



The largest study to look at sex differences in brain anatomy found that women tend to have thicker cortices, whereas men had higher brain volume.

Study finds some significant differences in brains of men and women

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<https://www.sciencemag.org/news/2017/04/study-finds-some-significant-differences-brains-men-and-women><https://www.sciencemag.org/news/2017/04/study-finds-some-significant-differences-brains-men-and-women>

Do the anatomical differences between men and women—sex organs, facial hair, and the like—extend to our brains? The question has been as difficult to answer as it has been controversial. Now, the largest brain-imaging study of its kind indeed finds some sex-specific patterns, but overall more similarities than differences. The work raises new questions about how brain differences between the sexes may influence intelligence and behavior.

For decades, brain scientists have noticed that on average, male brains tend to have slightly higher total brain volume than female ones, even when corrected for males' larger average body size. But it has proved notoriously tricky to pin down exactly which substructures within the brain are more or less voluminous. Most studies have looked at relatively small sample sizes—typically fewer than 100 brains—making large-scale conclusions impossible.

In the new study, a team of researchers led by psychologist Stuart Ritchie, a postdoctoral fellow at the University of Edinburgh, turned to data from UK Biobank, an ongoing, long-term biomedical study of people living in the United Kingdom with 500,000 enrollees. A subset of those enrolled in the study underwent brain scans using MRI. In 2750 women and 2466 men aged 44–77, Ritchie and his colleagues examined the volumes of 68 regions within the brain, as well as the thickness of the cerebral cortex, the brain's wrinkly outer layer thought to be important in consciousness, language, memory, perception, and other functions.

Adjusting for age, on average, **they found that women tended to have significantly thicker cortices than men. Thicker cortices have been associated with higher scores on a variety of cognitive and general intelligence tests. Meanwhile, men had higher brain volumes than women in every subcortical region they looked at, including the hippocampus (which plays broad roles in memory and spatial awareness), the**

amygdala (emotions, memory, and decision-making), striatum (learning, inhibition, and reward-processing), and thalamus (processing and relaying sensory information to other parts of the brain).

When the researchers adjusted the numbers to look at the subcortical regions relative to overall brain size, the comparisons became much closer: There were only 14 regions where men had higher brain volume and 10 regions where women did.

Volumes and cortical thickness between men also tended to vary much more than they did between women, the researchers report this month in a paper posted to the bioRxiv server, which makes articles available before they have been peer reviewed.

That's intriguing because it lines up with previous work looking at [sex and IQ tests](#). “[That previous study] finds no average difference in intelligence, but males were more variable than females,” Ritchie says. “This is why our finding that male participants’ brains were, in most measures, more variable than female participants’ brains is so interesting. It fits with a lot of other evidence that seems to point toward males being more variable physically and mentally.”

Despite the study’s consistent sex-linked patterns, the researchers also found considerable overlap between men and women in brain volume and cortical thickness, just as you might find in height. In other words, just by looking at the brain scan, or height, of someone plucked at random from the study, researchers would be hard pressed to say whether it came from a man or woman. That suggests both sexes’ brains are far more similar than they are different.

The study didn’t account for whether participants’ gender matched their biological designation as male or female.

The study’s sheer size makes the results convincing, writes Amber Ruigrok, a neuroscientist at the University of Cambridge in the United Kingdom who has studied sex differences in the brain, in an email to *Science*. “Larger overall volumes in males and higher cortical thickness in females fits with findings from previous research. But since previous research mostly used relatively small sample sizes, this study confirms these predictions.”

Ruigrok notes one factor that should be addressed in future studies: menopause. Many of the women in the study were in the age range of the stages of menopause, and hormonal fluctuations have been shown to influence brain structures. That may have played some role in the sex differences noted in the study, she says.

The controversial—and still unsettled—question is whether these patterns mean anything to intelligence or behavior. Though popular culture is replete with supposed examples of intellectual and behavioral differences between the sexes, only a few, like higher physical aggression in men, have been borne out by scientific research.

For the moment, Ritchie says his work isn’t equipped to answer such heady questions: He is focused on accurately describing the differences in the male and female brain, not speculating on what they could mean.

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