Autism spectrum disorder linked to shape of brain's cerebellum

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Structural differences in the cerebellum may be linked to some aspects of autism spectrum disorder, according to a neuroimaging study from Columbia University Irving Medical Center (CUIMC).

The findings were published online today in *PLOS ONE*.

The cerebellum—which means 'little brain' in Latin—constitutes only 10 percent of the brain's total volume, though it contains 80 percent of all neurons in the human brain. It was once thought that this irregularly shaped structure of the brain primarily governed motor function, but recent studies suggest that it also plays an important role in implicit learning (extracting the underlying rules without explicit instruction) as well as sensory and cognitive function.

Most brain imaging studies in autism focus on the cerebrum, which is larger than the cerebellum despite having fewer neurons. That's partly a function of the unique, irregular shape of the cerebellum, which is difficult to analyze with conventional imaging techniques. "Imagine looking at only 20 percent of the brain's neurons and attempting to paint a comprehensive picture of atypical development in humans based on such limited knowledge," says Kristina Denisova, Ph.D., senior author of the study and assistant professor of clinical neurobiology (in psychiatry) at the Columbia University Vagelos College of Physicians and Surgeons.

To examine this structurally complex brain region, the researchers applied high-resolution 3-D fractal analysis to MRI data to estimate fractal dimension—a measure of structural complexity—of the outer layer of the cerebellum in 20 boys with autism ages 6 to 12 years and 18 age-matched controls with similar verbal skills and cerebellar volume.

They found that the boys with autism had significantly lower fractal dimension—indicating a flatter surface structure—in the right cerebellar cortex compared with the controls. Because the right side of the cerebellum supports language processing in typically developing individuals, this finding suggests that having a flatter cerebellar surface may be related to communication difficulties in those with autism.

In previous studies, atypical features in the cerebellum were associated with autism, but the findings were inconsistent. "Our brain imaging study is the first to look at the structure of the cerebellum while controlling for volume and other potentially confounding variables," says Guihu Zhao, Ph.D., a postdoctoral fellow in the department of psychiatry at Columbia University Irving Medical Center and first author of the paper.

The researchers also found that fractal dimension was linked to differences in the children's cognitive abilities and communication—areas that are often affected by autism. In general, boys with autism who had better social communication skills had a more normal cerebellar structure, as did those with greater nonverbal skills relative to verbal skills.

"Our findings suggest we may need to rethink the role of cerebellar function and structure in young individuals at risk for atypical brain development," says Dr. Denisova. "Early life differences in perception, including timing (i.e., concerning atypical detection of pauses in conversation or atypical coordination of inputs from different modalities), could shape cerebellar development and account for the current structural findings in boys with autism."

Dr. Denisova also notes, "one interpretation of the findings is that increased structural complexity of the cerebellum may enhance implicit learning in atypically developing boys." The researchers are currently pursuing this question in studies of infants and toddlers who are at risk for developing autism later in life.

The study is titled, "Reduced structural complexity of the right cerebellar cortex in male children with autism spectrum disorder."

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