

GINA RIPPON

The Gendered Brain

The new neuroscience that shatters the
myth of the female brain

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For Jana and Hilda – two indomitable grandmothers who
certainly over-rode their Inner Limiters.

For my parents, Peter and Olga – whose love and support
gave me so many of the opportunities I have had in my life's
journey – and for my twin brother, Peter, who has been with
me along the way.

For Dennis – partner, sounding board, sommelier and
horticulturalist extraordinaire, with thanks for his tireless
patience and support (and lashings of gin).

For Anna and Eleanor, for your future,
whatever it might hold.

Few tragedies can be more extensive than the stunting of life,
few injustices deeper than the denial of an opportunity to strive
or even to hope, by a limit imposed from without, but falsely
identified as lying within.

Stephen Jay Gould,
The Mismeasure of Man

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Introduction:

Whac-a-Mole Myths

This book is about an idea that has its roots in the eighteenth century and still persists today. That is the notion that you can 'sex' a brain, that you can describe a brain as 'male' or 'female' and that you can attribute any differences between individuals in behaviour, abilities, achievements, personality, even hopes and expectations to the possession of one or the other type of brain. It is a notion that has inaccurately driven brain science for several centuries, underpins many damaging stereotypes and, I believe, stands in the way of social progress and equality of opportunity.

The question of sex differences in the brain is one that has been debated, researched, encouraged, criticised, praised and belittled for over 200 years, and can certainly be found in different guises for long before that. It is an area of entrenched opinion and has been the ongoing focus of just about every research discipline from genetics to anthropology, mixed with history, sociology, politics and statistics. It is characterised by bizarre claims (women's inferiority comes from their brains being five ounces lighter) which can readily be dismissed, only to pop up again in another form (women's inability to read maps comes from wiring differences in the brain). Sometimes a single claim lodges itself firmly in the public consciousness as a fact and, despite the best efforts of concerned scientists, remains a deeply entrenched belief. It will be frequently referred to as a

well-established fact and triumphantly re-emerge to trump arguments about sex differences or, more worryingly, to drive policy decisions.

I think of these seemingly endlessly recurring misconceptions as ‘Whac-a-Mole’ myths. Whac-a-Mole is an arcade game which involves repeatedly hitting the heads of mechanical moles with a mallet as they pop up through holes in a board – just when you think you’ve dispatched them all, another pesky mole pops up elsewhere. The term ‘Whac-a-Mole’ is used nowadays to describe a process where a problem keeps recurring after it is supposedly fixed, or any discussion where some type of mistaken assumption keeps popping up despite it supposedly having been dispatched by new and more accurate information. In the context of sex differences, this might be the belief that newborn baby boys prefer to look at tractor mobiles rather than human faces (the ‘men are born to be scientists’ mole), or that there are more male geniuses and more male idiots (the ‘greater male variability’ mole). ‘Truths’ such as these have, as we shall see in this book, been variously whacked over the years but can still be found in self-help manuals, how-to guides and even in twenty-first-century arguments about the utility or futility of diversity agendas. And one of the oldest and apparently hardest of moles is the myth of female and male brains.

The so-called ‘female’ brain has suffered centuries of being described as undersized, underdeveloped, evolutionarily inferior, poorly organised and generally defective. Further indignities have been heaped upon it as being the cause of women’s inferiority, vulnerability, emotional instability, scientific ineptitude – making them unfit for any kind of responsibility, power or greatness.

Theories about women’s inferior brains emerged long before we were actually able to study the human brain, other than when it was damaged or dead. Nevertheless, ‘blame the brain’ was a consistent and persistent mantra when it came to finding explanations for how and why women were different from men. In the eighteenth and nineteenth centuries it was generally

accepted that women were socially, intellectually and emotionally inferior; in the nineteenth and twentieth centuries the focus shifted to women's supposedly 'natural' roles as carers, mothers, womanly companions of men. The message has been consistent: there are 'essential' differences between men's and women's brains, and these will determine their different capacities and characters and their different places in society. Even though we could not test these assumptions, they remained the bedrock on which stereotypes were firmly and immutably grounded.

But at the end of the twentieth century the advent of new forms of brain imaging technology offered the possibility that we could, at last, find out if there really were any differences between the brains of women and those of men, where they might come from, and what they might mean for the brains' owners. You might think that the possibilities offered by these new techniques would be seized on as 'game changers' in the arena of research into sex differences and the brain. The development of powerful and sensitive ways for studying the brain, together with a chance to reframe a centuries-old quest for differences, *should* be revolutionising the research agenda and galvanising discussion in media outlets. If only that were the case ...

Several things went wrong in the early days of sex differences and brain imaging research. With respect to sex differences, there was a frustrating backward focus on historical beliefs in stereotypes (termed 'neurosexism' by psychologist Cordelia Fine). Studies were designed based on the go-to list of the 'robust' differences between females and males, generated over the centuries, or the data were interpreted in terms of stereotypical female/male characteristics which may not have even been measured in the scanner. If a difference was found, it was much more likely to be published than a finding of no difference, and it would also breathlessly be hailed as an 'at last the truth' moment by an enthusiastic media. Finally the evidence that women are hard-wired to be rubbish at map reading and that men can't multi-task!

The second difficulty with early brain imaging research was the images themselves. The new technology produced

wonderfully colour-coded brain maps that gave the illusion of a window into the brain – the impression that this was an image of the real-time workings of this mysterious organ, now available for inspection by all. These seductive images have fed a problem which I have called ‘neurotrash’ – the sometimes bizarre representations (or misrepresentations) of brain imaging findings that appear in the popular press and in piles of brain-based self-help books. These books and articles are frequently illustrated with beautiful brain maps, which are considerably less frequently accompanied by any kind of explanation of what such maps are really showing. Understanding the differences between women and men has been a particular target for such manuals or headlines, bringing us apparently enlightening links to crowbars, polka dots and clams, and, of course, compounding the idea that ‘Men are from Mars, Women are from Venus’.

So the advent of brain imaging at the end of the twentieth century did not do much to advance our understanding of alleged links between sex and the brain. Here in the twenty-first century, are we doing any better?

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New ways of looking at the brain focus on connections between structures rather than just the size of the structures themselves. Neuroscientists today have started decoding the brain’s ‘chatter’, the way in which different frequencies of brain activity seem to pass on messages and bring back answers. We are getting better models of how the brain does what it does, and we are beginning to have access to huge data sets, so comparisons can be made and models can be tested using hundreds if not thousands of brains, rather than the handfuls that were available previously. Could these advances shed any light on the vexed question of the myth or the reality of the ‘female’ and the ‘male’ brain?

One major breakthrough in recent years has been the realisation that the brain is much more ‘proactive’ or forward-thinking

with respect to information gathering than we had first realised. It doesn't just respond to the information when it arrives, it generates predictions about what might be coming next, based on the kind of patterns it has identified on previous occasions. If it turns out that things didn't quite work out as planned, then this 'prediction error' will be noted and the guidelines adjusted accordingly.

Your brain is continuously making guesses as to what might be coming next, building templates or 'guide images' to help us take shortcuts to get on with navigating our lives. We could think of the brain as some kind of 'predictive texter' or high-end satnav, helpfully completing our words or sentences, or finishing off a visual pattern to let us get on with life quickly, or guiding us down the safest paths for 'people like us'. Of course, in order to make predictions you need to learn some kind of rules about what usually happens, about the normal course of events. So what our brain does with our world very much depends on what it finds in that world.

But what if the rules our brains are picking up are actually just stereotypes, those pervasive shortcuts that lump together past truths or half-truths or even untruths? And what might this mean for understanding sex differences?

This brings us into the world of self-fulfilling prophecies. The brain doesn't like making mistakes or prediction errors – if we are confronted with a situation where 'people like us' aren't commonly found or where we are clearly unwelcome, then our brain-based guidance system may drive us to withdraw ('Make a U-turn when possible'). If we are expected to make mistakes, then the additional stress makes it highly likely that mistakes will be made and we will lose our way.

Until the twenty-first century it was generally held that with regard to the brain, biology was destiny. The bottom line had always been that, apart from the known flexibility in very young, developing brains, the brains we ended up with were pretty much the ones we were born with (only bigger and a bit more connected). Once you were an adult, your brain had reached its developmental endpoint, reflecting the genetic and hormonal

information with which it had been programmed – no upgrades or new operating systems were available. This message has changed in the last thirty years or so – our brains are plastic and malleable and this has significant implications for our understanding of how entangled our brain is with its environment.

We now know that, even in adulthood, our brains are continually being changed, not just by the education we receive, but also by the jobs we do, the hobbies we have, the sports we play. The brain of a working London taxi driver will be different from that of a trainee and from that of a retired taxi driver; we can track differences among people who play videogames or are learning origami or to play the violin. Supposing these brain-changing experiences are different for different people, or groups of people? If, for example, being male means that you have much greater experience of constructing things or manipulating complex 3D representations (such as playing with Lego), it is very likely that this will be shown in your brain. Brains reflect the lives they have lived, not just the sex of their owners.

Seeing the life-long impressions made on our plastic brains by the experiences and attitudes they encounter makes us realise that we need to take a really close look at what is going on outside our heads as well as inside. We can no longer cast the sex differences debate as nature versus nurture – we need to acknowledge that the relationship between a brain and its world is not a one-way street, but a constant two-way flow of traffic.

Perhaps an inevitable consequence of looking at how the outside world is entangled with the brain and its processes is a greater focus on social behaviour and on the brains behind it. There is an emerging theory that humans have been successful because we evolved to be a co-operative species. We can decode invisible social rules, ‘mind-read’ our fellow humans to know what they might do, what they might be thinking or feeling, or what they might want us to do (or not to do). Mapping the structures and networks of this social brain has revealed how it is involved with forging our self-identity, with spotting members of our in-group (are they male or female?), and with

guiding our behaviour to be appropriate to the social and cultural networks to which we belong ('girls don't do that'), or to which we wish to belong. This is a key process to monitor in any attempt to understand gender gaps, and it appears to be a process that starts from birth, or even before.

Even the very youngest members of our world, highly dependent newborn babies, are in fact much more sophisticated socialites than we ever realised. Despite their fuzzy vision, rather rudimentary hearing and absence of pretty much all basic survival skills, babies are quickly picking up on useful social information: as well as key facts such as whose face and voice might signal the arrival of food and comfort, they start to register who is part of their in-crowd, to recognise different emotions in others. They appear to be tiny social sponges, quickly soaking up the cultural information from the world around them.

A story that neatly illustrates this comes from a remote village in Ethiopia, where computers had never been seen. Some researchers dropped off a pile of boxes, taped shut. The boxes contained brand-new laptops, preloaded with some games, apps and songs. And no instructions. The scientists videoed what happened next.

Within four minutes, one child had opened a box, found the on-off switch and powered the computer up. Within five days, every child in the village was using forty or more of the apps they found and singing the songs the researchers had preloaded. Within five months, they had hacked the operating system in order to reboot the camera that had been disabled.

Our brains are like these children. Unguided, they will work out the rules of the world, learn the applications, go beyond what was initially thought possible. They work by a combination of astute detection and self-organisation. And they will start very young!

And one of the first things they will turn their attention to is the rules of the gender game. With the relentless gender bombardment coming from social and mainstream media, it is an aspect of these little humans' world that we should be watching very carefully. Once we acknowledge that our brains

are not only rule-hungry scavengers, with a particular appetite for social rules, but that they are also plastic and mouldable, then the power of gender stereotypes becomes evident. If we could follow the brain journey of a baby girl or a baby boy, we could see that right from the moment of birth, or even before, these brains may be set on different roads. Toys, clothes, books, parents, families, teachers, schools, universities, employers, social and cultural norms – and, of course, gender stereotypes – all can signpost different directions for different brains.

*

Resolving arguments about differences in the brain really matters. Understanding where such differences come from is important for everyone who has a brain and everyone who has a sex or a gender (more on this later) of some kind. The outcomes of these debates and research programmes, or even just anecdotes, are embedded in how we think about ourselves and others, and are used as yardsticks against which to measure self-identity, self-respect and self-esteem. Beliefs about sex differences (even if ill-founded) inform stereotypes, which commonly provide just two labels – girl or boy, female or male – which, in turn, historically carry with them huge amounts of ‘contents assured’ information and save us having to judge each individual on their own merits or idiosyncrasies. As well as providing a list of the contents themselves, these labels may carry an additional nature or nurture stamp. Is this a ‘natural’ product, based on pure biology, with its characteristics fixed and unchangeable, or is it a socially determined creation, manured by the world around it, with its characteristics quickly adjustable by the flick of a policy switch or an added sprinkling of environmental input?

With input from exciting breakthroughs in neuroscience, the neat, binary distinctiveness of these labels is being challenged – we are coming to realise that nature is inextricably entangled with nurture. What used to be thought fixed and inevitable is being shown to be plastic and flexible; the powerful

biology-changing effects of our physical and our social worlds are being revealed. Even something that is ‘written in our genes’ may come to express itself differently in different contexts.

It has always been assumed that the two distinct biological templates that produce different female and male bodies will also produce differences in the brain, which will underpin sex differences in cognitive skills, personalities and temperament. But the twenty-first century is not just challenging the old answers – it is challenging the question itself. One by one, we will see that past certainties are being dismantled. We will see what is happening to those well-known differences in masculinity and femininity, in fear of success, in nurturance and caring – even the very notion of female and male brains. Revisiting the evidence that supported these conclusions suggests that these characteristics do *not* neatly match the male/female labels they have been given.

So, yes, this is another book about sex differences in the brain, in the wake of many influential and hugely well-informed predecessors. It is a book that I believe is needed, as the old misconceptions still keep popping up in new guises, Whac-a-Mole style. There are still problems to solve – we will see how big the gender gaps are in key areas of achievement – and there are still gender paradoxes to explain, such as why do the most gender equal countries have the lowest proportion of female scientists?

The message at the heart of this book is that a gendered world will produce a gendered brain. I believe that understanding how this happens and what it means for brains and their owners is important, not just for women and girls, but for men and boys, parents and teachers, businesses and universities, and for society as a whole.

Sex, Gender, Sex/ Gender or Gender/ Sex: A note on gender and sex

We need to address the issue of whether we should talk about 'sex' or 'gender' or neither or both or some sort of combination. This book will be about sex differences in the brain but it will also be about gender differences in the brain. So are these the same thing – does your biologically determined sex bring with it all the characteristics that define your socially constructed gender? Will being the possessor of two X chromosomes, or an XY pair, determine your place in society, the roles you will play, the choices you will make?

For centuries, the answer to this was an unequivocal 'yes'. As well as bestowing on you the appropriate reproductive gear, your biological sex allegedly gave you an appropriately distinct brain, and thus determined your temperament, your skills, your fitness to lead or be led. The term 'sex' was commonly used to refer to both biological and social characteristics of women and men.

Towards the end of the twentieth century, in the light of feminist concerns, there was a move to challenge this deterministic approach. There was an emerging insistence that the term 'gender' be used when referring to matters that were solely to do with social matters, distinct from 'sex', which should be reserved

for any reference to biology. Fast-forward a few years and, as we shall see, it became clear that it was getting harder and harder to sustain this neat distinction between sex and gender. Our emerging understanding of how much the brain can be influenced by social pressures meant that we needed a term to reflect this entanglement; in academic circles, the use of 'sex/gender' or 'gender/sex' has been offered as a solution. But this is not widespread in everyday usage and is rarely to be found in the popular media or in more populist articles about females and males.

The solution there seems to be to use 'sex' or 'gender' pretty interchangeably, with perhaps a greater tendency to use 'gender' to avoid the impression that you believe whatever you are talking about is actually all down to biology. You never see articles on 'sex pay gaps' or 'sex imbalances', for example, in business leadership. But when it comes down to it, it is clear that the term 'gender' now bundles together all aspects of females and males in just the same way that 'sex' used to. Recently browsing through the BBC's popular online revision guides for sixteen-year-olds (not, I hasten to add, for tips for this book) I noted that there was a section on the determination of gender. It was actually about the production of XX and XY chromosome pairs, headed by the statement 'So a human baby's *gender* [my emphasis] is determined by the sperm that fertilises the egg cell'. So even august institutions such as the BBC are cheerily contributing to this linguistic confusion.

What does this mean for how I will label the brain differences (or lack of them) that are at the heart of this book? Are they 'sex differences' or 'gender differences' or both? Given that many of the arguments are about the core role of biology, I shall use the term 'sex' or 'sex differences' as the default option when talking about the brain or about individuals clearly being divided according to whether they are biologically female or male. 'Gender differences' will mainly be reserved for when we are looking at socialisation issues such as, for example, the pink and blue tsunami which washes over newly arrived humans. The title *The Gendered Brain* aims to acknowledge that we are looking at the brain-changing effects of social processes.

Gendered pronouns can also be a fraught topic. If you don't know the sex (or gender) of the person you are writing about, the default option has, historically, been the male version, 'he'. In a book where part of the story is to challenge default options, doing so would clearly be unacceptable. Although 'he or she' or 's/he' can be alternatives, this can become awkward and distracting in a lengthy tome like this. My solution has been to try and redress the balance by, where appropriate, deliberately using 'she' rather than 'he'.