intermedia, a band of gray matter and fiber that connects the right and left halves of the thalamus. While the data are sketchier for these areas than for the corpus callosum, Gorski's team found that the massa intermedia tends to be absent altogether in men more frequently than it is in women. While the function of the massa intermedia isn't known, some early NIH studies have found a correlation between the presence of it and I.Q. scores (with different patterns in men and women). Says Witelson: "Obviously, intelligence isn't situated in the massa intermedia, but it could be correlated with other anatomical features that are relevant to some aspects of intelligence."

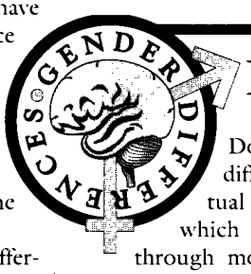
Although evidence of anatomical differences between male and female brains is accumulating fast, many researchers think the surface has barely been scratched. "People haven't [looked in other regions] so far," says Swaab. They should, he says, "because brain weight is already sexually dimorphic. That leads me to expect that differences will be found all over the brain."

One of the most promising regions for future study is the hippocampus, a temporal lobe structure that is thought to participate in memory and spatial processing. Studies of the hippocampus could go beyond documenting differences into the key puzzle of why male and female brains have evolved differently. That possibility is hinted at by intriguing studies of the hippocampus in wild rodents conducted by University of Pittsburgh anthropologist Steven J.C. Gaulin. "If the hippocampus was critically important in spatial processing, then I wondered if you could see something as gross as size differences in the hippocampus of males and females," says Gaulin.

Working with University of Utah animal behavioralist Lucia Jacobs, he studied the behavior of three species of voles: polygynous wild meadow voles, a species in which the males travel farther than females to find mates—an activity that requires considerable spatial processing—and prairie voles and pine voles that are monogamous and stayed by the sides of their mates. On autopsying the rodents, the pair found the polygynous males' hippocampi were 11% bigger on average than those of females. But the monogamous males' hippocampi were no bigger than the females.' Says Gaulin: "I think this is the only sex difference in the mammalian brain for which we have a plausible evolutionary function that has been tested."

Although it might seem that there's a huge evolutionary distance between a vole and a man, "the obvious next step is to use MRI to image the hippocampus in humans," says University of Arizona psychobiologist Lynn Nadel, a specialist in the hippocampus.

Whether ideas derived from work on voles can be applied directly to humans or not, the observed differences between men's and women's brains are no doubt there for solid evolutionary reasons. Says Gaulin: "If you look at the present-day organisms as bearing the stigmata of their polygynous past, such as higher male metabolism rates, larger male body size, and higher male aggressiveness, then it's not at all implausible for us to bear other marks of it in the brain." Now that anatomical differences are being established, surely one of the next key steps will be to understand why those differences came into being. ■ ANN GIBBONS



Is "Gender Gap" Narrowing?

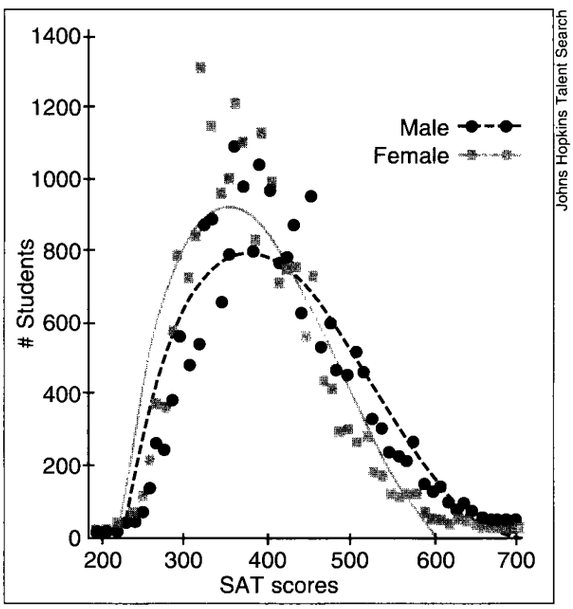
Do males and females have different kinds of intellectual abilities? That notion, which has probably prevailed through most of recorded history, has undergone sharp alterations as a result of both scientific and political developments in the last 3 decades. And particularly now, when "political correctness" has become a hot button, this area of research is something of a political minefield.

The starting point for this debate is a large body of evidence, accumulated over many decades, suggesting that there are some differences in cognition and perception between men and women. Generally speaking, test results show that females are somewhat better at verbal expression, while males have a persistent advantage in certain quantitative and spatial abilities. (These generalizations were the main ones that emerged from the first major attempt to synthesize the literature, *The Psychology of Sex Differences*, written in 1974 by Eleanor Maccoby and Carol Nagy Jacklin.)

But are these differences "real?" And are they diminishing? Both questions are currently being fiercely debated. Indeed, in the opinion of one researcher, psychologist Diane Halpern of the University of Southern California, "The hostile and politically charged climate surrounding sex differences research has called into question the possibility of ever obtaining bias-free research."

Within this supercharged atmosphere, there's something of a polarity between biologically and socially oriented researchers. Those at the biological end of the spectrum, such as behavioral neuroscientist Sandra Witelson of McMaster University in Ontario, think it's obvious that biology has a role in cognitive sex differences. "The neurobiological evidence is continuing to mount...there are too many incontestable findings—things that have to have consequences in behavior and thinking." (See story p. 957.) In fact, she says, "if one didn't observe these sex differences, one would hypothesize that they must exist."

But more socially oriented investigators—such as psychologist Janet Hyde of the University of Wisconsin—flatly disagree. "We've constructed theories of sex differences in the brain to account for differences in abilities," says Hyde. But now, she argues, the gender gap in test scores is waning. "We've come to question the very existence of the phenomenon the brain theories were constituted to explain."



Mathematical gap. *Math scores of precocious 12-year-olds show boys predominate at the top.*

Getting a grip on the available data is not easy: Male-female differences in cognition are often subtle, they change according to age and ability level, and standardized tests are crude tools for resolving questions about sex differences they weren't designed to measure. As a result, even a slight change in a test question can result in a big change in "effect size"—the proportion of a standard deviation by which the sexes differ. Furthermore, generalizing about "verbal ability" obscures the fact that this category includes a va-

riety of skills: verbal fluency (where females excel), analogies (where males do better), spelling, writing, and comprehension. Similarly, the typical male advantages in "visual-spatial ability" vary widely depending on test population and the subskill being measured.

But in spite of such subtleties and confusions, at least one general trend has become apparent in the past decade: Increasing attention is being focused on the question of whether the "gender gap" is narrowing. Evidence to support a narrowing comes largely from the past decade's meta-analyses—studies of studies that crunch disparately gathered data into cumulative results. One such analysis, on "gender differences in verbal ability," published in the *Psychological Bulletin* in 1988 by Hyde and psychologist Marcia Linn of the University of California at Berkeley, proposed that, in fact, overall sex differences had almost disappeared. The effect size in favor of females from studies published before 1973 was .23, and it fell to .10 for those published after 1973. Since .80 is commonly regarded as a large effect size, this means the difference went from small to just about nothing.

In a companion meta-analysis on math performance, published in the *Psychological Bulletin* last year, Hyde and psychologists Elizabeth Fennema and Susan Lamon of the University of Wisconsin again found declines in the average effect size: In this case, it was presumed male advantages that were diminishing. The study covered scores on computation, concepts, problem-solving, arithmetic, algebra, geometry, and calculus. The overall effect size decreased from .31 before 1973 to .14 in the post-1973 period.

Other researchers have also found a narrowing of the disparity between males and females. And indeed, data from average test populations seem encouraging to those who say the gap is narrowing. But that hardly settles the question. Those who believe the gender gap still exists question the meta-analytical approach, saying that, by pooling data, meta-analysis blurs rather than clarifies differences. For example, Halpern argues that if statistically insignificant results were eliminated from Linn and Hyde's meta-analysis, the female advantage in verbal performance would have remained. In addition, says Halpern, SAT data (eliminated from Linn and Hyde's final estimates on the grounds that they would overwhelm the other results) show that the mathematical advantage of males—about half a standard deviation—has remained unchanged for 23 years.

Furthermore, critics such as Halpern say that results from high-ability test subjects don't indicate a narrowing of the gap at all. The most striking findings supporting this view come from the Study of Mathematically Precocious Youth (SMPY), initiated in 1970 by Julian Stanley of Johns Hopkins University, which administers the Scholastic Aptitude Test to high-ability seventh and eighth graders. According to his colleague Camilla Benbow, who is continuing the project at Iowa State University, the pattern has remained constant for 2 decades: Among 12-year-olds who score 500 or higher on the math portion of the SAT, the male-female ratio is 2:1, rising to 4:1 at scores above 600, and 13:1 above 700.

A major reason for these surprising discrepancies is something cognitive researchers call "greater male variability," meaning that there are always more males than females at both the bottom and the top of score distributions. This is particularly evident in the lopsided SMPY results. Benbow argues that the intrinsic difference in math ability coupled with this greater variability means that in math "there are many more extremely talented males than females." Her colleague David Lubinsky adds that the greater variability also has the effect—at the top ability levels—of wiping out females' advantage in verbal tasks: In the top 1%, the sexes are equally represented.

But those who think the gender gap is mainly a function of social influences don't buy that argument. Linn, for example, contends instead that in highly achieving test populations, the males are even more highly selected than the females. Why? Smart males get more encouragement from parents and teachers than do smart females. They take more advanced courses in high school, and their spatial skills benefit from their greater athletic participation.

It's clear that the whole question of the gender gap in cognition is still a hotbed of dispute. Nonetheless, some investigators believe enough data have been gathered to start zeroing in on the essence of male-female differences—including the differences in spatial reasoning that seem to persist over time and across cultures. As stated by psychologist David Lohman of the University of Iowa, the hypothesis is that the core difference has to do with what he calls the "visual-spatial scratchpad"—the mental ability to retain and manipulate spatial and numeric data that cannot be solved verbally.

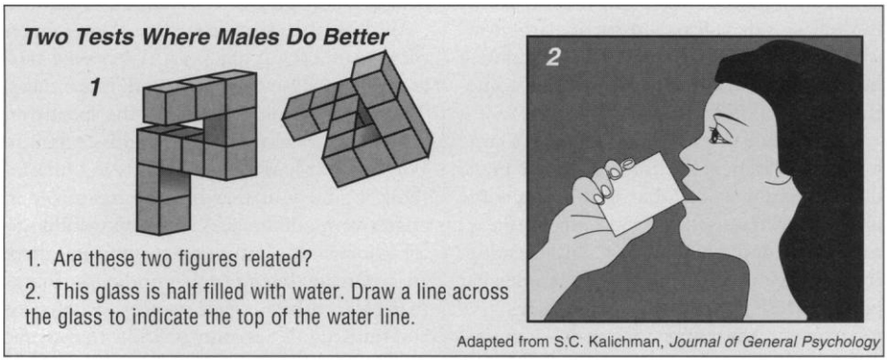
Lohman describes several tests that seem to rely on just such an internal scratchpad. One is "speed of closure"—a task involving the identification of a distorted or incomplete image. Another is a test of "horizontality," in which the subject must draw a line to show the water level in a tilted vessel. Males not only perform these tasks better than females, they do them more quickly. When females get a correct result, says Witelson, they seem to get it by reasoning. "Men just look at it and know that's the way it is...it's almost as if they look at it without trying to analyze or process it."

Even those researchers who believe that intrinsic factors underlie sex differences in cognition don't believe that these differences alone are sufficient to make females less suited for scientific careers. Halpern, for example, says she believes that the reason for lower female achievement in science results "much more [from] psychosocial [factors] than [from] ability differences." But "psychosocial" covers a lot of ground. Benbow and Lubinsky report, for example, that although sexually stereotyped attitudes are much less prevalent among their precocious subjects than among students in general, few SMPY females are choosing careers in math, engineering, or the physical sciences. "It's a gender difference coupled with an interest/value difference," says Benbow.

Just as researchers differ on the causes of these discrepancies, so do they place different emphases on what to do about them. Researchers such as Hyde want more resources put into environmental interventions such as "girl-friendly science classrooms." Others, like Benbow, think it's necessary to do more fine-grained research on cognitive abilities.

But ultimately everyone agrees: The country should be doing whatever works to get more women into science.

■ CONSTANCE HOLDEN



Answers: 1) Yes 2) Horizontal at lip level