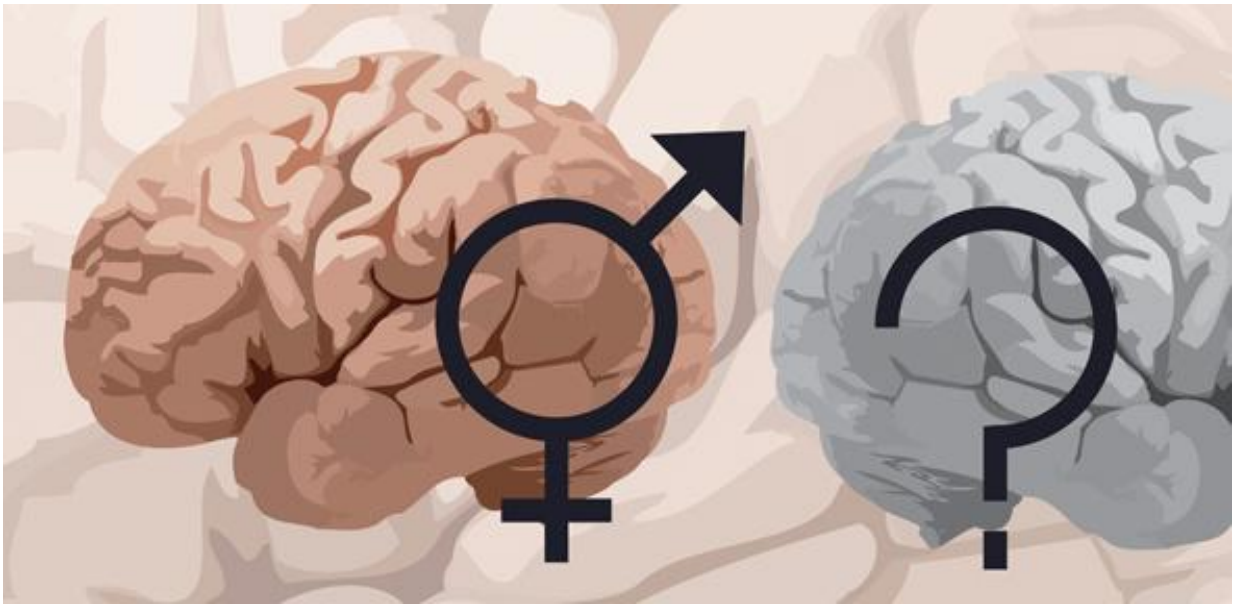
# Unexpected similarities between male and female brains

June 2 2016, by Julia Gottwald



Credit: Oran Maguire, BlueSci

*The male and female brains have more in common than media reports often suggest, argues Julia Gottwald, a third year PhD student at the Department of Psychiatry. She explains what we understand about the similarities and differences in our brains and why this is an important area of research.*

If you were a fruit fly and smelled male pheromones, you would show a

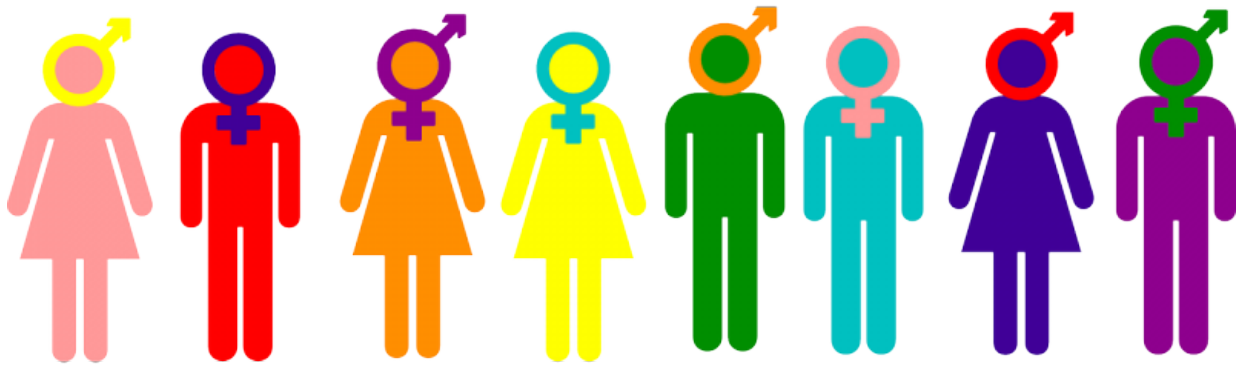
strong and consistent response. As a female fly, you would engage in courtship behaviour; as a male fly, you would become more aggressive. We know that pheromones activate different clusters of neurons in the brain of the male compared to the female fly. The differences do not end here. A collaboration between three groups led to the discovery of fruitless, the master gene controlling the male fruit fly's courtship ritual. When disabled, male flies don't mate. In contrast, when the gene is activated in females, they show male courtship behaviour such as chasing other females.

But you are not a fruit fly. The study of sex differences in the human brain is more complex, more controversial, and more emotionally laden than in any other species. This hot topic is frequently misrepresented in the media. Studies on sex differences are often oversimplified and taken out of context. Some articles have claimed that we now know why "men are so obsessed with sex", although the original study focused on worms. This style of reporting promotes stereotypes and misconception of science. The truth is that the brains of men and women have a lot in common.

The Royal Society has recently released a special issue on sex differences in the brain. It features an opinion piece which argues that human brains do not fall into the two distinct categories of male and female. The piece is partly based on a study from last year: a revolutionary analysis on some 1,400 human brains. The authors looked at the volume of brain regions and connectivity between them to select the areas that differed most between the sexes. For each area, the researchers then designated the upper and lower ends of the spectrum as either "male" or "female", according to where men or women were more prevalent. If brains truly fell into two distinct categories, we would see brains which had either all "male" or all "female" areas. The study revealed that such consistent brains are indeed rare. Our brains are more like a patchwork quilt, with most people having a mixture of features

that are "typical" male, female, or common in both sexes.

Biology alone cannot explain why our brains are such a colourful mixture; we also need to consider the environment. How stressed was your mother during pregnancy? Did you grow up with close friends? How often did you exercise? All these factors will influence the development of your brain and consequently its appearance today. Even as an adult, your daily experiences shape your neuroanatomy. Your environment and behaviour leave a mark on the brain; it is not solely shaped by biological sex. Moreover, sex is associated with gender – the personal and societal perception of your sex. Gender encompasses all the expectations, biases, and norms of behaviour, which differ for males and females. It is this combination of genes and environment that determines our brain structure.



Credit: University of Cambridge

Despite the patchwork structure of our brains, there seem to be neuroanatomical differences between the average man and woman. But do these differences necessarily cause different behaviours? Actions such as mating, navigating through London, or writing an essay are controlled by complex networks. The underlying anatomy is important, but so are other internal and external influences, such as stress, hunger, or exhaustion. Our behaviour is modulated by many pathways.

Geert de Vries, director of the Neuroscience Institute at Georgia State University, has another take on sex differences in the brain. He argues that these differences could not produce but instead prevent differences in behaviour. According to de Vries, men and women differ dramatically in their physiology and hormones; having different brains might be a way of compensating for these differences. Do male and female brains develop differently in order to promote similar behaviour?

We do not know if these structural differences really are compensatory. However, this concept is not new and we can observe such compensations on other levels. For example, female mammals have two copies of the X chromosome in their cells, while males only receive one copy. If all chromosomes were equally active, women would make twice as many gene products from their X chromosomes as men. To prevent this, female mammals silence one of their X chromosomes, a process known as X-inactivation. A similar process might happen with brain structures on a more complex level.

So our brains are not distinctly male or female, and structural differences do not necessarily cause behavioural differences. Then why study sex differences at all? There are five times more studies with all-male than all-female animals in neuroscience and pharmacology, whereas only one in four studies includes animals of both sexes. Hormonal fluctuations in females were seen as an unwelcome confound, and sex differences were often thought to be irrelevant for the research

question. However, results from males do not always apply to females. Some drugs such as aspirin are taken up or cleared away differently in men and women. Sex is also important for some diseases: multiple sclerosis is more common in women, as are depression and anorexia. On the other hand, autism and some addictions are more common in males.

Clearly it is not sufficient to investigate and address these questions by using subjects of only one sex. How can we expect to get the whole picture by looking at only one half of the population? Since 1993, the inclusion of women has been a requirement in clinical trials funded by the National Institute of Health in the USA. Since 2014, all animal studies funded by them also have to include females. Moreover, many scientific journals now ask authors to publish the numbers of males and females included in their sample.

Steps like these are necessary to learn more about how sex and gender influence our development and eventually our brains. The findings need to be analysed and communicated carefully. Men and women might be different in subtle ways, but our similarities probably outweigh the differences. A small change in your complex anatomy would usually not reverse your behaviour – after all, you're not a fruit fly!

**More information:** Joel, D. & Fausto-sterling, A. (2016). Beyond sex differences : new approaches for thinking about variation in brain structure and function. Philos. *Trans. R. Soc. B Biol. Sci.*, 371(1688)

Joel, D. et al. (2015). Sex beyond the genitalia : The human brain mosaic. *Proc. Natl. Acad. Sci.* U. S. A., 112, 15468–15473

De Vries, G. J. & Boyle, P. A. (1998). Double duty for sex differences in the brain. *Behav. Brain Res.*, 92, 205–213.

Beery, A. K. & Zucker, I. (2011). Sex bias in neuroscience and

biomedical research. *Neurosci. Biobehav. Rev.*, 35, 565–572.