

Evidence advanced to support 'extreme male brain' theory of autism

In a new article, Simon Baron-Cohen outlines the evidence for the "extreme male brain" theory of autism that he and other researchers have proposed (see ARRI 16/2).

"Two neglected dimensions for understanding human sex differences," Baron-Cohen says, "are 'empathizing' and 'systemizing.'" Systemizing, he says, is "the drive to analyze the variables in a system, to derive the underlying rules that govern the behavior of a system"—for instance, a computer system, a weather pattern, an abstract system such as mathematics, or a legal or business system.

Systemizing, he notes, works well for phenomena that follow set, finite, predetermined laws. "Systemizing is of almost no use, however," he says, "when it comes to predicting moment-by-moment changes in a person's behavior." To thrive socially, he says, it is necessary to empathize—to attribute mental states to others, and generate an appropriate affective response to another person's mental state. "Empathizing," he says, "involves an imaginative leap in the dark, in the absence of much data (thoughts like 'Maybe she didn't phone me because she was feeling hurt by my comment')." It is likely, Baron-Cohen says, that empathizing and systemizing skills are mediated by different brain regions.

According to Baron-Cohen, females in general have more developed empathizing than systemizing skills, while males show the

The "systemizing" skills at which males excel—and at which autistic individuals excel to an often even greater degree—work well for phenomena that follow set, finite, predetermined laws, Baron-Cohen notes. "Systemizing is of almost no use, however," he says, "when it comes to predicting moment-by-moment changes in a person's behavior."

opposite pattern—and autistic individuals of either sex show an "extreme male" pattern. Among the evidence he cites:

—**Empathizing skills.** In general, girls outperform boys on standard tests of "theory of mind" (the ability to understand that other people have thoughts and feelings). Girls also outscore boys on tests of general empathy, the ability to detect emotion by looking at other people's eyes, the ability to interpret complex facial expressions, and the understanding of social errors. In addition, they make eye contact more often, develop vocabulary faster, understand the "pragmatics" of conversation better, and exhibit more empathy in their friendships. In each of these areas, males are impaired when compared to females, while autistic individuals are even more impaired than males.

—**Systemizing skills.** In general, males are better than females at math, physics, mechanics, and engineering; assembling, ma-

nipulating, rotating, and/or copying objects; focusing on relevant details (for instance, a target embedded in larger pattern); and creating and reading maps. Boys also prefer Legos, toy vehicles, toy weapons, and mechanical toys, all of which, Baron-Cohen notes, "are open to being 'systemized.'" In addition, studies show that men are better at classifying organizable systems (such as botanical specimens), and that boys are more interested than girls in making collections of items. Similarly, Baron-Cohen notes, individuals with autism or Asperger syndrome show extreme attention to detail, score high on tests of "intuitive physics," often exhibit islands of skill in areas such as mathematics or calendar calculation, and prefer playing with construction/vehicle toys and making collections of objects. On a "Systemizing Quotient" test developed by Baron-Cohen and colleagues, males score higher than females, and people with autism and Asperger syndrome score higher than non-disabled males.

In addition, Baron-Cohen notes, non-disabled males score higher on the Autism Spectrum Quotient than do non-disabled females (see ARRI 16/2). Moreover, males tend to have a longer ring finger than second finger, a marker of higher testosterone exposure during prenatal development, and Baron-Cohen notes that this pattern is also seen in autism "in magnified form." Autistic children tend to come from families in which a high percentage of male relatives are engineers (a profession requiring excellent systemizing skills but little empathizing ability), and there is a higher rate of autism in the families of people who excel in math, physics, and engineering than in families of people who excel in the humanities—an indication, Baron-Cohen says, that "the extreme male cognitive style is in part inherited."

Baron-Cohen says that the "extreme male brain" theory helps to explain why unpredictable phenomena frighten or bore autistic individuals, while predictable phenomena attract them. "The more able individuals," he says, "report that they struggle to work out a huge set or rules of how to behave in each and every situation, attempting to develop a mental 'manual' for social interaction.... It is as though they are trying to systemize social behavior when the natural approach to socializing should be via empathizing."

"The extreme male brain theory of autism," Simon Baron-Cohen, *Trends in Cognitive Sciences*, Vol. 6, No. 6, June 2002, 248-254. Address: Simon Baron-Cohen, Autism Research Centre, Depts. of Experimental Psychology and Psychiatry, Cambridge University, Downing St., Cambridge, UK CB2 3EB.

Milk, viral peptides linked to autoimmunity in autism

Clinical studies and anecdotal reports reveal that in many cases, exposure to milk peptides (protein fragments) exacerbates autistic symptoms and a milk-free diet alleviates these symptoms. Other research strongly links some cases of autism to infectious diseases. A new study, says lead researcher Aristo Vojdani, "puts the pieces together" by shedding light on the relationship of milk proteins and infectious processes to autism.

Vojdani and colleagues tested blood samples from 40 autistic and 40 non-autistic children, looking for evidence of autoantibodies to nine neuron-specific antigens (molecules on the surfaces of neurons that identify them as "self" rather than invaders such as viruses or bacteria). They also searched for the presence of antibodies to peptides from milk and two infectious agents, streptococcus group A and *Chlamydia pneumoniae*. They report, "Autistic children showed the highest levels of IgG, IgM and IgA antibodies against all neurologic antigens as well as the three cross-reactive peptides." ("Cross-reactive"

means that the body may respond to these peptides by creating antibodies that also attack human tissue, in a case of mistaken identity.)

The researchers suggest that in vulnerable children, abnormally permeable intestines (a common finding in autism) allow peptides to escape into the bloodstream; this causes the body to respond to exposure to milk proteins or infections by creating antibodies capable of compromising the blood-brain barrier and entering the brain where they mistakenly attack cells that appear similar to the "enemy" viral or milk antigens.

"Antibodies to neuron-specific antigens in children with autism: possible cross-reaction with encephalitogenic proteins from milk, *Chlamydia pneumoniae* and Streptococcus group A," A. Vojdani, A. Campbell, E. Anyanwu, A. Kashanian, K. Bock, and E. Vojdani, *Journal of Neuroimmunology*, Vol. 129, No. 1-2, August 2002, 168-177. Address: Aristo Vojdani, Section of Neuroimmunology, Immunoscience Laboratory, Inc., 8693 Wilshire Boulevard., Suite 200, Beverly Hills, CA 90211.