NATIONAL SCIENTIFIC COUNCIL ON THE DEVELOPING CHILD

SCIENCE BRIEF

# ADHD Delays, Rather than Alters, Brain Development

*A review of a recent report that used magnetic resonance imaging to show that certain parts of the brain implicated in ADHD grow at a slower rate than, but in the same pattern as, typical, unaffected children.*

Each Science Brief summarizes the findings and implications of a recent study in basic science or clinical research. Studies are selected for review based on their scientific merit and contributions to understanding early development. No single study is definitive, of course. Understanding of early development is based on many studies that, taken together, permit broad conclusions and human applications. Generalizing to human children the results of studies with animals, for example, must be done cautiously and confirmed by research with children and their families. The National Scientific Council rests its work on a rigorous discussion of the validity of many studies like these conducted over many years and using different methodologies and samples. For more information, go to www.developingchild.net

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## Why was the study done?

Attentional deficit hyperactivity disorder (ADHD) is among the most common of developmental disorders, affecting 3-5 percent of school-age children. Genetic factors, maternal stress, and perinatal trauma increase the risk for ADHD, but there is debate regarding whether there is a fundamental deviation from typical developmental patterns of growth, or a delay in the growth of the brain regions that are not functioning properly. The cerebral cortex is divided into distinct regions that perform unique functions that include processing of visual, auditory, and other sensory information, and "higher" cognitive and emotional functions like mood regulation, attention, learning, and memory. It grows gradually from birth over a period of years, ultimately reaching a peak in size between 7-11 years of age before going through a normal period of reduction in size due to pruning of less effective nerve connections (synapses). Brain growth occurs at different rates in different children, but we don't yet understand the meaning of the unique growth rates. The distinction between a delay in growth and a completely different pattern of brain growth in children with ADHD may help elucidate the causes, and even the development of better strategies for treating children with ADHD.

## What did the study find?

First, the findings illustrate that in both typical children and those with ADHD, the patterns of growth, termed "developmental trajectory", were identical. Areas that perform primary sensory functions, like vision or hearing, reach peak thickness prior to the areas engaged in the "higher" cognitive functions. Second, the age at which the ADHD group reached the peak thickness milestone was delayed. The age for reaching peak cortical thickness in typically developing children was 7.5 years of age, compared to 10.5 years in the ADHD-diagnosed children. Differences between groups were greatest in the cognitive and mood-regulating regions of the cerebral cortex, particularly the frontal lobe, where there was a 5-year difference in reaching peak thickness. One additional, unexpected finding is that the motor

cortex in the ADHD group actually reached peak thickness slightly faster than in the control group, 7.0 years to 7.4 years respectively.

## How was the study conducted?

The authors of this study had collected structural neuroimaging data using a magnetic resonance imaging (MRI) scanner, over multiple ages on more than 400 typical and ADHD-diagnosed children matched for IQ. This provided an opportunity to calculate the trajectory of brain growth within each individual in the study. Each subject was imaged prior to puberty and on one, two, or three subsequent occasions, up to 20 years of age. The authors used mathematical equations to calculate growth curves as well as the age for each subject when peak cortical thickness was reached. Moreover, the authors analyzed different functional regions of the cerebral cortex, including primary sensory areas that mediate functions such as vision, hearing, and touch, and so-called "higher order" cognitive and mood-regulating areas in the frontal and temporal lobes.

## What do the findings mean?

The authors conclude that the growth of the brain in children with ADHD is fundamentally different than in children with other neurodevelopmental disorders; with autism or intellectual disability, the patterns of growth differ greatly from those in typically developing children. Instead, the current study indicates that the maturation of brain architecture occurs in a highly similar fashion between typically developing children and those with ADHD, with a significant delay in those with the disorder. This delay also leads to a shift in when individuals with ADHD go through the process of pruning of nerve connections that is part of the normal maturation process during adolescence. The findings have implications for defining the biological factors that cause ADHD, and for designing new interventions that take into account the delay in development.

## Study Title and Authors

Shaw, P., Eckstrand, K., Sharp, W., Blumenthal, J., Lerch, J.P., Greenstein, D., Clasen, L., Evans, A., Giedd, J. & Rappaport, J.L. (2007). Attention-deficit/hyperactivity disorder is characterized by a delay in cortical maturation. *Proc. Natl. Acad. Sci*, 104:19649-19654.