Feature

The empathising-systemising theory of autism: implications for education

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Abstract

The education of children with autism spectrum conditions deserves a fresh look, for several reasons. First, it is unclear whether some approaches – such as applied behavioural analysis (ABA) – are simply shaping behaviour but not fundamentally leading to conceptual development. Second, it is ethically questionable whether educational methods depend on external reinforcement or reward or methods that are intrinsically rewarding would be preferable. Third, many educational approaches to autism have proceeded without a clear theoretical rationale. In this article, I summarise a new two-factor psychological theory of autism spectrum conditions, and present some examples of educational methods that are based on this theory, and that are intrinsically rewarding. I argue that such methods may be more autism-friendly.

Key words

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Classic autism and Asperger's Syndrome share three core diagnostic features:

- difficulties in social development
- difficulties in the development of communication
- unusually strong, narrow interests and repetitive behaviour (APA, 1994).

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). This 'normal' distribution of autistic traits is evident in the results from the Autism Spectrum Quotient (or AQ) (Baron-Cohen *et al*, 2006, 2001c). 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 AS occurs in nine males for every one female) (Rutter, 1978), this may suggest that the number of autistic traits a person has is linked to a sex-linked biological factor – genetic or hormonal, or both (Baron-Cohen *et al*, 2005, 2004).

The mindblindness theory

Early work 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 mind-read or mentalise, we not only make sense of another person's behaviour (Why did their head swivel on their neck? Why did their

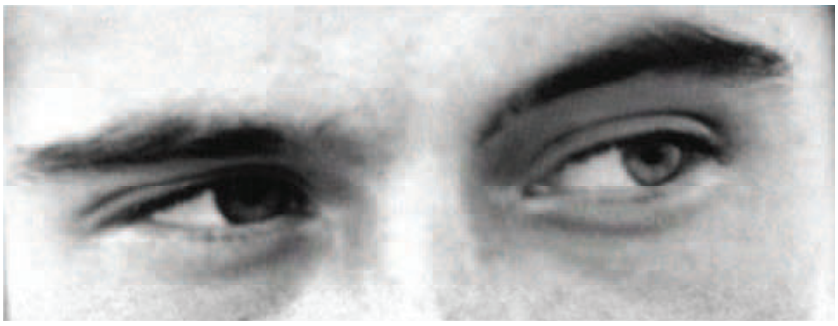
eyes move left?), but we also imagine a whole set of mental states (they have seen something of interest, they know something or want something) and we can predict what they might do next.

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 the difficulties they show at each point in the development of the capacity to mind-read.

- 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 also pay attention to what the other person is interested in (Scaife & Bruner, 1975). Children with autism and Asperger's Syndrome show reduced frequency of joint attention in toddlerhood (Swettenham *et al*, 1986).
- The typical 24-month-old engages in **pretend play**, using their mind-reading skills to be able to understand that, in the other person's mind, they are just 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).
- 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 & Goodheart, 1994).
- The typical four-year-old child passes the '**false belief**' test, recognising when someone else has a mistaken belief about the world (Wimmer & Pernet, 1983). Most children with autism and Asperger's Syndrome are delayed in passing this test (Baron-Cohen *et al*, 1985).
- Deception is easily understood by the typical four-year-old child (Sodian & Frith, 1992). Children with autism and Asperger's Syndrome tend to assume that everyone is telling the truth, and may be shocked by the idea that other people might not say what they mean (Baron-Cohen, 1992, 2007a).
- The typical nine-year-old can work 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 *et al*, 1999a).
- The typical nine-year-old can interpret another person's expressions from their eyes, to work out what they might be thinking or feeling (***Figure 1***, below).

FIGURE 1: THE CHILD VERSION OF THE *READING THE MIND IN THE EYES* TEST

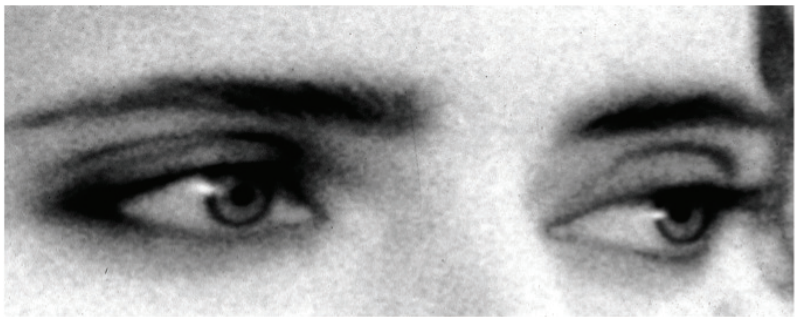
1.FEELING SORRY **2.BORED**



3.INTERESTED **4.JOKING**

FIGURE 2: THE ADULT VERSION OF THE *READING THE MIND IN THE EYES* TEST

1.SARCASTIC 2.STERN



3.SUSPICIOUS 4.DISPIRITED

- Children with Asperger's Syndrome tend to find such tests far more difficult (Baron-Cohen et al, 2001b), and the same is true when the adult test of Reading the Mind in the Eyes is used (***Figure 2***, above). Adults with autism and Asperger's Syndrome score below average on this test of advanced mindreading (Baron-Cohen *et al*, 2001a).

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, 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, while mind-reading 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 about 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 schizophrenia (Corcoran & Frith, 1997), narcissistic and borderline personality disorders (Fonagy, 1989) and, in some studies, conduct disorder (Dodger, 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 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**, while explaining the areas of strength by reference to intact or even superior skill in **systemising** (Baron-Cohen, 2002).

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 as **affective empathy** (Davy, 1994). On the Empathy Quotient (EQ), a questionnaire filled in either by an adult about themselves, or by a parent about their child, both cognitive 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. Systemising is the drive to analyse or construct systems – 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). The main kinds of system include:

- collectable systems (eg distinguishing between types of stone or wood)
- mechanical systems (eg a video-recorder or a window lock)
- numerical systems (eg a train time-table or a calendar)
- abstract systems (eg the syntax of a language, or musical notation)
- natural systems (eg weather patterns, or tidal wave patterns)
- social systems (eg a management hierarchy, or a dance routine with a dance partner)
- motoric systems (eg throwing a Frisbee or bouncing on a trampoline).

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 *et al,* 2001b). Children with Asperger's Syndrome as young as eight or eleven 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 than people in the general population (Baron-Cohen et al, 2003). The above tests of systemising are 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*, 1985). They also score above average on a test of how to discover how a Polaroid camera works, even though they have difficulties in understanding people's thoughts and feelings (Baron-Cohen *et al*, 1985; Pernet *et al*, 1989). Both 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 social and non-social features in autism spectrum conditions. Below-average empathy is a simple way to explain the social-communication difficulties, while 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 was first proposed, one criticism was that it might apply only to high-functioning individuals with autism or Asperger's Syndrome. While their obsessions (with computers

or maths, for example) could be seen in terms of strong systemising (Baron-Cohen *et al*, 1999b) 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. Some examples are listed in ***Box 1***, below.

Like the Weak Central Coherence (WCC) theory (Frith, 1989), the E-S theory is about a different cognitive style (Happe, 1996). The WCC theory argues that people on the autistic spectrum have an attentional bias towards local processing rather than

BOX 1: SYSTEMISING IN CLASSIC AUTISM AND/OR ASPERGER'S SYNDROME

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

Musical systemising
  - Playing a tune on an instrument over and over again
  - *Analysing the musical structure of a song*

global processing. Like that theory, the E-S theory also posits excellent attention to detail (in perception and memory), since when you systemise you have to pay attention to the tiny details, because each tiny detail in a system might have a functional role. Excellent attention to detail in autism has been demonstrated repeatedly (Jilliffe & Baron-Cohen, 2001; Mottron *et al*, 2003; O'Riordan *et al*, 2001; Shah & Frith, 1983, 1993). The difference between these two theories is that while 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 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 the system might be).

Whereas the WCC theory predicts that people with autism or Asperger's Syndrome will be forever lost in the detail and never achieve 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 the system. The existence of talented mathematicians with AS 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 (Ozonoff *et al*, 1991; Rumsey & Hamberger, 1998; Russell, 1997), which proposes that there is deficit in the frontal-lobe brain systems that exercise control over attention, action and planning, has even more difficulty in explaining instances of good understanding of a whole system, such as calendrical calculation, or indeed why the so-called 'obsessions' in autism and AS should centre on systems at all.

When the low-functioning person with classic autism has shaken a piece of string thousands of times close to his eyes, while 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 the 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 in the 'golden ratio' (that a + b /a = a/b) and that it **always** comes out as 1.61803399, 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 in the predictability of the world. This may be what is clinically described as 'stimming' (Wing, 1997). 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 this each system as a **unique** system. A good systemiser is a splitter, not a lumper, since lumping things together can lead you to miss 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), 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), such that 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 (1944). To see how this theory is really 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 them, five 'brain types' are seen:

- Type E (E >S): individuals whose empathy is stronger than their systemising
- Type S (S >E): individuals whose systemising is stronger than their empathy
- Type B (S = E): individuals whose empathy is as good (or as bad) as their systemising (B stands for 'balanced')
- Extreme Type E (E >>S): individuals whose empathy is above average, but who are challenged when it comes to systemising
- 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. A majority of males (54%) **do** have a brain of Type S, Type E is the most common brain in females (44%) and a majority of people with autism and Asperger's Syndrome (65%) have an extreme of the male brain (Goldenfield *et al*, 2005).

Apart from the evidence from the SQ and EQ, there is other evidence that supports the EMB theory. Among 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 more slowly than typical boys (Baron-Cohen *et al*, 1999a). 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). Among 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, and some interesting findings are emerging (Baron-Cohen *et al*, 2005). Thus, in regions of the brain that on average are smaller in males than in females (such as 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 (for example the amygdala, cerebellum, overall brain size/weight and head circumference), people with autism have even bigger brain regions than typical males. 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 than females develop autism and Asperger's Syndrome. It needs 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.

Implications for education

The E-S theory has implications for education, for example by 'systemising empathy', presenting emotions in an autism-friendly format. One such example is the *Mindreading* DVD (www.jkp.com/mindreading), an electronic encyclopaedia of emotional expressions, so that the strongly systemising mind can learn to improve in emotion recognition in much the same way as one might teach oneself a foreign language. The idea here is that if people with ASC prefer to learn systematically, they might find it easier to learn emotions via a computer.

A 'treatment trial' comparing a group of adults with AS who used the DVD for 10 weeks (two hours per week) with a group of adults with AS who did not found that the intervention group improved significantly more than the controls in their ability to recognise emotions (Golan *et al*, 2006).

The second example is the *Transporters* DVD (www.thetransporters.com). This is an animation designed for pre-school children on the autistic spectrum, in which vehicles that move along tracks have real human faces. Using systems like mechanical vehicles is a way to capture the child's interest, if they are on the autistic spectrum, ensuring that they are exposed to faces and increase their opportunity to learn about emotions. Again, a 'treatment trial' comparing a group of children with ASC who used this DVD for 15 minutes a day over a four-week period found that these children improved in their emotion recognition relative to a control group who did not have this intervention (Baron-Cohen, 2007b; Golan *et al*, in press).

These two interventions share a common feature, namely, that they are highly structured and centre on a system (a taxonomic system in the case of the *Mindreading* DVD, and presented on a mechanical system (a computer), and mechanical systems in the form of animated vehicles, in the case of *The Transporters*). What is striking is that people on the autistic spectrum don't seem to need any persuading to use such DVDs. They find them intrinsically interesting. As argued in the introduction, other educational methods such as applied behavioural analysis depend heavily on external rewards to motivate the child. While I do not wish to question the value of such methods (and some parents and teachers have found them extremely valuable), it is nevertheless the case that methods that appeal to the child succeed in circumventing a whole host of ethical issues. I do not wish to over-claim the benefits of these two DVDs, and indeed they are simply examples of what I regard as educational methods that are tightly linked to a theory of the autistic mind.

A final example is Lego Therapy, which has also been shown to lead to significant gains for children with ASC (Owens *et al*, 2008). In Lego Therapy, groups of three children with ASC are invited to play in a Lego group, not in a solitary fashion but collaboratively. One child has the toy bricks (the supplier). The other has the instructions (the designer). The third has to receive the relevant brick to assemble the model (the builder). As with the DVDs mentioned earlier, in Lego Therapy children need no persuasion to take part, and no external reinforcement. They find it intrinsically rewarding. It is likely that no single method of education will work for all children or adults with ASC, but it may be that the methods that are most successful will be those that appeal to the autistic mind. Ethically, this also means that, rather than expecting the child with ASC to join our world, we are adapting the environment to meet him or her halfway.

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