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They just can't help it

What kind of brain do you have? There really are big differences between the male and female brain, says Simon Baron-Cohen. And they could help explain conditions such as autism Do you have a male or female brain?

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Are there essential differences between the male and female brain? My theory is that the female brain is predominantly hard-wired for empathy, and that the male brain is predominantly hard-wired for understanding and building systems. I call it the empathising-systemising (E-S) theory.

Empathising is the drive to identify another person's emotions and thoughts, and to respond to these with an appropriate emotion. The empathiser intuitively figures out how people are feeling, and how to treat people with care and sensitivity. Systemising is the drive to analyse and explore a system, to extract underlying rules that govern the behaviour of a system; and the drive to construct systems. The systemiser intuitively figures out how things work, or what the underlying rules are controlling a system. Systems can be as varied as a pond, a vehicle, a computer, a maths equation, or even an army unit. They all operate on inputs and deliver outputs, using rules.

According to this theory, a person (whether male or female) has a particular "brain type". There are three common brain types: for some individuals, empathising is stronger than systemising. This is called the female brain, or a brain of type E. For other individuals, systemising is stronger than empathising. This is called the male brain, or a brain of type S. Yet other individuals are equally strong in their systemising and empathising. This is called the "balanced brain", or a brain of type B. There are now tests you can take to see which type (E, S, or B) you are. Not which type you'd like to be, but which you actually are.

A key feature of this theory is that your sex cannot tell you which type of brain you have. Not all men have the male brain, and not all women have the female brain. The central claim of this new theory is only that on average, more males than females have a brain of type S, and more females than males have a brain of type E.

So are females better at empathising? This theory rings true at an anecdotal level. For example, we've always known that people choose different things to read in the newsagent on the railway platform or in the airport departure lounge. Women are more likely to go to the magazine rack featuring fashion, romance, beauty, intimacy, emotional problems and agony-aunts, counselling, relationship advice, and parenting. Men are more likely to go to a magazine rack featuring computers, cars, boats, photogra phy, DIY, sport, hi-fi, action, guns, tools, and the outdoors.

And we all have anecdotal impressions about typical hobbies for men and women. Men are more likely to spend hours happily engaged in car or motorbike maintenance, light aircraft piloting, sailing, bird- or trainspotting, mathematics, tweaking their sound systems, computer games and programming. Women are more likely to spend hours happily engaged in coffee mornings or pot-luck suppers, advising friends on relationship problems, or caring for friends, neighbours, or pets.

But the E-S theory goes beyond such anecdotal evidence to pull together the scientific evidence, and investigate the origins of these differences.

The evidence for a female advantage in empathising comes from many different directions. For example, studies show that when children play together with a little movie player that has only one eye-piece, boys tend to get more of their fair share of looking down the eye piece. They just shoulder the girls out of the way. Less empathy, more self-centred. Or if you leave out a bunch of those big plastic cars that kids can ride on, what you see is that more little boys play the "ramming" game. They deliberately drive the vehicle into another child. The little girls ride around more carefully, avoiding the other children more often. This suggests the girls are being more sensitive to others.

Baby girls, as young as 12 months old, respond more empathically to the distress of other people, showing greater concern through more sad looks, sympathetic vocalisations and comforting. This echoes what you find in adulthood: more women report frequently sharing the emotional distress of their friends. Women also spend more time comforting people.

When asked to judge when someone might have said something potentially hurtful, girls score higher from at least seven years old. Women are also more sensitive to facial expressions. They are better at decoding non-verbal communication, picking up subtle nuances from tone of voice or facial expression, or judging a person's character.

There is also a sex difference in aggression. Males tend to show far more "direct" aggression such as pushing, hitting and punching. Females tend to show more "indirect" (or "relational", covert) aggression. This includes gossip, exclusion, and bitchy remarks. It could be said that to punch someone in the face or to wound them physically requires an even lower level of empathy than a verbal snipe.

Two other ways to reveal a person's empathising skill are to see how they (as a newcomer) join a group of strangers, and to see how they (as a host) react to a new person joining their group. This has been cleverly investigated in children by introducing a

new boy or girl to a group who are already playing together. If the newcomer is female, she is more likely to stand and watch for a while, to check out what's going on, and then try to fit in with the ongoing activity. This usually leads to the newcomer being readily accepted into the group. If the newcomer is a boy, he is more likely to hijack the game by trying to change it, directing everyone's attention on to him. And even by the age of six, girls are better at being a host. They are more attentive to the newcomer. Boys often just ignore the newcomer's attempt to join in. They are more likely to carry on with what they were already doing.

How early are such sex differences in empathy evident? Certainly, by 12 months , girls make more eye contact than boys. But a new study carried out in my lab at Cambridge University shows that at birth, girls look longer at a face, and boys look longer at a suspended mechanical mobile. Furthermore, the Cambridge team found that how much eye contact children make is in part determined by a biological factor: prenatal testosterone. This has been demonstrated by measuring this hormone in amniotic fluid.

All this adds up to a large amount of evidence for a female advantage in empathising, with at least some biological determinants. What about the claimed male advantage in systemising?

Boys, from toddlerhood onwards, are more interested in cars, trucks, planes, guns and swords, building blocks, constructional toys, and mechanical toys - systems. They seem to love putting things together, to build toy towers or towns or vehicles. Boys also enjoy playing with toys that have clear functions, buttons to press, things that will light up, or devices that will cause another object to move.

You see the same sort of pattern in the adult workplace. Some occupations are almost entirely male. Think of metal-working, weapon-making, crafting musical instruments, or the construction industries, such as boat-building. The focus of these occupations is on constructing systems. Professions such as maths, physics, and engineering, which require high sys temising, are also largely male-chosen disciplines.

Some psychological tests also show the male advantage in systemising. For example, in the mental rotation test, you're shown two shapes, and asked if one is a rotation or a mirror image of the other. Males are quicker and more accurate on this test. Reading maps has been used as another test of systemising. Men can learn a route in fewer trials, just from looking at a map, correctly recalling more details about direction and distance. If you ask boys to make a map of an area that they have only visited once, their maps have a more accurate layout of the features in the environment, eg, showing which landmark is south-east of another.

If you ask people to put together a 3D mechanical apparatus in an assembly task, on average, men score higher. Boys are also better at constructing block buildings from 2D blueprints. These are constructional systems. And in Nick Hornby's novel, High Fidelity, the male protagonist is obsessed with his record collection, and works in a second-hand record shop catering for (almost all male) customers searching for that one missing item in their collections of music. Collections (of albums, or anything else) are often highly systematic in nature.

The male preference for focusing on systems again is evident very early. Our Cambridge study found that at one year old, little boys showed a stronger preference to watch a film of cars (mechanical systems), than a film of a person's face (with a lot of emotional expression). Little girls showed the opposite preference. And at one day old, little boys look for longer at a mechanical mobile.

We, of course, know that with time, culture and socialisation do play a role in determining a male brain (stronger interest in systems) or female brain (stronger interest in empathy). But these studies strongly suggest that biology also partly determines this.

Some of the most convincing evidence for biological causes comes from studies of the effects of hormones. There was a time when women were prescribed a synthetic female hormone (diethylstilbestrol), in an attempt to prevent repeated spontaneous miscarriages. Boys born to such women are likely to show more female-typical, empathising behaviours, such as caring for dolls. And if a female rat is injected at birth with testosterone, she shows faster, more accurate maze learning, compared with a female rat who has not been given such an injection.

Some important lessons have been learnt from studies of clinical conditions. Male babies born with IHH (idiopathic hypogonadotrophic hypogonadism) have very small testes (and therefore low levels of testosterone) and they are worse at spatial aspects of systemising, relative to normal males. Other male babies born with androgen insensitivity (AI) syndrome (testosterone is an androgen) are also worse at systemising. Compare these with female babies born with CAH (congenital adrenal hyperplasia), who have high levels of androgens and who have enhanced spatial systemising.

But even if you leave aside these clin ical conditions, there is evidence for the effects of hormones on the mind in the typical child: our own study found that toddlers who had lower foetal testosterone had higher levels of eye contact. Presumably eye contact may have something to do with sociability and empathising. And a group of Canadian researchers found that the higher your prenatal testosterone the better you do on the mental rotation (systemising) test.

Should a theory like this be a cause of concern? Some people may worry that this is suggesting one sex is better than the other, but a moment's reflection should allay this fear. The theory is saying that, on average, males and females differ in what they are drawn to and what they find easy, but that both sexes have their strengths and their weaknesses. Neither sex is superior overall.

Others may worry that a theory like this stereotypes the sexes. But we need to distinguish stereotyping from the study of sex differences. The study simply looks at males and females as two groups, and asks why on average, differences are seen. There is

no harm in that, and even some important scientific advances that can come out of it. Stereotyping, on the other hand, is when a characteristic of a group is assumed to apply to an individual, and this is potentially discriminating and harmful. The E-S theory does not stereotype. Rather, it seeks to explain why individuals are typical or atypical for their sex.

What are the potential new insights from a theory like this? It may help us understand the childhood neurological conditions of autism and Asperger syndrome, which appear to be an extreme of the male brain. Such individuals may have impairments in empathising alongside normal or even talented systemising. The theory also predicts the existence of the mirror-image of autism or Asperger syndrome, namely, the extreme female brain. Science has not even begun to investigate what such people are like, but we know they must have impairments in systemising, alongside normal or even talented empathising. Finally, the theory delineates two key dimensions of individual differences - empathising and systemising - that exist among any group of children, so that parents and educators can become more tolerant of difference.

Is there an explanation for autism?

I argue that people with autism may have an extreme of the male brain - good at systemising, very bad at empathising - and that studying autism with E-S theory in mind, can help increase our understanding of the condition.

Two largest sub-groups of autism are classic autism, and Asperger syndrome. Both share certain features: a difficulty in developing social relationships; a difficulty in communication; the presence of unusually strong, narrow interests; and a strong adherence to routines.

They differ in that in classic autism, the person might have an IQ at any point on the scale (even in the learning disabled range) and the person invariably had a language delay as a toddler. In Asperger syndrome, the person is always at least average in IQ (and may be well above average), and talked on time as a toddler. Autism spectrum conditions affect about one child in every 200, with males being far more likely than to be diagnosed.

What's interesting is that the obsessional interests that people with autism spectrum conditions show often focus on a system. It may be an intense preoccupation with light switches in the house, or running water from the taps in different sinks in the house. For their long-suffering parents, these "obsessions" can be very hard to cope.

But according to the E-S theory the child may simply be focusing on the tiny details in the system - how fast the water flows when the tap is turned to different angles, or which lights go on when different switches are in the up or down position - using their intelligence to work out the underlying rules that govern the system. The characteristic approach they take is to home in on a topic or area of knowledge, and comb it for every detail, until they feel they've covered most if not all of the information available. The "obsession" might last weeks, months, or even years. And then typically, they move on to a new area to master.

Some parents and teachers will indulge the child so that the child can follow their obsessional interests all the way. And just sometimes, this can lead to great achievement or the development of expertise. Other parents or teachers - with good reason - feel a need to interrupt the child's obsessional focus. But the E-S theory sees individuals with autism spectrum conditions as having a learning style that prefers depth over breadth, and accuracy or exactness over gist.

So much for their strong systemising. What about their impaired empathising? This is the area that is likely to lead them into trouble, or to leave them disabled. Difficulty empathising translates into a whole set of hurdles. You might be last person to get the point of a joke, which can leave you feeling like an outsider. You might end up saying something that another person finds hurtful or offensive, when that was the last thing you intended. You might misinterpret other people's actions and motives. And you might just not pick up how others see you, and hence not know how you come across as odd or different. People's insincerity or subtle emotions may just go straight over your head.

Such difficulties can lead to a child with autism or Asperger syndrome being neglected, or even ostracised by their peer group. Or worse, teased and bullied. Tragically, such bullying often goes undetected by teachers and even parents, so that the child suffers in silence at school for years and years. During the teens, this difficulty in fitting into a peer group can lead the person with Asperger syndrome to become depressed.

No wonder educators are now urgently waking up to the existence of Asperger syndrome, since if it can be better recognised, many of these secondary difficulties might be avoided. And the hope is that a better understanding of such conditions - the extreme male brain - may lead teachers to be more tolerant of the very different learning style such children possess. If nurtured, systemising is not only a valuable contribution, but can even result in a refreshingly original way of thinking and seeing the world.

Simon Baron-Cohen is the director of the Autism Research Centre, Cambridge University. His new book, the Essential Difference: Men, Women and the Extreme Male Brain, will be published by Penguin on May 1 For more information, visit the National Autistic Society UK website www.nas.org.uk

Further reading

Sex and Cognition, Doreen Kimura, MIT Press,1999

Mindblindness: an essay on autism and theory of mind, Simon Baron-Cohen, MIT Press/Bradford Books, 1995

Male, Female: The Evolution of Human Sex Differences, David C Geary, American Psychological Society, 1998

The Two Sexes: growing up apart, coming together, Eleanor MacCoby Harvard University Press, 1998

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