence that boys possess an innate superiority in high-level math. In his book *The Blank Slate*, Harvard psychologist Steven Pinker argues that biological and evolutionary forces play a crucial role in male-female cognitive differences.

Like many such adherents, he cites a study that found precocious seventh-grade boys who scored at least 700 on the Math SAT for admission to an enrichment program outnumbered similar girls 13-to-1.<sup>29</sup> Does this huge gap suggest there will always be fewer brilliant female mathematicians? According to Pinker, the answer appears to be yes. Men "consistently" perform better on this and other tests of mathematical reasoning, he has argued<sup>30</sup> with the higher numbers of men at top scores "confirming an expectation from evolutionary psychology."<sup>31</sup>

But other researchers see environment as a greater influence on girls and question the immutability of the score differences. They note that the widely cited 13-to-1 ratio dates from 1983 and comes from a select sample of gifted children who volunteered to take the test in response to a talent search. In recent years, the boy-girl ratio in this talent search sample has fallen to about 3-to-1, according to psychologist Julian Stanley, founder of the Center for Talented Youth at Johns Hopkins University, in Baltimore. Stanley attributes the decline to girls' earlier and better math preparation in school.

This shrinking gap among exceptionally talented youngsters, along with the shrinking gender gap on other standardized tests, suggests these scores "are very malleable. It's conceivable we can change the ratio of women in that high end of distribution" to be equal to boys, says sociologist Shauman, who is dubious of a biological explanation. Boys' higher representation at the top end, she says, "could

be caused by differences in how boys and girls are treated and socialized."

Well-recognized gender differences could help explain why girls perform more poorly on timed multiple-choice tests like the Math SAT. Compared to men, "Women are less likely to be cavalier; they're more methodical and check their answers, and they run out of time," says Ann Gallagher, an educational psychologist at the Law School Admission Council, which creates the Law School Admission Test. "On the SAT, a number of the questions need to be solved in a way girls are not taught to do it in the classroom; they need to think of an unconventional route. Girls may be hesitant because they're trying to do it the correct way."

Shauman believes girls may be socialized in ways that make them perform more poorly on high-stakes math tests but better on tests of material they learned in class. "We expect girls to behave well, do well in class, to follow directions," she says.

By contrast, "Men tend to be more likely to take leaps, to take risks," says James Kaufman, a psychologist at California State University, San Bernardino, and coeditor with Gallagher of *Gender Differences in Mathematics*, published this year. While that approach may help men guess right on multiple-choice tests like the Math SAT, "in the classroom that doesn't necessarily help, and it doesn't necessarily help in real life, because these risks are just as likely to be wrong," he says. (Kaufman's explanation could help explain why girls who get the same grades in college math classes as boys often scored many points lower than their male peers on the Math SAT.)

Experts on both sides of the divide agree gender differences are real, even if they disagree about how much is socially learned and how much biologically based. Girls do better on writing and on algebra problems, probably because algebraic equations are similar to sentences, and girls excel in language processing.<sup>32</sup> Boys are

better at mathematical word problems; girls are better at mathematical calculation.

Boys and girls also differ on spatial skills, and experts are divided over how innate or important these differences are. A recent study of the Graduate Record Exam, for instance, found men did better on math problems where a spatially based solution was an advantage.<sup>33</sup>

Boys are better at geographic navigation and envisioning a three-dimensional object rotating in space; girls are better at remembering the location of objects and landmarks. When boys and girls are taken to an unfamiliar college campus and asked to draw a map of where they've been, "Boys get the position right: This building was x degrees northwest," according to David C. Geary, a psychologist at the University of Missouri in Columbia, Mo. "Girls get the landmarks, but the geometric position is not as accurate."

Sex hormones have been shown in several studies to affect the ability to envision an object rotating in space. Females who take male hormones to prepare for a sex-change operation improve on tests of 3-D rotation and get worse on tests of verbal fluency, at which women typically excel. During their menstrual cycle, women do better on 3-D rotation when levels of the female hormone estrogen are low; they do better on verbal fluency when estrogen levels are high.<sup>34</sup>

If differences between boys and girls stemmed mostly from socialization, Pinker argues in his book, "It would seem odd that the hormones that make us male and female in the first place also modulate the characteristically male and female mental traits."<sup>35</sup>

New research by Harvard anthropologist Carole Hooven, however, suggests the male hormone testosterone is tied not to better spatial ability but to greater confidence, which leads to better decisions on spatial tests. That finding, Hooven says, is "consistent with a huge amount of data on hu-

mans and non-human animals about what testosterone does — males have to be more aggressive for mating."

If differences in spatial abilities were innate, one might expect them to show up early in children's lives. But Harvard psychologist Elizabeth Spelke says that in 30 years of study on infants' and toddlers' cognitive and navigation skills, she has found no sex differences on any task. "If there were a genetic basis behind the fact that Harvard's math department has no women on its senior faculty, one place to look for that is early in development. And when we look there we see no differences whatsoever," she says.

Since many of these skill differences appear after adolescence, she suggests they're socially derived.

But Pinker disagrees. "Pubic hair, lowered voice and breasts don't show up until adolescence, but that does not mean they are products of socialization," he says, adding, "Spelke's research tests extremely basic cognitive abilities, such as the concept of number and space. The abilities in question here are far more esoteric and refined — we're talking about abilities that differentiate an MIT math professor from everyone else — and those could be sex differentiated even if basic concepts are not."

In any case, Gallagher and Kaufman point out in their book, there is no evidence that spatial skills "are actually necessary or important in solving complex mathematical problems of the type students encounter in college-level or graduate-level mathematics." Moreover, they note, the one skill the SAT does test — "speediness" in answering a question every two minutes — may be less prized by true mathematicians than persistence in solving a problem over days or weeks.<sup>36</sup>

Other researchers suggest there might be a middle ground in which biology and environment interact. For instance, says Beth Casey, a professor of applied developmental and educational psychology at Boston College, an attrac-

tion to experiences involving spatial and mechanical skills may be genetic, and, "because boys are attracted to them they do them more often and get better at them." The contention that interest in objects is inborn in males is, however, controversial and disputed by Spelke. (*See sidebar, p. 459.*)

Even a recent finding by Haier that men are more likely to use a part of the brain associated with visual-spatial processing when taking an IQ test — a region that was unusually large in Albert Einstein's brain — "doesn't speak to whether or not that's innate," Haier says.<sup>37</sup> "We know from one study that learning juggling seems to increase gray matter in some of the motor areas; there's a sense that environmental influences interact with genetic influences to produce biological differences. But how much of the math difference is due to biological and other differences — you can't put a number on that yet."

### ***Is enough being done to encourage women in science and math?***

Since the publication of AAUW claims that schools were shortchanging girls, schools across the country have introduced "girl-friendly" approaches to math and science designed to combat bias against girls, aided by millions of dollars in federal funding.

"We found if we taught science differently with a hands-on, inquiry-based approach, it sustains girls' interest in science," particularly in middle school, when girls tend to turn away from science, says Ruta Sevo, who directs the National Science Foundation's research program on gender in science and engineering. The foundation has spent \$8-\$10 million a year since 1993 to study successful teaching approaches for girls and share the findings with schools.

"Girls like to work in cooperative teams; [previously,] a lot of science was taught in a competitive mode," Sevo says. Programs like these, along with a more

*Continued on p. 456*

# Chronology

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**1900s** *Number of girls taking science falls as home economics, male science teachers gain ascendancy and colleges open doors to women.*

**1900**

Commissioner of Education recommends teaching girls housekeeping skills, not trigonometry.

**1903**

Marie Curie, first woman to win Nobel Prize, shares prize for physics with her husband.

**1905**

Girls score higher on first IQ test designed by Alfred Binet; he removes questions favoring girls.

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**1950s** *Number of girls taking science continues to plummet.*

**1955**

Only 2 percent of high school girls take physics.

**1957**

Russians launch *Sputnik* satellite, focusing renewed attention on U.S. science education.

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**1960s-1980s** *Women's movement spurs legal fight for equal education; re-search finds brain differences in men and women.*

**1964**

Canadian psychologist Herbert Lansdell reports anatomical differences between men's and women's brains.

**1972**

Congress passes Education Amendments, including Title IX prohibition on sex discrimination.

**1989**

In New York, federal judge finds SAT biased against girls, rules the state cannot use SAT scores to award scholarships.

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**1990s** *Reports that schools shortchange girls in math and science spur federal programs to help girls. Critics say boys are in more trouble.*

**1992**

American Association of University Women (AAUW) releases report "How Schools Shortchange Girls," saying girls lag behind boys in math and science.

**1994**

Congress passes Gender Equity in Education Act to counter bias against girls in school.

**1998**

Department of Education report shows high school girls take as many math and science courses as boys in most subjects, a gap that was closing in 1992.

**1999**

Two teenage boys go on shooting rampage at Columbine High School in Littleton, Colo., shifting national concern to boys' poorer performance in school.

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**2000s** *Congressional and university panels blame low hiring rate of female scientists on discrimination and family-unfriendly policies; debate rages over whether there are innate aptitude differences between the sexes.*

*tists on discrimination and family-unfriendly policies; debate rages over whether there are innate aptitude differences between the sexes.*

**2002**

Sen. Ron Wyden, D-Ore., chairs hearings urging stronger enforcement of Title IX to counter discrimination in university hiring of women scientists.

**2003**

Women make up 20 percent of all U.S. scientists, compared to less than 3 percent in 1960. But most are concentrated in life sciences.

**2004**

GAO report finds women lagging in rank, salary and numbers on university science faculties; urges stronger enforcement of Title IX.

**Jan. 14, 2005**

Harvard President Lawrence Summers suggests gender differences in "intrinsic aptitude" partly explain low number of women scientists.

**February 2005**

Ten university presidents recommend part-time tenure positions to counter flight of women from family-unfriendly universities.

**March 2005**

More than 6,000 women scientists urge Sen. Wyden to investigate low numbers of women in science academia.

**May 2005**

Harvard President Summers pledges to spend \$50 million to implement task force recommendations aimed at improving the climate for women in science at Harvard as well as recruiting and retaining more women faculty. . . . A report on the University of California system finds a decline in the proportion of women faculty hired.

## Is the Math SAT Biased Against Girls?

Since the development of the first IQ test in 1905, test-makers have struggled with gender bias but have usually resolved the issues in favor of boys, according to some experts.

In the early days of IQ testing, girls scored better than boys, a finding that was thought to undermine the test. So French psychologist Alfred Binet, the developer of the first IQ test, threw out the items most favorable to girls, and the gender difference disappeared.<sup>1</sup>

More recently, on the Math SAT, test-makers removed a girl-friendly class of questions — those asking whether there was sufficient data to answer a given problem. Likewise, when girls were found to score higher on the verbal section, boy-friendly problems on sports, politics and business were added, resulting in an increase in male test scores.

But today — even though girls score on average about 36 points lower than boys on the Math SAT, “no similar attempt has been made to ‘balance’ the Math SAT,” an editorial in *Nature Neuroscience* recently charged.<sup>2</sup>

Such a history of anti-female bias in testing “should cast doubt” on the SAT as “some gold standard of mathematical ability,” contends Susan F. Chipman, an educational psychologist at the Office of Naval Research.<sup>3</sup>

Indeed, FairTest, a nonprofit group in Cambridge, Mass., claims the Math SAT is biased against girls due to its reliance on multiple choice, speed and guessing. In 1989, the group won a favorable federal court decision from the Southern District of New York, barring the use of SAT scores to award New York state Regents’ scholarships.<sup>4</sup>

FairTest also filed a complaint in 1989 with the Education Department’s Office of Civil Rights, charging that the Prelimi-

nary SAT (PSAT) — which is given to 10th- and 11th-graders — discriminates against girls. The PSAT is the primary factor determining eligibility for National Merit Scholarships. In response, The College Board, which creates both the PSAT and the SAT, added a multiple-choice writing test to the PSAT, which helped bridge the gap between male and female performance on the test by 40 percent, according to FairTest.

However, the Math SAT “remains biased against girls,” says Robert Schaeffer, public education director for FairTest. “The sole scientific claim made for the SAT is its capacity to predict first-year college grades. But despite their lower scores, women continue to earn higher grades in identical math classes than their male counterparts.”

Some experts theorize that perhaps girls’ average Math SAT scores are lower than boys’ because more girls than boys apply to college — and thus take the test — including more girls with lower math preparation or ability.

Other studies suggest that girls perform more poorly on high-stress tests when reminded — by filling out questionnaires asking their sex — of the stereotype that girls are bad at math or by hearing examiners’ statements about boys’ superior performance.<sup>5</sup>

<sup>1</sup> See Robert Pool, *Eve’s Rib* (1994), p. 23.

<sup>2</sup> “Editorial: Separating Science from Stereotype,” *Nature Neuroscience*, March 2005, p. 253.

<sup>3</sup> Ann M. Gallagher and James C. Kaufman, *Gender Differences in Mathematics* (2005), p. 16.

<sup>4</sup> “Gender Bias in College Admissions Tests,” at [www.fairtest.org](http://www.fairtest.org). The case was *Sharif v. New York State Education Department*.

<sup>5</sup> Gallagher and Kaufman, *op. cit.*, p. 199.

*Continued from p. 454*

encouraging national climate, have helped shrink the gender gap in math and science achievement, supporters claim.

But Sommers, at the American Enterprise Institute, a conservative think tank, says the government wasted millions of dollars to study a “manufactured crisis.” Federally funded programs to counter bias against girls have stigmatized boys, who are doing far more poorly in school, she contends. “A boy today, through no fault of his own, finds himself implicated in the social crime of ‘shortchanging’ girls,” she writes in *The War Against Boys*. “Yet the allegedly silenced and neglected girl sitting next to him is likely to be the better student.”<sup>38</sup>

Some programs, for instance, have gone to ludicrous extremes to eliminate competition, she contends. One K-3 anti-harassment curriculum she cites, called “Quit It!” recommends that teachers replace tag with a new, less aggressive game, “Circle of Friends,” where nobody is ever “out.”<sup>39</sup>

While much of the concern about prejudice against grade-school girls has dissipated, women’s groups say there is still a major problem in universities. For example, while women received close to 45 percent of the doctoral degrees in biology between 1993 and 2002, they accounted for only about 30 percent of the entry-level assistant professors in 2002.<sup>40</sup> The low number of women hired in science posts

is not due to an “innate lack of ability but to discriminatory barriers,” according to Jocelyn Samuels, vice president of education and employment at the National Women’s Law Center.

She blames not only individual instances of bias against qualified women on hiring committees but also “a chilling environment where the atmosphere and culture sends the message, ‘Women don’t belong.’” Specifically, she contends that female graduate students and faculty tend to receive less lab space, less mentoring by senior faculty and fewer invitations to participate in large research grants. She points to a 1999 study at the Massachusetts Institute of Technology (MIT), which found that women received lower

salaries than their male peers and were excluded from leadership positions.<sup>41</sup>

In a Jan. 27 letter, the center and 21 other women's groups called on Summers and other university officials to "aggressively pursue and ensure full compliance" with Title IX of the Education Amendments of 1972, prohibiting sex discrimination in education, and Title VII of the 1964 Civil Rights Act, which bars employment discrimination on the basis of sex. Meanwhile, the GAO last year said federal agencies that make science grants should do more to ensure that universities receiving grants are complying with Title IX.<sup>42</sup> Women's groups also have cited the low percentages of full-time women faculty in engineering (10 percent), mathematics (26 percent) and physical sciences (16 percent) and a drop in the numbers of women receiving undergraduate degrees in computer sciences (from 37 percent in 1984 to 28 percent in 2001) as evidence of discrimination and a climate unfriendly to women.<sup>43</sup>

But some experts say women's low numbers in those fields represent their differing interests from men, not discrimination. "Women worldwide are more interested in nurturing, and men are more interested in things. It makes perfect evolutionary sense," vocational expert Gottfredson says. That divide explains why women get a small proportion of the PhDs in physics and engineering (things) but account for 71 percent of doctorates in clinical psychology (people), according to Gottfredson. "It's putting unrealistic pressure on everyone to expect 50-50 in everything," she says. "It just doesn't fit what women themselves say they want" in surveys.

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Three professors led the task forces that recommended sweeping changes to improve the climate for women students and faculty at Harvard: from left, Radcliffe Institute Dean Drew Gilpin Faust, Professor of the History of Science and of African and African-American Studies Evelyn Hammonds, and Barbara J. Grosz, Higgins Professor of Natural Sciences and Dean of Science at the Radcliffe Institute.

Harvard University/Kris Snibbe

Gottfredson's "people vs. things" dichotomy is "just the kind of stereotype Title IX and Title VII were enacted to eliminate," Samuels retorts. Women's interest in something "cannot be measured in the absence of opportunity," she says. "You're really measuring lack of exposure." She points to the explosive growth of women entering medicine and law once the doors of professional schools opened to them and the quadrupling of women in college sports following the enforcement of Title IX. "Their genes haven't changed," she says.

Motherhood also has an impact on why more women don't progress up the academic ladder, several studies have concluded. At nearly every stage of the academic track, married women — especially those with children — "leak out of the academic pipeline at a disproportionately high rate," researchers at the University of California-Berkeley found. Since the average age for granting tenure to a PhD is 33, junior women faculty are expected to increase their publication rate during the very years when childbearing and child-raising duties are heaviest.<sup>44</sup>

Responding to these trends, 10 university presidents recently recommended that universities offer a family-friendly policy considered highly innovative for

academia — part-time tenured faculty positions. U.S. higher education "cannot afford to lose any of its potential intellectual work force," particularly in science and technology, they said in a report highlighting the loss of women from science.<sup>45</sup>

But some skeptics of family-friendly policies question whether women who drop out of the tenure track or cut back on work hours to care for their children do so unwillingly. "A lot of it is choice," says Wayne State University Professor of

Law Kingsley Browne. "A lot of studies show that women think they need to be taking care of children because their husbands don't do a good enough job."

Women scientists also earn less than men. In fact, full-time female life scientists earn \$72,000 a year — 23 percent less than the \$94,000 earned by their male counterparts.<sup>46</sup>

But it's only fair that women who work fewer hours face the economic consequences of lower salaries and less status, Browne argues in his 2002 book *Biology at Work: Rethinking Sexual Equality*.

Increasingly, economists are starting to agree that the leakage of women from the pipeline has something to do with the fact that women's child-raising responsibilities coincide with the years when most universities decide tenure. "We're still working from a model that worked well when men had stay-at-home wives," says Harvard researcher Cathy Trower, who is conducting a nationwide study of junior faculty. Most promotion and tenure standards were formulated in 1940 by an all-male conference of the American Association of University Professors, she notes.

Most of the top 50 research universities and many smaller colleges already

offer an option known as “stopping the tenure clock” so faculty who take a leave during a child-related break will not be penalized for slowing down publication. But several studies have found that women are often reluctant to take advantage of these policies for fear that it will cast doubt on their professional commitment and productivity when they come up for tenure.<sup>47</sup>

“It’s not just a matter of putting programs and policies in place. You’ve got to create a culture where it’s OK to take advantage of them,” says Gloria Thomas, associate project coordinator at the American Council on Education, which issued a report this year recommending part-time tenure positions and other family-friendly policies. ■

## BACKGROUND

### Women in Science

The question is not why there haven’t been more women in science; the question is rather why we have not heard more about them,” Naomi Oreskes, a historian of science at the University of California-San Diego, has observed.<sup>48</sup>

For example, Ada Byron — the Countess of Lovelace (1815-1852) and the daughter of the British Romantic poet Lord Byron — is often identified as the founder of scientific computing. Her mother, Lady Byron, had her tutored in mathematics to shield her from the loose morals and passions inspired by poetry. Ada wrote some of the first computer programs — or computing tables — for Charles Babbage, a mathematics professor at Cambridge University and inventor of the elaborate calculating machine known as the Difference Engine.<sup>49</sup>

Marie Curie (1867-1934), who with her husband Pierre discovered radium, is of course known for having received two Nobel Prizes. In 1903 she and Pierre

received the Nobel Prize for physics for their study into spontaneous radiation. In 1911, she received a second Nobel, this time in chemistry for her work in radioactivity. But other female Nobel Prize winners have been less well known: Two received prizes in chemistry, two in physics and seven in physiology and medicine, most recently Linda B. Buck, of the Fred Hutchinson Cancer Research Center in Seattle, in 2004 for discovering the body’s odor receptors and the organization of olfactory systems.

As the biographies of Ada Byron and Marie Curie suggest, math and science were not always considered men’s work. In many early-19th century U.S. schools, more girls than boys studied science, and girls routinely outperformed boys on math and physics through much of the 1800s. Upper- and middle-class boys concentrated on learning the classics — Latin and Greek — because they were a status symbol and required for entering college. Since most colleges at the time barred women, girls focused on science. Physics, astronomy, chemistry and botany were seen as morally and spiritually uplifting subjects for upper- and middle-class girls.<sup>50</sup>

With the rise of coeducational schools later in the century, it became clear many boys were failing in their studies, while far more girls were excelling. Some educators blamed the feminizing influence of women teachers and textbooks that taught science through stories about anthropomorphized plants and animals. At the end of the 19th century, these views triggered a backlash against female science teachers and marked the beginning of a gradual decline in the proportion of women entering science education.

After the Civil War, college doors were opened to women, who took up the study of Latin in growing numbers. But by 1900, so-called progressive educators were advocating making schooling more “practical,” recommending, for instance, that high school girls be taught home economics, which drew girls away from

enrolling in science and mathematics classes. Girls would be far better prepared “for a full, happy life,” said a 1900 report issued by the Commissioner of Education, by taking a course in “dress-making or cookery and arithmetic” instead of studying “trigonometry and art.”<sup>51</sup>

Partly as a result, fewer young women entered institutions of higher education with the necessary background to major in a scientific field.

### Growing Sexism

At the turn of the 20th century, women were particularly interested in the nature-study movement, which peaked in 1900-1910 and provided opportunities for women as science teachers, amateur collectors and museum and laboratory assistants. Much of the attack against women teachers, which gathered force after 1910, was aimed at the nature-study movement, which with its spiritual overtones was criticized for being too sentimental and feminizing to appeal to boys.

During the first decades of the 20th century, male science teachers began to dominate the newly formed professional associations. Textbooks and curriculum increasingly emphasized the physical sciences with the goal of encouraging more boys to take up science as a vocation. The National Research Council, which dispensed Rockefeller and Carnegie foundation grants for scientific projects, played a role by supporting men but rejecting women for funding. Although women represented 13 percent of the doctorates in the sciences, they received only 5 percent of the fellowships between 1920 and 1938.

The launch of the Soviet satellite *Sputnik* in 1957 aroused alarm that American science education was lagging behind its Cold War rival’s. The federal government supported curriculum initiatives to train gifted students in science, but when asked to identify those who might be potential

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## Why Girls Like Dolls

In a famous experiment, more than 100 day-old babies were shown a smiling female student and then a dangling mobile of similar size. Female babies looked longer at the face; boys looked longer at the mobile.<sup>1</sup>

The experiment by Cambridge University psychologist Simon Baron-Cohen has generated much controversy between believers and skeptics of innate differences. Baron-Cohen says it proves “beyond reasonable doubt” that sex differences in social interest are “in part biological in origin” and supports his theory that girls tend to be “empathizers” (better at social relations) while boys are “systemizers” (better at math, science and mechanical tinkering).<sup>2</sup>

But Harvard psychologist Elizabeth Spelke questions whether the smiling student might have biased the experiment by acting more expressively with the girls than with the boys, and whether the babies’ parents may have behaved differently according to the infants’ sex. Hundreds of experiments by her and other researchers have found no differences in the ways infants perceive objects, she argues.

Maryland physician Leonard Sax has yet another explanation: The babies’ actions may reflect sex differences in the anatomy of the eye rather than in the anatomy of the brain. Studies have shown that the male retina has mostly cells that compile information about movement and direction while the female retina has smaller cells that compile information about texture and color. That explains why young girls are more likely to crayon in colors while boys prefer to draw in black and white, according to Sax.

That may also explain why girls are more attracted to the more complex texture of a human face and to dolls while boys are attracted to a dangling mobile and a moving toy truck, he suggests.<sup>3</sup>

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<sup>1</sup> Simon Baron-Cohen, *The Essential Difference: The Truth about the Male and Female Brain* (2003), pp. 54-56.

<sup>2</sup> Quoted in Leonard Sax, *Why Gender Matters* (2005), p. 19. Jennifer Connellan, Simon Baron-Cohen, *et al.*, “Sex Differences in Human Neonatal Social Perception,” *Infant Behavior and Development*, 2000, pp. 113-18.

<sup>3</sup> Sax, *ibid.*, pp. 18-22.

scientists, “contemporaries almost always identified boys,” writes Kim Tolley, director of the master of education program at Notre Dame de Namur University, in Belmont, Calif.<sup>52</sup>

Physicists’ central role in developing nuclear bombs may also have steered many girls away from physics. In the 1950s, high school students described the scientist as a “mad, godless ‘brain’ or a sort of sorcerer’s apprentice,” according to anthropologist Margaret Mead. By 1955, the proportion of girls taking high school physics had fallen to less than 2 percent, down from 23 percent in 1890.<sup>53</sup>

### **‘Weak-minded’ Women**

Throughout much of the 19th and early 20th centuries, numerous theories claimed women were biologically incapable of engaging in reason, science and medicine. German physician Paul Julius Mobius’ bestseller, *Regarding the Physiological Weak-Mindedness of Women*, argued that the smaller size of women’s skulls explained their weak-

er intellect. While that theory appears to have validity for men, we know today that women with high IQs do not have larger brains than women with low IQs.<sup>54</sup>

However, scientists have continued to find differences in men’s and women’s brains. In men, greater gray matter is correlated with higher IQ; for women more white matter is related to intellectual functioning. In his most recent imaging study, psychologist Haier found women and men of equal intelligence used different parts of the brain while taking an IQ test. “We concluded that there seem to be two different brain architectures — one for men, one for women — both leading to equivalent performance on tests of intelligence,” he says.

The modern era of research in gender differences began in 1964, when Canadian psychologist Herbert Lansdell reported the existence of anatomical differences in the organization of female and male brains. Over the next two decades, a series of studies demonstrated that while the left hemisphere of the brain is clearly specialized for

language functions in men, such asymmetrical organization is less noticeable in women. Women tend to use more parts of their brain to accomplish specific intellectual tasks, which may explain why they often have better recoveries from stroke, using healthy parts of the brain to compensate for injured regions.<sup>55</sup>

Maryland physician Sax says one of the most important findings of recent brain research is that different regions of the brain mature in different sequences for boys and girls. Some of the regions involved in mechanical, visual and spatial reasoning appear to mature four to eight years earlier in boys. Parts of the brain that handle language and fine motor skills like handwriting mature several years earlier in girls.<sup>56</sup>

“The fact that girls may not excel in geometry at 12 doesn’t mean they won’t have the brain of a Euclid or Einstein,” Sax says. Boys’ inferior language skills in the early grades “doesn’t mean among boys we won’t have a Faulkner or a Hemingway,” he adds.

## Did Evolution Make Males Better at Math?

Evolution is often offered as an explanation for differences in boys' and girls' math abilities, usually put forward by those who believe that boys have an innate, biological advantage. Although the theories may sound logical, they are just theories. "They're certainly not quoting any archeologist who's ever dug a site," says Shirley Gorenstein, professor emerita of anthropology at Rensselaer Polytechnic Institute. "We have only a vague idea" what life was like for the hunter-gatherer societies of 10,000 years ago, according to Gorenstein. And as psychologist Diane F. Halpern at Claremont McKenna College has noted, "almost any result can be explained post hoc" by an evolutionary theory.<sup>1</sup>

Here are three commonly offered evolutionary explanations:

- Men have better navigational skills and can better visualize an object rotating through space because early man needed these skills to hunt and find his way home. "If you're hunting or going on a raiding party, you don't know exactly where you're going before you start the trip. Men almost certainly engaged in activities that involved more moving around and that would lead to a better ability to represent 3-D space," says David C. Geary, a University of Missouri psychologist.

*Counterargument:* The spatial skills used to solve math and physics problems are "conceptually closer" to those typically used by females in traditional societies, such as weaving, Halpern argues.<sup>2</sup> According to Gorenstein, we don't even know for sure that men rather than women were the original hunters.

- Men are more interested in mechanical things than women because in early societies men made tools. The areas of the brain associated with spatial abilities "seem engaged when people are thinking about or using tools," says Geary, arguing it might explain males' superior ability in some forms of spatial reasoning.

*Counterargument:* "We don't know who the tool makers were," Gorenstein says. If Stone Age men dragged rocks back to home camps from the quarry, women could have made the tools at home, she says.

- Men are more variable in ability than women are (there are both more brilliant male minds and more subnormal male minds) because a male can have more offspring than a fe-

male. To achieve better reproductive success, Harvard psychologist Steven Pinker argues, men are more likely to be polygamous, seeking quantity in offspring, while women seek quality. In a recent *New Republic* article, Pinker stated "an exceptional son who might sire several-dozen grandchildren can more than make up for his dull, childless brothers."<sup>3</sup>

*Counterargument:* The problem with Pinker's philandering caveman, writes *New York Times* science reporter Natalie Angier, is that biologically "each episode of fleeting sex has a remarkably small probability of yielding a baby."<sup>4</sup> The bed-hopper might not have survived very long because each new effort at wooing a fertile female "would have pushed him smack up against a thicket of other suitors' spear tips."<sup>5</sup>

It's not clear why more men than women score at both the upper and lower ends on achievement tests, says Kimberlee Shauman, a sociologist at the University of California-Davis, nor that the greater number of top-scoring men is immutable.

"When people refer to the past to sustain a current argument, they either need archaeological data as direct evidence or they can imagine the past," Gorenstein says.

Imagining is just what the new school of evolutionary psychologists is doing when they promote ideas like these, Angier complains. But evolutionary psychology has found a popular audience, as evidenced by Pinker's best-selling book *The Blank Slate*, which argues that many feminists have gone too far in elevating nurture over nature.<sup>6</sup>

Angier contends that evolutionary psychologists often have little evidence to support their view of nature. In her book *Woman: An Intimate Geography*, Angier denounces evolutionary psychology as a form of "neo-Darwinism that has trampled across the campus of public opinion . . . feeling no humbleness for want of evidence or for the many exceptions to their book of rules."<sup>7</sup>

<sup>1</sup> Diane F. Halpern, "A Cognitive-Process Taxonomy for Sex Differences in Cognitive Abilities," *Current Directions in Psychological Science* (2004), pp. 138-9.

<sup>2</sup> *Ibid.*

<sup>3</sup> Steven Pinker, "The Science of Difference," *The New Republic Online*, post date Feb. 7, 2005.

<sup>4</sup> Natalie Angier, *Woman: An Intimate Geography* (1999), p. 368.

<sup>5</sup> *Ibid.*, p. 385.

<sup>6</sup> Steven Pinker, *The Blank Slate: The Modern Denial of Human Nature* (2002).

<sup>7</sup> Angier, *op. cit.*, p. 378.

### Gender-Equity Fight

The women's movement, which gained momentum in the 1960s, focused attention on careers that had previously been barred to women. Title IX of the Educational Amendments of 1972, barring gender dis-

crimination in education, provided a legal basis for women to fight in court for gender equity. In 1983 in *Newburg v. Board of Education*, a Pennsylvania state court ruled that Girls High School in Philadelphia had inferior course offerings in math and science, compared to the all-boys Central High. The court ordered Central to admit girls.

Rising concern about the neglect of girls in the classroom beginning in the 1980s sparked new efforts to interest girls in math and science. In the early 1990s, research by Harvard psychologist Carol Gilligan (now at New York University) described adolescence as a time when girls experience an ero-

*Continued on p. 462*

# At Issue:

## *Are gender differences in math and science innate?*

**STEVEN PINKER**  
*PROFESSOR OF PSYCHOLOGY, HARVARD UNIVERSITY*

FROM A DEBATE AT HARVARD, APRIL 22, 2005, POSTED ONLINE  
AT WWW.EDGE.ORG

**t**here is much hard evidence for innate sex differences, evidence that cannot be explained away by socialization and bias.

There are large differences between males and females in levels of sex hormones, and there are receptors for those hormones all over the brain. There are many small differences in men's and women's brains, including the overall size of the brain (even correcting for body size), the density of cortical neurons, the degree of cortical asymmetry and several others.

Sex differences seem to emerge even in the first week of life. Girls respond more to sounds of distress and make more eye contact than boys. Newborn boys [are] more interested in looking at a physical object than a face, whereas newborn girls are more interested in looking at a face than an object.

[L]ater in development there are vast and robust differences between boys and girls, seen all over the world, in all types of cultures, pre- and post-waves of feminism. Boys far more often than girls engage in rough-and-tumble play, which involves aggression, physical activity and competition. Girls spend a lot more time in cooperative play [and playing at] parenting.

Evidence disproves that these behaviors are just the products of socialization. In a famous 1970s incident called the John/Joan case, one member of a pair of identical twin boys lost his penis in a botched circumcision. Following advice from the leading gender expert of the time, the parents agreed to have the boy castrated, given female-specific hormones and brought up as a girl. All this was hidden from him throughout his childhood.

[I]t turned out that from the youngest age he exhibited boy-typical patterns of aggression and rough-and-tumble play, rejected girl-typical activities and showed a greater interest in things than in people. At age 14, his father finally told him the truth. He underwent surgery, married a woman, adopted two children and got a job in a slaughterhouse.

There seems to be a widespread assumption that if a sex difference conforms to a stereotype, the difference must have been caused by . . . differential expectations for boys and for girls. But, in fact, stereotypes might reflect differences rather than cause them. For example, there is a stereotype that basketball players are taller than jockeys. But that does not mean that basketball players grow tall, and jockeys shrink [just] because we expect them to have certain heights!

**ELIZABETH SPELKE**  
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FROM A DEBATE AT HARVARD, APRIL 22, 2005, POSTED ONLINE  
AT WWW.EDGE.ORG

**f**rom the moment of birth, there are unintentional but pervasive and important differences in the ways males and females are perceived and evaluated.

Studies . . . have found that parents of boys describe their babies as stronger, heartier and bigger than parents of girls, although medical records revealed the boys and girls were indistinguishable in weight, strength and coordination.

When parents of sixth-grade students were asked how talented their child was in mathematics, [boys'] parents were more likely to say their sons had talent than parents of daughters. Objective measures — including math grades, performance on standardized tests, teachers' evaluations and children's expressed interest in math — revealed no differences between the girls and boys.

So there's clearly a mismatch between what parents perceive in their kids and what objective measures reveal. If knowledge of a child's gender affects adults' perception of that child, then male and female children are going to elicit different reactions from the world and different patterns of encouragement.

These biased perceptions may deter some female students from even attempting a career in science or mathematics. . . . There's also likely to be a snowball effect. All of us have an easier time imagining ourselves in careers where there are other people like us. In a situation where there are few female scientists and mathematicians, young girls will be less likely to see math and science as a possible life.

Moreover, because of social forces it is currently impossible to evaluate whether biological differences factor into propelling more men than women into careers in mathematics and science.

As long as discrimination and biased perceptions affect people so pervasively, we'll never know if the argument holds any weight. The only way we can find out is to allow all of the evidence that men and women have equal cognitive capacity to permeate through society. Allow people to evaluate children in relation to their actual capacities, rather than one's sense of what their capacities ought to be, given their gender. Then we can see, as those boys and girls grow up, whether different inner voices pull them in different directions.

I don't know what the findings of that experiment will be. But I do hope that some future generation of children gets to find out.

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sion of self-esteem.<sup>57</sup>

Gilligan's work was bolstered in the 1980s by the observations of David and Myron Sadker, who reported that boys dominated classroom discussions and were more likely to get attention from teachers, which helped boys' superior achievement.<sup>58</sup>

National attention focused on the issue in 1992 when an AAUW study reported that girls were lagging seriously behind boys in math and science, particularly in taking advanced courses in those subjects. The report leaned heavily on research by the Sadkers reporting that teachers gave more classroom attention to elementary and middle-school boys, who called out answers more often than girls. By contrast, when girls called out they were usually corrected with comments like, "Please raise your hand if you want to speak," the Sadkers reported.<sup>59</sup>

These conclusions were harshly criticized by the American Enterprise Institute's Sommers, who said the Sadkers were never able to supply the original data for their finding that boys called out answers eight times more often than girls. "Whatever the accurate number may be, no one has even shown that permitting a student to call out answers in the classroom confers any kind of academic advantage," she wrote in *The War Against Boys*. Boys were probably less attentive than girls as evidenced by their generally poorer academic performance, she suggested, which might be why teachers called on them more.<sup>60</sup>

In 1998, former Education Department official Ravitch blamed the AAUW, as well as a gullible press, for diverting attention from the much larger gaps among African-Americans and Hispanics. She told *The New York Times* that the AAUW report had come out as "girls had just overtaken boys in almost every area."<sup>61</sup>

Indeed, sex differences in high school math course participation had

disappeared or even shifted to favor females. Even the differences in those taking calculus was small — 11.2 percent of males and 10.6 percent of females; AP calculus was taken by 7.3 percent of males and 6.4 percent of females.<sup>62</sup> Women earned close to half of all science and engineering bachelor's degrees that year. Beginning in the late 1990s, they were more likely than men to enter graduate school after obtaining a science bachelor's degree.<sup>63</sup>

Some of these changes had even predated the AAUW report. Between 1960 and 1972, the percentage of girls taking four years of high school math had more than doubled.<sup>64</sup> American women have received more college degrees than American men every year since 1982, a gap that continues to widen every year.<sup>65</sup>

In 1994, Congress passed the Gender Equity in Education Act, which defined girls as an "under-served population" on the same level as other discriminated-against minorities. The AAUW helped write provisions requiring teacher training in gender equity and mandating gender-equitable teaching methods in high-poverty schools. The federal government awarded millions of dollars to researchers to study the plight of girls and to educators to counter the bias against them. According to Sommers, this helped to foster a cottage industry of gender-bias experts, whom schools felt pressured to hire to avoid being charged with discrimination.

In the late 1990s, a spate of books about the plight of boys shifted attention to their far worse average performance in reading, their higher numbers in remedial education and the fact that they were a shrinking minority of those entering college. The mass murders committed by two adolescent boys at the Columbine High School in Littleton, Colo. in 1999 suddenly put boys in the spotlight as the troubled sex.<sup>66</sup> ■

## CURRENT SITUATION

### Discrimination or Choice?

The recent debate over the remarks by Harvard's Summers has sparked renewed attention to an area some would say has been studied to death. Earlier this month, women's science groups gathered over 6,000 signatures on a letter to Sens. Ron Wyden, D-Ore., and George Allen, R-Va., urging Congress to conduct a broad-ranging inquiry investigating "persistent under-representation" of women in science and engineering and to study how federal laws could address inequities.<sup>67</sup>

"People are really tired of waiting for there to be a change. They'd like attention to be paid to this consistently," says Carol Muller, one of the organizers of the signature drive and founder and CEO of Mentornet, an organization that pairs budding scientists with professional mentors.

Repeatedly, congressional committees and commissions have bewailed the low number of women in science careers, but action has been slow to follow, Muller says. For example, in 2000 the congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development recommended national education standards to encourage better preparation in math and science of girls and minorities and more aggressive efforts by employers to hire women and minorities in science and technology.<sup>68</sup> There was no follow-up, Muller contends.

Wyden chaired hearings in 2002 questioning the low representation of women in many university science departments and calling for stronger enforcement of Title IX prohibitions on sex discrimination. The hearings led Congress to pass legislation that year man-

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dating a National Academy of Sciences report on women's careers in science. That report, expected by the end of 2005, will investigate gender differences in hiring, promotion and such benefits as lab space at 89 research universities.

In a report last year, also mandated by the legislation, the GAO found that most federal science agencies responsible for distributing billions of dollars in research grants to universities have not set up procedures to ensure that the schools are complying with Title IX. While the proportion of women faculty in the sciences has increased in the past three decades, the report said, "they still lag behind men faculty in terms of salary and rank." It also cited studies suggesting that discrimination "may still affect women's choices and professional progress."<sup>69</sup>

In response to the GAO report, federal agencies including the National Science Foundation (NSF), the Department of Education, the Department of Energy and NASA have formed an interagency committee to jump-start Title IX enforcement. The NSF will be looking to see whether discrimination complaints have been filed, whether grievance procedures are in place at the schools and how many women are employed in math and science departments, according to Ronald Branch, director of NSF's Office of Equal Opportunity Programs.

The GAO also found that relatively few sex-discrimination complaints have been filed by women scientists against universities, suggesting little overt discrimination in the view of some critics of affirmative action. But women's advocacy groups say women either don't know about their legal rights or are afraid to file a complaint. "There's a real fear of retaliation out there," says Samuels of the National Women's Law Center. "That's why federal enforcement is so critical."

Just by threatening to withhold research grants from universities that don't comply with Title IX, federal agencies could have a huge impact on women's participation, says Har-

vard researcher Trower. "You need the big stick," she says. "You need to withhold money from people until they do what they say they're going to do."

## **More Women Scientists**

Women's participation in the sciences has grown dramatically in the last four decades. In 1960, women made up less than 3 percent of all scientists; by 2003 they composed 20 percent of scientists, according to the GAO. In 1960 they constituted less than 1 percent of engineers and 26 percent of mathematicians. By 2003, they made up 14 percent of engineers and a third of mathematicians.<sup>70</sup>

But women's representation in academic departments has not kept pace with their growth in science bachelor's and doctoral degrees. For example, female students now account for 47 percent of bachelor's degrees in chemistry but only 12 percent of chemistry faculty. They account for 48 percent of bachelor's degrees in math but only 8 percent of faculty.<sup>71</sup>

Harvard economist Claudia Goldin calls this trend puzzling considering that "the pipeline is now fuller at the start" with women getting degrees in science. "It is the leakage along the way to the top that is the new matter for concern."<sup>72</sup>

One factor may be the low turnover in academic departments, where full professors can retain tenure well into their 70s.

Some argue that discrimination still plays a big part in the way academic departments search for new faculty. "It's still the case at the majority of campuses that males constitute the majority of search committees," says Elizabeth Ivey, president of the Association for Women in Science. "They've got to learn you have to call more than just your male buddies."

The problem is exacerbated by the fact that women often lack female men-

tors and role models in science departments. Women's greater child-care responsibilities often mean they don't have the time to network informally like their male peers.

Protestations from faculty that they're unable to find qualified women often hide unconscious bias, critics say. Rhea Steinpreis, a neuroscientist at the University of Wisconsin-Milwaukee, tested this contention by sending the identical résumé to 238 randomly selected psychology professors. Fewer than half said they would hire the applicant when the name "Karen Miller" appeared at the top; two-thirds endorsed the applicant when the name "Brian Miller" headed the résumé.<sup>73</sup> ■

## **OUTLOOK**

### **Crisis Ahead?**

Pressure to bring more women into science may intensify along with growing national concerns about a potential shortage of homegrown scientists, engineers and technicians. Shirley Ann Jackson, president of Rensselaer Polytechnic Institute, in Troy, N.Y., has called the country's failure to meet its need for technically skilled workers a "crisis" that "could jeopardize the nation's pre-eminence" in the world.<sup>74</sup>

As the American Council on Education noted in a recent report, the United States can no longer rely so heavily on foreign students, many of whom used to assume faculty or research careers. Immigration restrictions imposed since 9/11 have recently stemmed this tide, and burgeoning economic powers like India and China are establishing their own universities to retain native-born scientists.<sup>75</sup>

A study by Harvard researchers now getting under way will rate universities based on their family-friendly policies. Survey researcher Trower hopes junior

women faculty will request the ratings when they're seeking jobs, placing competitive pressure on universities to institute such policies in order to attract the best and the brightest. "We're trying to bring market forces to bear on [colleges and universities], because all the task forces and recommendations are not changing the workplace," she says.

But some educational experts say the focus on shrinking gender differences in science seems misplaced, considering that the most disturbing educational lag in achievement is found among minority boys, not girls.

"Only one-third of Latinos and less than half of African-Americans are graduating from high school; that's very serious news," says Halpern, noting African-American boys perform more poorly than African-American girls on almost every measure.

In addition, many areas of research on gender differences are still in their infancy. Only recently have scientists been able to look inside the brain with the new technology of functional magnetic resonance imaging to see what parts of the brain light up when men and women perform intellectual tasks. The significance of these exciting new pictures in explaining gender differences in learning could take many years to tease out.

Other schools of thought are highly speculative and controversial, such as evolutionary explanations attributing women's growing numbers in the biological sciences to their traditional nurturing roles or boys' superior spatial skills to their territorial wanderings

as early hunter-gatherers.

Meanwhile, research from the environmental camp concluding that negative gender stereotypes hurt girls' performance on high-stakes math tests has been dismissed as flimsy by experts in the biological camp.

Historically, differing pictures of science have been marshaled by advocates depending on how much stock they put in innate differences, how they picture feminine "nature" and whether they think women's participation in science can increase dramatically. That fight is likely to continue. ■

## Notes

<sup>1</sup> Summers phrased his comment this way: "So, my best guess, to provoke you, is . . . there are issues of intrinsic aptitude . . . and that those considerations are reinforced by what are in fact lesser factors involving socialization and discrimination." For his complete remarks, see "Full Transcript: President Summers' Remarks at the National Bureau of Economic Research, Jan. 14, 2005," *The Harvard Crimson*, Feb. 18, 2005 at [www.thecrimson.com](http://www.thecrimson.com). His comment that there were "innate differences" came in a later interview: See Marcella Bombardieri, "Summers' Remarks on Women Draw Fire," *The Boston Globe*, Jan. 17, 2005, p. A1.

<sup>2</sup> Donna J. Nelson, "A National Analysis of Diversity in Science and Engineering Faculties at Research Universities," Jan. 6, 2005.

<sup>3</sup> Linda Chavez, "Harvard Prez's Admission: Men and Women are Different," *Jewish World Review*, Jan. 19, 2005, at [www.jewishworldreview.com](http://www.jewishworldreview.com).

<sup>4</sup> Anat Zohar, *et al.*, "Her Physics, His Physics: Gender Issues in Israeli Advanced Placement Physics Classes," *International Journal of Science*

*Education*, Vol. 25, No. 2, 2003, pp. 245-268.

<sup>5</sup> Diane F. Halpern, "A Cognitive Process Taxonomy for Sex Differences in Cognitive Abilities," *Current Directions in Psychological Science*, Vol. 13, No. 4, 2004, pp. 135-139.

<sup>6</sup> Editorial, "Separating Science from Stereotype," *Nature Neuroscience*, March 2005, p. 253.

<sup>7</sup> Richard J. Haier and Camilla Persson Benbow, "Sex Differences and Lateralization in Temporal Lobe Glucose Metabolism During Mathematical Reasoning," *Developmental Neuropsychology*, 11(4), 1995, pp. 505-514.

<sup>8</sup> A recent study showed men and women use different parts of the brain while taking an IQ test. Richard J. Haier, *et al.*, "The Neuroanatomy of General Intelligence: Sex Matters," *NeuroImage*, Jan. 16, 2005 (online), pp. 320-327.

<sup>9</sup> American Association of University Women, "How Schools Shortchange Girls," 1992 at [www.aauw.org](http://www.aauw.org).

<sup>10</sup> Department of Education, press release, "Study Shows Educational Achievement Gender Gap Shrinking," Nov. 19, 2004.

<sup>11</sup> Jay R. Campbell, *et al.*, "NAEP 1999 Trends in Academic Progress: Three Decades of Student Performance," August 2000, Department of Education.

<sup>12</sup> Halpern, *op. cit.*

<sup>13</sup> Nelson, *op. cit.*

<sup>14</sup> Government Accountability Office, "Gender Issues: Women's Participation in the Sciences Has Increased, but Agencies Need to Do More to Ensure Compliance with Title IX," July 2004.

<sup>15</sup> These score statistics are from Yu Xie and Kimberlee Shauman, *Women in Science* (2003). Excerpts at [www-personal.umich.edu/~yuxie](http://www-personal.umich.edu/~yuxie). Also see presentation at National Bureau of Economic Research, Jan. 14-15, 2005, at <http://nber15.nber.org/~sewp/events/2005.01.14/Agenda-1-14-05-WEB.htm>.

<sup>16</sup> American Council on Education, "An Agenda for Excellence," February 2005, p. 4. For background, see Sarah Glazer, "Mother's Movement," *The CQ Researcher*, April 4, 2003, pp. 297-320.

<sup>17</sup> Tamar Lewin, "University of California System Said to Lag in Hiring Women," *The New York Times*, May 18, 2005, p. A14.

<sup>18</sup> The report can be found at [www.aauw.org](http://www.aauw.org).

<sup>19</sup> Diane Ravitch, "Girls are Beneficiaries of Gender Gap," *The Wall Street Journal*, Dec. 17, 1998.

<sup>20</sup> See Sarah Glazer, "Boys' Emotional Needs," *The CQ Researcher*, June 18, 1999, pp. 521-544, see p. 529.

<sup>21</sup> National Center for Education Statistics, "Projections of Education Statistics to 2012," at [http://nces.ed.gov/pubs2002/proj2012/ch\\_2.asp](http://nces.ed.gov/pubs2002/proj2012/ch_2.asp).

## About the Author

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<sup>22</sup> Beatriz Chu Clewell and Patricia B. Campbell, "Taking Stock: Where We've been, Where We Are, Where We're Going," *Journal of Women and Minorities in Science and Engineering*, Vol. 8, issues 3 & 4, 2002, pp. 255-284, p. 259.

<sup>23</sup> *Ibid.*, p. 260.

<sup>24</sup> *Ibid.*, p. 263.

<sup>25</sup> New York Academy of Sciences, "Women in Science: Are They Being Held Back?" panel discussion held April 14, 2005, Cooper Union, New York City.

<sup>26</sup> Georgia Institute of Technology, press release, "Breaking Down Gender Barriers: New Book Looks at Roadblocks Impeding Women Scientists and Engineers," Feb. 16, 2004.

<sup>27</sup> Nelson, *op. cit.*, p. 3.

<sup>28</sup> Department of Education, press release, *op. cit.*

<sup>29</sup> Steven Pinker, *The Blank Slate* (2002), p. 344. For original data see Camilla Persson Benbow, *et al.*, "Sex Differences in Mathematical Reasoning Ability at Age 13," *Psychological Science*, November 2000, pp. 474-480.

<sup>30</sup> See [www.edge.org](http://www.edge.org).

<sup>31</sup> Pinker, *op. cit.*, p. 344.

<sup>32</sup> Halpern, *op. cit.*, p. 136.

<sup>33</sup> *Ibid.*, p. 138.

<sup>34</sup> Pinker, *op. cit.*, p. 348.

<sup>35</sup> *Ibid.*, p. 350.

<sup>36</sup> Ann M. Gallagher and James C. Kaufman, *Gender Differences in Mathematics* (2005), p. 318.

<sup>37</sup> Haier, *et al.*, *op. cit.*

<sup>38</sup> Christina Hoff Sommers, *The War Against Boys* (2000), p. 43.

<sup>39</sup> *Ibid.*, p. 52.

<sup>40</sup> Nelson, *op. cit.* This study was of the top 50 research universities.

<sup>41</sup> "A Study on the Status of Women Faculty in Science at MIT," MIT Faculty Newsletter, March 1999, at <http://web.mit.edu/fnl/women/women.html>.

<sup>42</sup> For background on Title IX, see Jane Tanner, "Women in Sports," *The CQ Researcher*, May 11, 2001, pp. 401-424.

<sup>43</sup> Letter to Lawrence Summers at [www.nwlc.org/pdf/1-27-05LarrySummersSignOnLetter.pdf](http://www.nwlc.org/pdf/1-27-05LarrySummersSignOnLetter.pdf). For percentages of women faculty in math, engineering and physics, see American Council on Education, "An Agenda for Excellence: Creating Flexibility in Tenure-Track Faculty Careers," February 2005, p. 2.

<sup>44</sup> American Council on Education, *ibid.*

<sup>45</sup> *Ibid.*, p. iv. The panel is composed of presidents of Tufts University, University of North Carolina, Syracuse University, University of Michigan, University of California-Riverside, Vanderbilt University, State Univer-

## FOR MORE INFORMATION

**Association for Women in Science**, 1200 New York Ave., N.W., Washington, DC 20005; (202) 326-8940; [www.awis.org](http://www.awis.org). Promotes women in scientific fields.

**Committee on Women in Science and Engineering**, National Academy of Sciences; [www7.nationalacademies.org/cwse/About\\_CWSE.html](http://www7.nationalacademies.org/cwse/About_CWSE.html). Aims to increase women's participation in the sciences.

**Edge**; [www.edg.org](http://www.edg.org). This site posts an April 22, 2005, debate on gender differences between Harvard psychologists Steven Pinker and Elizabeth Spelke and other online debates.

**FairTest**, 342 Broadway, Cambridge, MA 02139; (617) 864-4810; [www.fairtest.org](http://www.fairtest.org). This gadfly organization considers the SAT biased against girls.

**Implicit Association Test**; <https://implicit.harvard.edu/implicit/demo/>. Offers a much-discussed 10-minute online test, which reveals unconscious assumptions about gender and science. The test, developed by Harvard psychologist Mahzarin Banaji, has been cited as proof of widespread gender bias against women in science.

**National Center for Education Statistics**, 1990 K St., N.W., Washington, DC 20006; (202) 502-7300; <http://nces.ed.gov>. The federal database for national education statistics.

**National Science Foundation**, 4201 Wilson Blvd., Arlington, VA 22230; (703) 292-5111; [www.nsf.gov](http://www.nsf.gov). Links to recent studies funded by the NSF's Research on Gender in Science and Engineering program, at [www.nsf.gov/funding/pgm\\_summ.jsp?pims\\_id=5475](http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5475).

**New York Academy of Sciences Women Investigators Network**; [www.nyas.org/channels/index.asp?channelID=53](http://www.nyas.org/channels/index.asp?channelID=53). Posts numerous conferences on women in science.

**UC Faculty Family Friendly Edge**; <http://ucfamilyedge.berkeley.edu/ucfamilyfriendlyedge.html>. Maintained by University of California researchers, contains numerous studies about academia's work/family conflicts.

sity of New York at Albany, Ohio State University, University System of Maryland and Pennsylvania State University.

<sup>46</sup> Natalie Angier, "Pay Gap Remains for Women in Life Sciences," *The New York Times*, Oct. 16, 2001, p. A3.

<sup>47</sup> American Council on Education, *op. cit.*

<sup>48</sup> Quoted in "The San Diego Supercomputer Center Presents Women in Science," at [www.sdsc.edu/sciencewomen/index.html](http://www.sdsc.edu/sciencewomen/index.html).

<sup>49</sup> *Ibid.*

<sup>50</sup> Kim Tolley, *The Science Education of American Girls* (2003), see pp.182-3, 184.

<sup>51</sup> *Ibid.*, p. 171.

<sup>52</sup> *Ibid.*, p. 215.

<sup>53</sup> *Ibid.*, pp. 215-216.

<sup>54</sup> Leonard Sax, *Why Gender Matters* (2005) pp. 31-32.

<sup>55</sup> *Ibid.*, pp. 11-12.

<sup>56</sup> Amanda Ripley, "Who Says a Woman Can't Be Einstein?" *Time*, March 7, 2005, p. 50.

<sup>57</sup> Carol Gilligan, *In a Different Voice* (1982) and *Making Connections* (1990).

<sup>58</sup> The Sadkers' research was outlined in their book *Failing at Fairness* (1994).

<sup>59</sup> Glazer, *op. cit.*, June 18, 1999, p. 531.

<sup>60</sup> Sommers, *op. cit.*, p. 23.

<sup>61</sup> *Ibid.*, p. 22.

<sup>62</sup> Gallagher and Kaufman, *op. cit.*, p. 5.

<sup>63</sup> Clewell and Campbell, *op. cit.*, p. 262.

<sup>64</sup> Gallagher and Kaufman, *op. cit.*, p. 4.

<sup>65</sup> Halpern, *op. cit.*, p. 135.

<sup>66</sup> See Glazer, June 18, 1999, *op. cit.*

<sup>67</sup> For text of letter see [www.mentornet.net/wyden-allen](http://www.mentornet.net/wyden-allen).

<sup>68</sup> *Land of Plenty* (2000). Summary of report is at [www.spie.org/web/oe/september/sep00/landofplenty.html](http://www.spie.org/web/oe/september/sep00/landofplenty.html).

<sup>69</sup> GAO, *op. cit.*

<sup>70</sup> *Ibid.*

<sup>71</sup> Nelson, *op. cit.*, p. 2.

<sup>72</sup> Claudia Goldin and Lawrence F. Katz, "Sommers is Right," *The Boston Globe*, Jan. 23, 2005.

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