CHAPTER 3

The Autistic Mind

The Empathizing-Systemizing Theory

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CLASSIC autism and Asperger's syndrome both share *three* core diagnostic features: 1) difficulty in social development, 2) difficulty in the development of communication, and 3) unusually strong, narrow interests and repetitive behavior (American

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Psychiatric Association 2000). Because 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 an IQ that is average or above average.

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 by looking at the results from the Autism Spectrum Quotient (Baron-Cohen et al. 2001b, 2006). This screening instrument takes the form of a questionnaire that is completed either by a parent about his or her 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 disorder (ASD) fall between 26 and 50. Eighty percent score above 32, and 99% score above 26. So the Autism Spectrum Quotient neatly separates the groups, showing that 93% of the general population fall in the average range, and 99% 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. Because ASDs 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; 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. 2004, 2005).

The Mindblindness Theory

Early work explored the theory that children with ASDs are delayed in developing a *theory of mind:* the ability to put oneself into someone else's shoes and to imagine their thoughts and feelings (Baron-Cohen 1995; Baron-Cohen et al. 1985). When we mindread or *mentalize*, we not only make sense of another person's behavior (Why did his head swivel on his neck? Why did her eyes move left?), but also imagine a whole set of mental states (he saw something of interest, she knows something or wants something) and can predict what he or she might do next.

The mindblindness theory proposes that children with autism and Asperger's syndrome are delayed in the development of their theory of mind, leaving them with degrees of *mindblindness.* As a consequence, they find other people's behavior 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 he not only looks at another person's face and eyes but also pays attention to what the other person is interested in (Scaife and Bruner 1975). Children with autism and Asperger's syndrome show reduced frequency of joint attention in toddlerhood (Swettenham et al. 1998).
- The typical 24-month-old engages in *pretend play*, using her mindreading skills to be able to understand that in the other person's mind, she is just pretending (Leslie 1987). Children with autism and Asperger's syndrome show less pretend play, or their pretense is limited to more rule-based formats (Baron-Cohen 1987).
- The typical 3-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 and Bryant 1990). Children with autism and Asperger's syndrome are delayed in acquiring this understanding (Baron-Cohen and Goodhart 1994).
- The typical 4-year-old child passes the *false belief* test, recognizing when someone else has a mistaken belief about the world (Wimmer and Perner 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 4-year-old child (Sodian and Frith 1992). 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, 2007a). The typical 9-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 3 years in this skill, despite their normal IQ (Baron-Cohen et al. 1999b).
- The typical 9-year-old can interpret another person's expressions from the person's eyes to figure out what he or she might be thinking or feeling (see Figure 3–1). Children with Asperger's syndrome

tend to find such tests far more difficult (Baron-Cohen et al. 2001a), and the same is true when the adult version of the Reading the Mind in the Eyes Test (RMET) is used (Figure 3–2). Adults with autism and Asperger's syndrome score below average on this test of advanced mindreading (Baron-Cohen et al. 2001c).

PREPRESS: Figures 3–1 and 3–2 should be placed about here after proof review.

Two strengths of the mindblindness theory are 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. One shortcoming of this theory is that it cannot account for the nonsocial features. A second shortcoming is that although 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 by how to *respond* to another person's emotions (Grandin 1996). A final shortcoming of the mindblindness theory is that a range of clinical conditions show forms of mindblindness, such as schizophrenia (Corcoran and Frith 1997), narcissistic and borderline personality disorders (Fonagy 1989), and, in some studies, conduct disorder (Dodge 1993), so mindblindness may not be specific to autism and Asperger's syndrome.

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

The Empathizing-Systemizing Theory

A newer theory, the empathizing-systemizing (E-S) theory, explains the social and communication difficulties in autism and Asperger's syndrome by referencing delays and deficits in *empathy* while explaining the areas of strength by referencing intact or even superior skill in *systemizing* (Baron-Cohen 2002).

Theory of mind 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—which is referred to as *affective empathy* (Davis 1994). On the Empathy Quotient, a questionnaire filled out 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 ASDs score lower than comparison groups.

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

To understand this theory we need to turn to this second factor, the concept of systemizing. *Systemizing* is the drive to analyze or construct systems. These might be any kind of system. What defines a system is that it follows rules, and when we systemize we are trying to identify the rules that govern the system in order to predict how that system will behave (Baron-Cohen 2006). The major kinds of systems include

- *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., weather patterns or tidal wave patterns)
- *Social* systems (e.g., a management hierarchy or a dance routine with a dance partner)
- *Motoric* systems (e.g., throwing a Frisbee or bouncing on a trampoline)

In all these cases, you systemize by noting regularities (or structure) and rules. The rules tend to be derived by noting if A and B are associated in a systematic way. The evidence for intact or even unusually strong systemizing 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. 2001a). 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 Systemizing Quotient: the higher your score,

the stronger your drive to systemize. People with high-functioning autism or Asperger's syndrome score higher on the Systemizing Quotient compared with people in the general population (Baron-Cohen et al. 2003). These tests of systemizing are designed for children or adults with Asperger's syndrome, not classic autism. However, children with classic autism perform better than control subjects 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, 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 systemizing.

The strength of the E-S theory is that it is a two-factor construct that can explain the cluster of both the social and nonsocial features in ASDs. Below-average empathy is a simple way to explain the social-communication difficulties, whereas average or even above-average systemizing is a way of explaining the narrow interests, repetitive behavior, and resistance to change/need for sameness. This is because when you systemize, 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 high-functioning individuals with autism or Asperger's syndrome. Although the obsessions of these individuals (with computers or math, for example) could be seen in terms of strong systemizing (Baron-Cohen et al. 1999a), surely this did not apply to the *low*-functioning individuals? However, when we think of children with autism, many of the classic behaviors can be seen as a reflection of their strong systemizing. Some examples are listed in Table 3–1.

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Like the Weak Central Coherence theory (Frith 1989), the E-S theory is about a different cognitive style (Happe 1996). It posits excellent attention to detail (in perception and memory), because when you systemize you have to pay attention to the tiny details, since each tiny detail in a system might have a functional role. Excellent attention to detail in autism has been repeatedly demonstrated (Jolliffe and Baron-Cohen 2001; Mottron et al. 2003; O'Riordan et al. 2001; Shah and Frith 1983, 1993). The difference between these two theories is that whereas the Weak Central Coherence theory sees people with ASDs 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 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 Weak Central Coherence 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 (because 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, such as 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 theory (Ozonoff et al. 1991; Rumsey and Hamberger 1988; Russell 1997) has even more difficulty in explaining why some people with autism or Asperger's syndrome have good understanding of a whole system, such as calendrical calculation, or indeed why the "obsessions" in autism and Asperger's syndrome should center on systems at all.

Thus, when the low-functioning person with classic autism has shaken a piece of string thousands of times close to his eyes, the Executive Dysfunction theory sees this as perseveration arising from some neural dysfunction that would normally enable the individual to shift attention. The E-S theory, on the other hand, sees the same behavior 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 that the "golden ratio" (that $a + b/a = a/b$) *always* comes out as 1.61803399, so the child—even a child with low-functioning autism—who produces the same outcome every time with his or her repetitive behavior may derive some emotional pleasure at the predict-

ability 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 that important clinical observation may be the hallmark of strong systemizing.

One further advantage of the E-S theory is that it can explain what is sometimes seen as an inability to "generalize" in ASD (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 systemizer is a splitter, not a lumper, because lumping things together can lead to missing key differences that enable you to predict how these two things behave differently. Finally, the E-S theory destigmatizes autism and Asperger's syndrome, relating them to individual differences we see in the population (between the sexes, and within the sexes) rather than viewing them as categorically distinct or mysterious.

The Extreme Male Brain Theory

The E-S theory has been extended into the Extreme Male Brain theory of autism (Baron-Cohen 2002). This is because there are clear sex differences in empathizing (females performing better) and in systemizing (males performing better), 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 pediatrician Hans Asperger (1944). 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 systemizing) in which individual differences are observed in the population. When these dimensions are plotted, five different "brain types" are seen:

- *Type E* (E > S): individuals whose empathy is stronger than their systemizing
- *Type S* (S > E): individuals whose systemizing is stronger than their empathy
- *Type B* (S = E): individuals whose empathy is as good (or as bad) as their systemizing (B stands for "balanced")
- *Extreme Type E* (E > > S): individuals whose empathy is above average but who are challenged when it comes to systemizing
- *Extreme Type S* (S > > E): individuals whose systemizing 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 ASDs, 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 systemizing (the Empathy Quotient and Systemizing Quotient), the results fit this model reasonably well. The majority of males (54%) *do* have a brain of Type S, the majority of females (44%) *do* have a brain of Type E, and the majority of people with autism and Asperger's syndrome (65%) have an extreme of the male brain (Goldenfeld et al. 2005).

Apart from the evidence from the Systemizing Quotient and Empathy Quotient, there is other evidence that supports the Extreme Male Brain theory. Regarding tests of empathy, on the *faux pas* test, in which a child has to recognize when someone has said something that could be hurtful, typically girls develop faster than boys, and children with ASDs develop even slower than typical boys (Baron-Cohen et al. 1999b). On the RMET, on average women score higher than men, and people with ASDs 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 and 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, cerebellum, overall brain size/weight, and head circumference), people with autism have even bigger brain regions than is typical. 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. It will also be important to address the neurobiological mechanisms that may be causing this hypermasculinization, one candidate being fetal testosterone (Auyeung et al.

2009).

In summary, the Extreme Male Brain 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 only the social-communication deficits in ASD but also the uneven cognitive profile, repetitive behavior, islets of ability, savant skills, and unusual narrow interests that are part of the atypical neurology of this subgroup in the population.

The Autistic Mind: In Search of "Truth"

The function of systemizing is to predict lawful events, including lawful change, or patterns in data. The hypersystemizing theory of ASDs can explain the preference of individuals with ASDs for systems that change in highly lawful or predictable ways; why they become disabled when faced with systems characterized by less lawful change; and their "need for sameness" or "resistance to change." If *truth* is defined as lawful patterns in data, then, according to the hypersystemizing theory, one could view people with ASDs as strongly driven to discover the "truth." I am defining the term *truth* as precise, reliable, consistent, or lawful patterns or structure in data. If a wheel is spinning round and round, there are consistent, lawful patterns to be detected. Sometimes the pattern will occur with 100% predictability (this particular person's birthday always falls on April 4th) and sometimes with relatively high predictability (daffodils typically bloom in the second week of March in England). Systemizing is the means by which we identify lawful patterns in data.

When we systemize, we make the *implicit* assumption that the pattern of data coming into our senses reveals the truth. My contention is that the autistic brain, being highly tuned to systemize, is the ultimate pattern detector and truth detector (Baron-Cohen 2006). In a high-functioning individual on the autistic spectrum, such pattern seeking can reveal scientific truths about the nature of reality, because their systemizing can help the individual understand how things work. What was previously dismissed as an "obsession" can be viewed more positively as a "strong, narrow interest" in a topic that, when harnessed, can lead the person with autism or Asperger's syndrome to excel in a highly specific field.

Although systemizing can deliver truths in the form of laws, it can only do so in domains that are ultimately lawful. One reason why people with ASD (postulated to be hypersystemizers) may struggle with empathy and be less interested in topics such as pure fiction, pretense, or deception is that these are not and never will be truth oriented. Regarding the domain of emotions, human behavior is not 100% lawful. Different people can express the same emotion differently or an emotion may even have no external expression. Regarding the domain of mental states, as Alan Leslie pointed out, the domain of mental states plays havoc with "truth relations," because of the opacity of mental states such as "belief" or "pretense" (Leslie 1987). The sentence "Mary believes that John is having an affair with his colleague" is true if Mary believes it, regardless of whether John really is having an affair. When we mindread, we have to keep track of what we believe to be true (John is not having an affair) while representing someone else's different (possibly false) belief—what they believe to be true (Mary believes he is). Empathy is therefore arguably impossible without such an ability to play with and even suspend the truth.

Hypersystemizing: Implications for Intervention

The E-S theory has implications for intervention, such as in "systemizing empathy," an approach being tried that presents emotions in an autism-friendly format (Baron-Cohen 2007b; Golan et al. 2006, 2010). In one example of a mindreading exercise, actors pose with facial expressions such that people with autism can teach themselves emotion recognition via DVD or computer (www.jkp.com/mindreading). This exercise involves taking the quite artificial approach of presenting mental states (such as emotional expressions) as though they are lawful and systemizable, even if they are not (Golan et al. 2006). The children's animation *The Transporters* (www.thetransporters.com) grafts human actors' facial expressions of emotion onto mechanical systems such as trains and trams that move in a highly predictable fashion, along tracks, so that even young children with autism are attracted to look at faces while they are drawn to watch the kinds of material that is intrinsically rewarding for them (Golan et al. 2010). Such approaches tailor the information to the child's learning style, and these approaches have been evaluated and shown to lead to improvements in

emotion recognition.

Conclusion

This chapter has described a psychological theory of ASD (the E-S theory) and its link to typical sex differences in the general population. The latter link was discussed in terms of its possible relevance to understanding the marked sex ratio in ASDs and for its etiological implications. It was argued that the E-S theory may be useful not only as a way of explaining the very broad range of features of ASDs but also in designing autism-friendly psychological interventions. The guiding principle here is that if people with ASDs have a learning style that is different from that of "neurotypical" individuals, and if people with ASDs have a profile of strengths as well as disabilities, teaching methods should be designed to target their areas of disability by harnessing their areas of strength. Teaching about emotions in a highly systematic format is one example of this principle applied to education.

AUTHOR: Please consider adding five or so Summary Points, as has been done in most other chapters. Thanks!

SUMMARY POINTS

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TABLE 3–1. Systemizing in classic autism and/or Asperger's syndrome (in *italics*)

Sensory systemizing	
	Tapping surfaces or letting sand run through one's fingers
	Insisting on the same foods each day
Motoric systemizing	
	Spinning round and round or rocking back and forth
	Learning knitting patterns or a tennis technique
Collectible systemizing	
	Collecting leaves or football stickers
	Making lists and catalogs
Numerical systemizing	
	Obsessions with calendars or train timetables
	Solving math problems
Motion systemizing	
	Watching washing machines spin round and round
	Analyzing exactly when a specific event occurs in a repeating cycle
Spatial systemizing	
	Obsessions with routes
	Developing drawing techniques
Environmental systemizing	
	Insisting on toy bricks being lined up in an invariant order
	Insisting that nothing is moved from its usual position in the room
Social systemizing	
	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 systemizing	
	Asking over and over again what the weather will be today
	Learning the Latin names of every plant and their optimal growing conditions
Mechanical systemizing	
	Learning to operate the video cassette recorder
	Fixing bicycles or taking apart gadgets and reassembling them
Vocal/auditory/verbal systemizing	
	Echoing sounds
	Collecting words and word meanings
Systemizing action sequences	
	Watching the same video over and over again
	Analyzing dance techniques
Musical systemizing	
	Playing a tune on an instrument over and over again
	Analyzing the musical structure of a song

1. feeling sorry 2. bored

3. interested 4. joking

FIGURE 3–1. The child version of the Reading the Mind in the Eyes Test (correct answer = interested).

sarcastic stern

suspicious dispirited

FIGURE 3–2. The adult version of the Reading the Mind in the Eyes Test (correct answer = dispirited).