

Brain Development Differences in Autism Spectrum Disorder

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Introduction

Autism Spectrum Disorder is a neurological condition in the brain that affects how people behave, communicate, and learn. The abilities and needs of autistic people vary and can change over time. Some can live independently with interventions that improve basic skills, while others have severe challenges that require chronic support. Autism Spectrum Disorder accounts for a diverse group of conditions related to the development of the brain. The topic of this paper focuses on differences in brain development and how it is associated with Autism Spectrum Disorder, looking at how brain growth, the structure, and connections develop differently in autistic individuals. (Mayo Clinic)

Differences in Overall Brain Growth

One of the earliest differences researchers have investigated is the rate of overall brain growth. Studies of infants and young children show that some children who later receive an autism diagnosis experience an abnormal pattern of brain growth during the first years of life. To be specific, some studies have found accelerated growth in total brain volume during early childhood. (Hazlett et al., 2017) used longitudinal MRI scans to examine infants at high genetic risk for autism and found differences in the growth of total brain volume in the first two years of life. But this does not mean that autistic people have larger brains in their lives. Differences in total brain size have shown to change with age, and research shows that older children and adults are less consistent. The important difference is the trajectory of brain growth, the rate and timing at which the brain develops, compared to a permanently larger or smaller brain. (Hazlett et al., 2017)

Difference in the Cerebral Cortex

Another major area of research involves the cerebral cortex, the outer layer of the brain responsible for many complex functions. Researchers examine several individual characteristics of the cortex, including cortical thickness, surface area, and volume. These characteristics can

change separately, which means that a difference in cortical thickness does not mean that the cortex is thicker. Research has revealed differences in cortical thickness and surface area in multiple regions of autistic brains compared with normal developing individuals. These differences can also change depending on age. Because the cortex develops rapidly during childhood and adolescence, differences in cortical development may be associated with changes in the timing of growth and maturation rather than a structural difference. This makes longitudinal research imperative when studying autism disorders. (Amaral et al., 2008).

Regional differences in Gray Matter

Studies also show that certain parts of the brain are shaped and sized differently in autistic children. In 2024, researchers tracked brain scans over time for 166 autistic toddlers and 109 non autistic toddlers. After comparing these groups, the researchers found that autistic toddlers had larger or thicker regions in parts of the temporal and fusiform cortex, while other regions, including parts of the inferior frontal cortex and midline structures, were smaller and thinner (Duan et al., 2024). The researchers also found that a larger volume in a portion of the corpus callosum and a smaller cerebellum. These findings show that brain differences in autism happen in specific areas rather than across the whole brain equally. Some regions of the brain might be larger or more developed, while other regions might be smaller or less developed within the same period. (Duan et al., 2024).

Differences in the Temporal and Fusiform Regions

Researchers pay special attention to the temporal and fusiform areas because they have found structural differences in these specific brain parts during early childhood. The temporal cortex is located along the sides of the brain, while the fusiform cortex is located toward the bottom of the temporal and occipital lobes. In the 2024 toddler study, several temporal and fusiform regions were found to be larger or thicker in autistic toddlers than in typical toddlers.

(Duan et al., 2024). These differences are notable because they appear very early in development, before or around the age when many children begin receiving autism diagnoses. The findings do not indicate that every autistic person will have the same structural pattern. Instead, they show that regional brain development can follow a different path in some autistic children.

Differences in the White Matter

Brain development also involves changes in white matter, which consist largely of nerve fibers that connect different areas of the brain. Researchers can examine white matter microstructure using diffusion tensor imaging which is also known as DTI. One commonly examined characteristic is fractional anisotropy, which shows the directional movement of water through white matter. Another is mean diffusivity, which measures the overall diffusion of water molecules. A body of DTI research has found differences in these measurements in autistic individuals. A meta analysis of 25 DTI studies found profoundly lower fractional anisotropy in autistic individuals compared with typical individuals. Increased mean diffusivity was also observed in several of these pathways. (Aoki et al., 2013) These findings show differences in microstructural of white matter rather than just the overall region.

Differences in Connectivity

Differences in functional connectivity is also shown with structural differences in the brain. Functional connectivity describes how strongly the activity of different brain regions is correlated while a person is performing a task or resting. Research has found different patterns of functional connectivity in autism, including differences in communication between distant regions and increased connectivity among nearby regions. (Rane et al., 2015) However, functional connectivity findings are less consistent than some structural findings. Results can vary according to age, brain regions, method, and participants. Therefore researchers do not consider autism to involve too much or too little connectivity throughout the entire brain.

Differences in Main Brain Connections

Researchers frequently study white matter, which acts as the brain's pathway for transferring information connecting far regions. The corpus callosum, the main bridge of nerve fibers connecting the left and right side of the brain, shows structural differences in autistic people. (Aoki et al., 2013) (Travers et al., 2012) Scientists have also found similar differences in other major far pathways, such as the uncinate fasciculus. In conclusion, studies of brain imaging show that autism involves changes in both long and short distance connections across the brain (Rane et al., 2015). These findings show that autism is linked to differences in how communication networks are organized throughout the entire brain.

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