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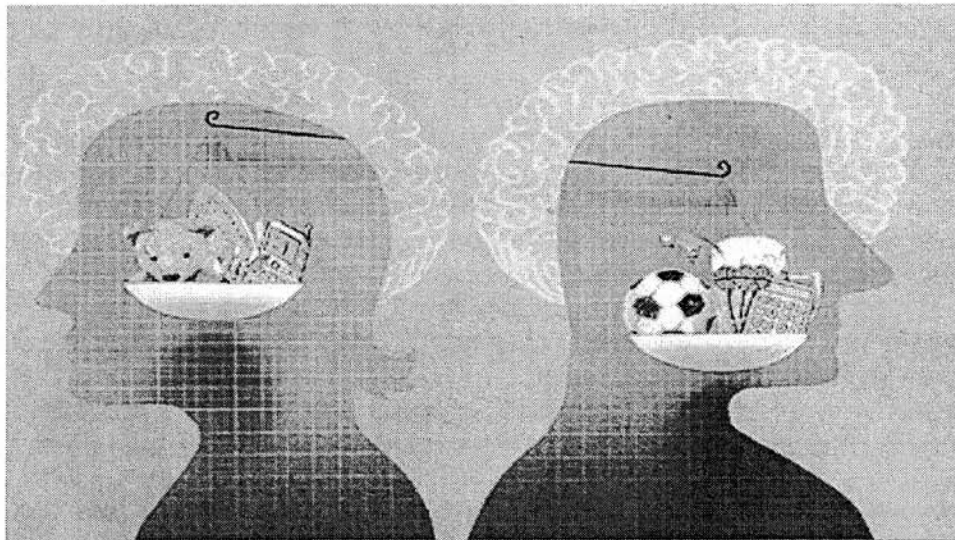
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### Differences between the sexes

## The mismeasure of woman

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### Men and women think differently. But not that differently

IN THE 1970s there was a fad for giving dolls to baby boys and fire-engines to baby girls. The idea was that differences in behaviour between the sexes were solely the result of upbringing: culture turned women into ironers, knitters and chatterboxes, and men into hammerers, drillers and silent types. Switching toys would put an end to sexual sorting. Today, it is clear why it did not. When boys and girls are born, they are already different, and they favour different toys from the beginning.

That boys and girls—and men and women—are programmed by evolution to behave differently from one another is now widely accepted. Surely, no one today would think of doing what John Money, of Johns Hopkins University, did in 1967: amputating the genitalia of a boy who had suffered a botched circumcision, and advising the parents to bring him up as a girl. The experiment didn't work, and the consequences were tragic. But which of the differences between the sexes are "biological", in the sense that they have been honed by evolution, and which are "cultural" or "environmental" and might more easily be altered by changed circumstances, is still fiercely debated.

The sensitivity of the question was shown last year by a furore at Harvard University. Larry Summers, then Harvard's president, caused a storm when he suggested that innate ability could be an important reason why there were so few women in the top positions in mathematics, engineering and the physical sciences.

Even as a proposition for discussion, this is unacceptable to some. But biological explanations of human behaviour are making a comeback as the generation of academics that feared them as a covert way of justifying eugenics, or of thwarting Marxist utopianism, is retiring. The success of neo-Darwinism has provided an intellectual underpinning for discussion about why some differences between the sexes might be innate. And new scanning techniques have enabled researchers to examine the brain's interior while it is working, showing that male and female brains do, at one level, operate differently. The results, however, do not always support past clichés about what the differences in question actually are.

## **Baby blues and pinks**

In the past, it was assumed that a female was simply a male with hormones, says Tracey Shors, a professor of neuroscience at Rutgers University. The truth is the exact opposite. Female is the default brain setting. Until the eighth week of gestation every human fetal brain looks female. The brain, like the rest of the human body, becomes male as a result of surges of testosterone—one during gestation and one shortly after birth.

This wash of hormones creates an organ that generates typically boyish behaviour, such as rough-and-tumble play. Behavioural differences appear early. For example, a one-day-old girl will look for longer at a face than at a mechanical mobile; a boy will prefer the mobile. That it is testosterone exposure which causes such preferences is suggested by two sorts of research. Several studies have shown that girls with a genetic disorder which exposes them to abnormally high prenatal levels of testosterone often develop boyish patterns of play. As regards boys, Simon Baron-Cohen and Svetlana Lutchmaya, two researchers at Cambridge University, found that boys exposed to relatively high levels of testosterone in the womb looked less often at their mothers' faces, made eye contact less frequently and had smaller vocabularies than those exposed to lower levels—though this study has yet to be replicated successfully by other researchers.

Within a year of birth, boys and girls also prefer different toys. Boys prefer cars, trucks, balls and guns. Girls prefer dolls and tea sets. Although evolution has clearly not had the opportunity to mould a preference for tea sets, there is evidence from another species which suggests that human infants might be predisposed to prefer toys that have particular adaptive significance to their sex. Several years ago, Melissa Hines, of City University in London, and Gerianne Alexander, of Texas A&M University, gave some vervet monkeys a selection of toys, including rag dolls, pans, balls and trucks. Male monkeys spent more time with the trucks and balls. Females played for longer with the dolls.

Obviously, cultural stereotyping is an improbable explanation for this. Nor could male monkeys have evolved a preference for fire engines. The theory put forward to explain what happened—and the similar innate preferences of human children—is that the toys preferred by young females are objects that offer opportunities for expressing nurturing behaviour, something that will be useful to them later in life. Young males, whether simian or human, prefer toys that can be used actively or propelled in space, and which afford greater opportunities for rough play.

## **Just behave**

Differences in behaviour between the sexes must, in some way, be reflections of systematic differences between the brains of males and females. Such differences certainly exist, but drawing inferences from them is not as easy as it may appear.

For a start, men's brains are about 9% larger than those of women. That used to be cited as evidence of men's supposedly greater intelligence. Actually, the difference is largely (and probably completely) explained by the fact that men are bigger than women.

In recent years, more detailed examination has refined the picture. Female brains have a higher percentage of grey matter (the manifestation, *en bloc*, of the central bodies of nerve cells), and thus a lower percentage of white matter (the manifestation of the long, thin filaments that connect nerve cells together), than male brains. That, plus the fact that in some regions of the female brain, nerve cells are packed more densely than in men, means that the number of nerve cells in male and female brains may be similar.

Oddly, though, the main connection between the two hemispheres of the brain, which is known as the corpus callosum and is made of white matter, is proportionately smaller in men than women. This may explain why men use only one side of the brain to process some problems for which women employ both sides.

These differences in structure and wiring do not appear to have any influence on intelligence as measured by IQ tests. It does, however, seem that the sexes carry out these tests in different ways. In one example, where men and women perform equally well in a test that asks them to work out whether nonsense words rhyme, brain scanning shows that women use areas on both the right and the left sides of the brain to accomplish the task. Men, by contrast, use only areas on the left side. There is also a correlation between mathematical reasoning and temporal-lobe activity in men—but none in women. More generally, men seem to rely more on their grey matter for their IQ, whereas women rely more on their white matter.

These examples show how tricky it is to find correlations between behaviour and differences in brain structure and brain activity. And even if a connection to brain structure is found, that does not mean it is innate. Most of these studies are done on adults, so it is not clear when differences start to arise. The brain is by no means immutable, even in adulthood. In the hippocampus, an area thought to be involved in spatial learning, new nerve cells can be born in an adult and hormones influence their birth and survival. Dr Shors says that her work has shown that the female brain, at least, is very plastic, changing dramatically during life in response to pregnancy and menopause as well as puberty.

Dr Baron-Cohen suggests that innate preferences can be carried into adulthood, too. He studies autism and Asperger's syndrome, conditions that are far more common in boys than girls. His theory is that, from birth, female brains are hardwired for understanding emotions (empathising) and male brains for understanding and building systems (systemising). Hence the diverse preferences for toys. The notion is that autistic children—and autistic adults—have extremely male brains. In other words, they are especially good at systemising and especially bad at empathising.

Autism is, indeed, an extreme example. But there are thousands of studies on psychological differences between the sexes. They have looked at personality, social behaviour, memory and abilities in particular fields. For example, men are said to be more aggressive and better at mathematics, while women are more emotional and have better verbal skills.

There are a number of problems with these studies. One, according to Dr Hines, is science's bias towards reporting positive results, so that research which shows no differences is likely to get lost. Another is that because differences between the sexes are so often popularised and played up in the popular media, people tend to pay them disproportionate attention.

For example, although it is commonly held that there are reliable differences between the verbal abilities of males and females, Dr Hines suggests this is not exactly correct. She says that the results of hundreds of tests of vocabulary and reading comprehension show there is almost no gap between the sexes. Though teenage girls are better at spelling than teenage boys, the only aspect of verbal ability that is known to show a sex difference in adults is verbal fluency (the ability to produce words rapidly). For example, when asked to list as many words as possible that start with a particular letter, women usually come up with more than men. Furthermore, even when there are differences in ability between the sexes, research suggests that the scale of these differences is often smaller than people generally believe.

## Storm in a d cup

In comparing differences between the sexes, researchers use a statistical measure called  $d$ . This indicates how far apart the averages of two groups (in this case men and women) are, taking into account the range of values that contribute to each average. The value of  $d$  for adult height is around 2. There is no arguing that in any given population men, on average, are taller than women. For behavioural and psychological phenomena, a value of  $d$  greater than 0.8 is considered large, of 0.5, moderate, and of 0.2, small. Any  $d$  less than 0.2 is a negligible difference.

Equipped with this statistical tool, Janet Hyde of the University of Wisconsin-Madison decided to investigate just how different men and women are. She collected all the important meta-analyses that have been conducted on differences between the sexes. (A meta-analysis combines many studies by treating the result of each as a single piece of data for statistical purposes.) Given that most of the meta-analyses she looked at addressed questions where differences were reputed to be reliable (mathematical performance, verbal ability and aggressive behaviour, in particular) she feels her results were surprising. Of the 124 effect-sizes she calculated, 30% had a value of  $d$  close to zero and in a further 48% of cases,  $d$  was small. In other words, only 22% of reported behavioural differences between the sexes are worth raising an eyebrow over.

The largest gaps were, not surprisingly, in physical attributes such as throwing velocity ( $d=2.14$ ) and throwing distance ( $d=1.98$ ). These closely reflect the difference in height between men and women. Another area where she found large differences was in some areas of sexuality—for example, frequency of masturbation ( $d=0.96$ ) and attitudes about sex in a casual relationship ( $d=0.81$ ). However, men and women reported the same degree of sexual satisfaction.

Not surprisingly, on average men were physically more aggressive ( $d=0.6$ ). But in this case other work shows the danger of jumping too rapidly to a conclusion. A study done in 1994 hints that if women think nobody is watching and judging them, and there are no physical consequences, they might be more aggressive than men.

In this study, participants played a video game in which they defended themselves from attackers, and the number of bombs they chose to drop was a measure of aggression. When participants thought they were known to the experimenter and were having their performance assessed, men dropped more bombs than women did. But when those same participants were given the impression that they were anonymous, women became the more enthusiastic bombers.

### Slugs and snails v sugar and spice

Differences between the sexes on a range of variables

Men better than women	$d^*$
Mental rotation	+0.73
Physical aggression	+0.60
Mathematical problem solving <sup>†</sup>	+0.32
No significant difference	
Mathematical problem solving <sup>‡</sup>	-0.02
Vocabulary	-0.02
Reading comprehension	-0.03
Women better than men	
Smiling	-0.40
Spelling <sup>§</sup>	-0.45
Indirect aggression	-0.74 to +0.05

\* $d$  is a statistical measure of the difference between two groups. Positive values favour men, negative values women. <sup>†</sup>Age 19-25  
Source: Janet Hyde <sup>‡</sup>Age 11-14 <sup>§</sup>Adolescents

Violent or not, women have as many angry thoughts as men, if not more. In a study carried out in 2004, Robin Simon, of Florida State University, and Leda Nath, of the University of Wisconsin, found no difference between the sexes in the reported frequency of incidents of feeling angry over a period of time. However, women tended to report anger that was more intense and prolonged.

A similar result on the greater intensity of female anger was reported earlier this year by Nicole Hess, of the Max Planck Institute in Berlin, and Edward Hagen, of the same city's Humboldt University. Dr Hess and Dr Hagen, however, took the matter one stage further by asking their participants what they wanted to do about it.

The researchers read the participants, who were undergraduate students, an "aggression-evoking scenario". They were told they had just overheard a physically smaller classmate of the same sex making false and serious attacks on their reputation to a teacher. Once again, the women were angrier than the men. The real difference between the sexes, though, was in the way they proposed to retaliate. Women usually said that they would get their own back with gossip. Men were more evenly divided, with roughly half wanting to punch the slanderous classmate.

One idea to explain this is that in animals such as humans, where there is a lot of maternal care, females find physical aggression less affordable. And just because a smear is not physical does not mean that it is less damaging than a punch. Indeed, research suggests that girls find such indirect or social aggression much more hurtful than boys do.

## Does it add up?

Another behavioural difference that has borne a huge amount of scrutiny is in mathematics, particularly since Dr Summers's comments. The problem with trying to argue that the male tendency to systemise suggested by Dr Baron-Cohen might lead to greater mathematical ability is that, in fact, girls and boys are equally good at maths prior to puberty. Until recently, it was believed that males outperformed females in mathematics at all ages. Today, that picture has changed, and it appears that males and females of any age are equally good at computation and at understanding mathematical concepts. However, after their mid-teens, men are better at problem solving than women are.

Males also have better spatial abilities than females. If asked to imagine rotating a three-dimensional object, a skill useful in engineering, the difference is quite large ( $d=0.73$  and  $0.56$  in different studies). In this case the limited evidence available suggests the difference is related to the post-birth testosterone surge in boys. Women who were exposed to high levels of testosterone in the womb do not do noticeably better in spatial-rotation tasks.

Men do not excel in all spatial tasks, though. Again contrary to popular myth, men and women are equally good at navigating. But this is another example of a task in which the sexes take different paths to the same destination. Women tend to rely on remembering landmarks, whereas men rely on their geometric skills to work out direction and distance.

Another proposal to explain the lack of women professors of maths and science is that even if there is little or no difference in average ability, there might be differences in the variation around this average, with more men found in the tails of the distribution curve and fewer in the middle. In other words, among males there are more idiots and more prodigies. One study of IQ, covering everyone born in Scotland in 1932, supports this idea. It showed that there were more women in the middle of the distribution, but more men at both of the extremes.

The question raised by Dr Summers does get to the heart of the matter. Over the past 50 years, women have made huge progress into academia and within it. Slowly, they have worked their way

into the higher echelons of discipline after discipline. But some parts of the ivory tower have proved harder to occupy than others. The question remains, to what degree is the absence of women in science, mathematics and engineering caused by innate, immutable ability?

Innate it may well be. That does not mean it is immutable. Spatial ability is amenable to training in both sexes. And such training works. The difference between the trained and the untrained has a  $d$  value of 0.4, and one programme to teach spatial ability improved the retention rate of women in engineering courses from 47% to 77%. Biology may predispose, but even in the rugged world of metal bashing, it is not necessarily destiny.

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A list of references is [here](#).

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