

Theories of the autistic mind

Simon Baron-Cohen, winner of the Society's President's Award, outlines a career at the forefront of thinking over autism and Asperger's syndrome

The challenge has been to explain all of the features of autism, across all individuals on the autistic spectrum. After 25 years of careful testing, Simon Baron-Cohen concludes that 'mindblindness' or difficulties with empathy can explain the social-communication difficulties in autism, whilst the newer concept of 'hyper-systemising' can explain the areas of strength in autism: excellent attention to detail, and unusually narrow interests.

Classic autism and Asperger's syndrome both share three core diagnostic features: difficulties in social development, and in the development of communication, alongside unusually strong, narrow interests and repetitive behaviour. Since communication is always social, it might be more fruitful to think of autism and Asperger's syndrome as sharing features in two broad areas: social-communication, and narrow interests/repetitive actions. As for distinguishing features, a diagnosis of Asperger's syndrome requires that the child spoke on time and has average IQ or above.

Today the notion of an autistic spectrum is no longer defined by any sharp separation from 'normality' (Wing, 1997). The clearest way of seeing this 'normal' distribution of autistic traits is using the Autism Spectrum Quotient (or AQ) (Baron-Cohen et al., 2006; Baron-Cohen, Wheelwright, Skinner et al., 2001). This is a screening instrument in the form of a questionnaire, either completed by a parent about their child, or by self-report (if the adult is 'high-functioning'). There are 50 items in total, and when administered to a large population the results resemble a 'normal distribution'. Most people without a diagnosis fall in the range 0–25; most with a diagnosis of an autism spectrum condition fall between 26 and 50. Of those with an autistic spectrum condition, 80 per cent score above 32, and 99 per cent above 26. So the AQ neatly separates the groups – 93 per cent of the general population fall in the average range of the AQ, and 99 per cent of the autistic population fall in the extreme (high-end) of the scale.

In the general population, males score slightly (but statistically significantly) higher than females. Since autism spectrum conditions are far more common in males than in females (classic autism occurs in four males for every one female, and Asperger's syndrome occurs in nine males for every one female), this may suggest that the number of autistic traits a person has is connected to a sex-linked biological factor – genetic or hormonal, or both (Baron-Cohen et al., 2005; Baron-Cohen et al., 2004). These two aspects – the autistic spectrum and the possibility of sex-linked explanations – have been at the core of my research and theorising over recent years.

The mindblindness theory

In my early work I explored the theory that children with autism spectrum conditions are delayed in developing a *theory of mind* (ToM): the ability to put oneself into someone else's shoes, to imagine their thoughts and feelings (Baron-Cohen, 1995; Baron-Cohen et al., 1985). When we mindread or mentalise, we not only make sense of another person's behaviour (why did their head swivel on their neck? Why did their eyes move left?), but we also imagine a whole set of mental states (they have seen something of interest, they know something or want something) and we can predict what they might do next.

The mindblindness theory proposes that children with autism and Asperger's syndrome are delayed in the development of their ToM, leaving them with degrees of *mindblindness*. As a consequence, they find other people's behaviour confusing and unpredictable, even frightening. Evidence for this comes from difficulties they show at each point in the development of the capacity to mindread:

- A typical 14-month-old shows joint attention (such as pointing or following another person's gaze), during which they not only look at another person's face and eyes, but pay attention to what the other person is interested in (Scaife & Bruner, 1975). Children with autism and Asperger's syndrome show reduced

questions

How can one characterise the differences between those with and without autism?

And what implications does such a characterisation have for clinical intervention and special education?

resources

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frequency of joint attention, in toddlerhood (Swettenham et al., 1998).

- I The typical 24-month-old engages in *pretend play*, using their mindreading skills to be able to understand that in the other person's mind, they are just

Asperger's syndrome are delayed in passing this test (Baron-Cohen et al., 1985).

- I Deception is easily understood by the typical four-year-old child (Sodian & Frith, 1992). Children with autism and

tests far more difficult (Baron-Cohen, Wheelwright, Scahill et al., 2001), and the same is true when the adult version of the test is used. Adults with autism and Asperger's syndrome score below average on this test of advanced mindreading (Baron-Cohen, Wheelwright, Hill et al., 2001).

sarcastic

stern



suspicious

dispirited

pretending (Leslie, 1987). Children with autism and Asperger's syndrome show less pretend play, or their pretence is limited to more rule-based formats (Baron-Cohen, 1987).

- I The typical three-year-old child can pass the *seeing leads to knowing* test: understanding that merely touching a box is not enough to know what is inside (Pratt & Bryant, 1990). Children with autism and Asperger's syndrome are delayed in this (Baron-Cohen & Goodhart, 1994).
- I The typical four-year-old child passes the 'false belief' test, recognising when someone else has a mistaken belief about the world (Wimmer & Perner, 1983). Most children with autism and

Asperger's syndrome tend to assume everyone is telling the truth, and may be shocked by the idea that other people may not say what they mean (Baron-Cohen, 1992; Baron-Cohen, 2007a).

- I The typical nine-year-old can figure out what might hurt another's feelings and what might therefore be better left unspoken – *faux pas*. Children with Asperger's syndrome are delayed by around three years in this skill, despite their normal IQ (Baron-Cohen, O'Riordan et al., 1999).
- I The typical nine-year-old can interpret another person's expressions from their eyes, to figure out what they might be thinking or feeling. Children with Asperger's syndrome tend to find such

A strength of the mindblindness theory is that it can make sense of the social and communication difficulties in autism and Asperger's syndrome, and that it is universal in applying to all individuals on the autistic spectrum. Its shortcoming is that it cannot account for the non-social features. A second shortcoming of this theory is that whilst mindreading is one component of empathy, true empathy also requires an emotional response to another person's state of mind (Davis, 1994). Many people on the autistic spectrum also report that they are puzzled by how to *respond* to another person's emotions (Grandin, 1996). A final limitation of the mindblindness theory is that a range of clinical conditions show forms of mindblindness, such as patients with schizophrenia (Corcoran & Frith, 1997) or narcissistic and borderline personality disorders (Fonagy, 1989), or children with conduct disorder (Dodge, 1993), so this may not be specific to autism and Asperger's syndrome.

Two key ways to revise this theory have been to explain the non-social areas of strength by reference to a second factor, and to broaden the concept of ToM to include an emotional reactivity dimension. Both of these revisions were behind the development of the next theory.

The empathising-systemising (E-S) theory

This newer theory explains the social and communication difficulties in autism and Asperger's syndrome by reference to delays and deficits in *empathy*, whilst explaining the areas of strength by reference to intact or even superior skill in *systemising* (Baron-Cohen, 2002).

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ToM is just the cognitive component of empathy. The second component of empathy is the response element: having an appropriate emotional reaction to another person's thoughts and feelings. This is referred to *affective empathy* (Davis, 1994). On the Empathy Quotient (EQ), a questionnaire either filled out by an adult about themselves, or by a parent about their child, both cognitive empathy and affective empathy are assessed. On this scale, people with autism spectrum conditions score lower than comparison groups.

According to the empathising-systemising (E-S) theory, autism and Asperger's syndrome are best explained not just with reference to empathy (below average) but also with reference to a second psychological factor (systemising), which is either average or even above average. So it is the discrepancy between E and S that determines whether you are likely to develop an autism spectrum condition.

To understand this theory we need to turn to this second factor, the concept of *systemising* – the drive to analyse or construct any kind of system. What defines a system is that it follows *rules*, and when we systemise we are trying to identify the rules that govern the system, in order to predict how that system will behave (Baron-Cohen, 2006). These are some of the major kinds of system:

- | *collectible* systems (e.g. distinguishing between types of stones or wood),
- | *mechanical* systems (e.g. a video-recorder or a window lock),
- | *numerical* systems (e.g. a train timetable or a calendar),
- | *abstract* systems (e.g. the syntax of a language, or musical notation),
- | *natural* systems (e.g. the weather patterns, or tidal patterns),
- | *social* systems (e.g. a management hierarchy, or a dance routine with a dance partner)
- | *motoric* systems (e.g. throwing a Frisbee).

Some people have a drive to analyse natural systems such as the tides

In all these cases, you systemise by noting regularities (or structure) and rules. The rules tend to be derived by noting whether A and B are *associated* in a systematic way. The evidence for intact or even unusually strong systemising in autism and Asperger's syndrome is that, in one study, such children performed above the level that one would expect on a physics test (Baron-Cohen, Wheelwright et al., 2001). Children with Asperger's syndrome as young as 8–11 years old scored higher than a comparison group who were older (typical teenagers).

A second piece of evidence comes from studies using the Systemising Quotient (SQ). The higher your score, the stronger your drive to systemise. People with high-functioning autism or Asperger's syndrome score higher on the SQ compared to people in the general population (Baron-Cohen et al., 2003). The above tests of systemising were designed for children or adults with Asperger's syndrome, not classic autism. However, children with classic autism perform better than controls on the Picture Sequencing Test where the stories can be sequenced using physical-causal concepts (Baron-Cohen et al., 1986). They also score

above average on a test of how to figure out how a Polaroid camera works (Leslie & Thaiss, 1992), even though they have difficulties figuring out people's thoughts and feelings (Baron-Cohen et al., 1985; Perner et al., 1989). Both of these are signs of their intact or even strong systemising.

The strength of the E-S theory is that it is a *two-factor theory* that can explain the cluster of both the social and non-social features in autism spectrum conditions. Below-average empathy is a simple way to explain the social-communication difficulties, whilst average or even above-average systemising is a way of explaining the narrow interests, repetitive behaviour, and resistance to change/need for sameness. This is because when you systemise, it is easiest to keep everything constant, and only vary one thing at a time. That way, you can see what might be causing what, rendering the world predictable.

When this theory first came out, one criticism of it was that it might only apply to the *high-functioning* individuals with autism or Asperger's syndrome. Whilst their obsessions (with computers or maths, for example) could be seen in terms of strong

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systemising (Baron-Cohen et al., 1999), surely this didn't apply to the low-functioning individuals? However, when we think of a child with autism, many of the classic behaviours can be seen as a reflection of their strong systemising (see box opposite).

Like the weak central coherence (WCC) theory (Frith, 1989), the E-S theory is about a different cognitive style (Happé, 1996). Like that theory, it also posits excellent attention to detail (in perception and memory), since when you systemise you have to pay attention to the tiny details. This is because each tiny detail in a system might have a functional role. Excellent attention to detail in autism has been repeatedly demonstrated (Jolliffe & Baron-Cohen, 2001; O'Riordan et al., 2001; Shah & Frith, 1983, 1993). The difference between these two theories is that whilst the WCC theory sees people with autism spectrum conditions as drawn to detailed information (sometimes called local processing) for *negative* reasons (an alleged inability to integrate), the E-S theory sees this same quality (excellent attention to detail) as being highly purposeful: it exists in order to understand a system. Attention to detail is occurring for *positive* reasons: in the service of achieving an ultimate understanding of a system (however small and specific that system might be).

Whereas the WCC theory predicts that people with autism or Asperger's syndrome will be forever lost in the detail, never achieving an understanding of the system as a whole (since this would require a global overview), the E-S theory predicts that over time, the person may achieve an excellent understanding of a whole system, given the opportunity to observe and control all the variables in that system. The existence of talented mathematicians with Asperger's syndrome, like Richard Borcherds, is proof that such individuals can integrate the details into a true understanding of the system (Baron-Cohen, 2003). It is worth noting that the executive dysfunction (ED) theory (e.g. Ozonoff et al., 1991) has even more difficulty in explaining instances of good understanding of a whole system, such

as calendrical calculation, or indeed of why the so-called 'obsessions' in autism and Asperger's syndrome should centre on systems at all.

So, when the low-functioning person with classic autism has shaken a piece of string thousands of times close to his eyes, whilst the ED theory sees this as perseveration arising from some neural dysfunction which would normally enable the individual to shift attention, the E-S theory sees the same behaviour as a sign that the individual understands the physics of that string movement. He may be able to

make it move in exactly the same way every time. When he makes a long, rapid sequence of sounds, he may know exactly that acoustic pattern, and get some pleasure from the confirmation that the sequence is the same every time. Much as a mathematician might feel an ultimate sense of pleasure at the 'golden ratio', so the child – even with low-functioning autism – who produces the same outcome every time with their repetitive behaviour, appears to derive some emotional pleasure at the predictability of the world. This may be what is clinically described as 'stimming' (Wing, 1997).

Examples of systemising in classic autism *and/or* Asperger's syndrome (*italics*)

Sensory systemising	Tapping surfaces, or letting sand run through one's fingers	<i>Insisting on the same foods each day</i>
Motoric systemising	Spinning round and round, or rocking back and forth	<i>Learning knitting patterns or a tennis technique</i>
Collectible systemising	Collecting leaves or football stickers	<i>Making lists and catalogues</i>
Numerical systemising	Obsessions with calendars or train timetables	<i>Solving maths problems</i>
Motion systemising	Watching washing machines spin round and round	<i>Analysing exactly when a specific event occurs in a repeating cycle</i>
Spatial systemising	Obsessions with routes	<i>Developing drawing techniques</i>
Environmental systemising	Insisting on toy bricks being lined up in an invariant order	<i>Insisting that nothing is moved from its usual position</i>
Social systemising	Saying the first half of a phrase or sentence and waiting for the other person to complete it	<i>Insisting on playing the same game whenever a child comes to play</i>
Natural systemising	Asking over and over again what the weather will be today	<i>Learning the Latin names of every plant and their optimal growing conditions</i>
Mechanical systemising	Learning to operate the VCR	<i>Fixing bicycles or taking apart gadgets and reassembling them</i>
Vocal/auditory/verbal systemising	Echoing sounds	<i>Collecting words and word meanings</i>
Systemising action sequences	Watching the same video over and over again	<i>Analysing dance techniques</i>
Musical systemising	Playing the same tune over and over again	<i>Analysing the musical structure of a song</i>

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Autism was originally described as involving 'resistance to change' and 'need for sameness' (Kanner, 1943), and here we see that important clinical observation may be the hallmark of strong systemising.

One final advantage of the E-S theory is that it can explain what is sometimes seen as an inability to 'generalise' in autism spectrum conditions (Plaisted et al., 1998; Rimland, 1964; Wing, 1997). According to the E-S theory, this is exactly what you would expect if the person is trying to understand each system as a *unique* system. A good systemiser is a splitter, not a lumpner, since lumping things together can lead to missing key differences that enable you to predict how these two things behave differently.

The extreme male brain theory

The E-S theory has been extended into the extreme male brain (EMB) theory of autism (Baron-Cohen, 2002). This is because there are clear sex differences in empathising (females performing better on many such tests) and in systemising (males performing better on tests of this). Autism and Asperger's syndrome can be seen as an extreme of the typical male profile, a view first put forward by the paediatrician Hans Asperger. To see how this theory is effectively just an extension of the E-S theory, one needs to understand that that theory posits two independent dimensions (E for empathy and S for systemising) in which individual differences are observed in the population. When you plot these, five different 'brain types' are seen:

- I Type E (E > S): individuals whose empathy is stronger than their systemising.
- I Type S (S > E): individuals whose systemising is stronger than their empathy.
- I Type B (S = E): individuals whose empathy is as good (or as bad) as their systemising. (B stands for 'balanced').
- I Extreme Type E (E >> S): individuals whose empathy is above average, but who are challenged when it comes to systemising.

- I Extreme Type S (S >> E): individuals whose systemising is above average, but who are challenged when it comes to empathy.

The E-S model predicts that more females have a brain of Type E, and more males have a brain of Type S. People with autism spectrum conditions, if they are an extreme of the male brain, are predicted to be more likely to have a brain of Extreme Type S. If one gives people in the general population measures of empathy and systemising (the EQ and SQ), the results fit this model reasonably well. The majority of males (54 per cent) do have a brain of Type S, whereas the largest group of females (44 per cent) have a brain of Type E, and the majority of people with autism and Asperger's syndrome (65 per cent) have an extreme of the male brain (Goldenfeld et al., 2005).

Apart from the evidence from the SQ and EQ, there is other evidence that supports the EMB theory. Regarding tests of empathy, on the faux pas test, where a child has to recognise when someone has said something that could be hurtful, girls typically develop faster than boys, and children with autism spectrum conditions develop even slower than typical boys (Baron-Cohen et al., 1999). On the 'Reading the Mind in the Eyes' Test, on average women score higher than men, and people with autism spectrum conditions score even lower than typical males (Baron-Cohen et al., 1997). Regarding tests of attention to detail, on the Embedded Figures Test, where one has to find a target shape as quickly as possible, on average males are faster than females, and people with autism are even faster than typical males (Jolliffe & Baron-Cohen, 1997).

Recently, the extreme male brain theory has been extended to the level of neurology, with some interesting findings emerging (Baron-Cohen et al., 2005). Thus, in regions of the brain that on average are smaller in

males than in females (e.g. the anterior cingulate, superior temporal gyrus, prefrontal cortex and thalamus), people with autism have even smaller brain regions than typical males. In contrast, in regions of the brain that on average are bigger in males than in females (e.g. the amygdala and cerebellum), people with autism have even bigger brain regions than typical males. Also, the male brain on average is larger than in females, and people with autism have been found to have even larger brains than typical males. Not all studies support this pattern but some do, and it will be important to study such patterns further.

In summary, the EMB theory is relatively new and may be important for understanding why more males develop autism and Asperger's syndrome than do females. It remains in need of further examination. It extends the E-S theory, which has the power to explain not just the social-communication deficits in autism spectrum conditions, but also the uneven cognitive profile, repetitive behaviour, islets of ability, savant skills, and unusual narrow interests that are part of the atypical neurology of this subgroup in the population. The E-S theory has implications for intervention, as is being tried by 'systemising empathy', presenting emotions in an autism-friendly format (Baron-Cohen, 2007b; Golan et al., 2006). Finally, the E-S theory destigmatises autism and Asperger's syndrome, relating these to individual differences we see in the population (between the sexes, and within the sexes), rather than as categorically distinct or mysterious.



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