

Is Brain Imaging Useful in the Diagnosis of Attention-Deficit/Hyperactivity Disorder?

By Jay N. Giedd, M.D.

Ever since Heinrich Hoffman introduced the modern age to AD/HD in 1884 with his delightful poems of Fidgety Phil and Johnny Head-in-the-Air, investigators have suspected and sought a brain-based cause for the disorder. However, nature's measures to protect the brain from harm by wrapping it in a tough leathery membrane, floating it in a moat of fluid, and completely encasing it in bone -- also served to protect it from the prying curiosity of scientists. The advent of X-rays and later, computerized tomography, made it technologically feasible to peer inside the living skull, but the use of ionizing radiation made these techniques unsuitable for study of the healthy children needed to provide a yardstick from which to assess clinical groups, such as AD/HD. Finally in the 1980s, magnetic resonance imaging (MRI), which does not use ionizing radiation, became widely available. MRI provides excellent anatomical resolution and its safety allows not only for the scanning of healthy controls, but even for repeated scans in the same individual to track the growth and development of the brain.

Using this MRI technology, our team at the Child Psychiatry Branch of the National Institute of Mental Health (F.X. Castellanos, J.L. Rapoport) has examined hundreds of brain scans of children with and without AD/HD. Our findings indicate three major areas of brain differences in children with AD/HD.

One area affected is the frontal lobes. The frontal lobes are the so-called CEO of the brain, responsible for the "executive" functions of initiating and sustaining activities, prioritizing, strategizing and most importantly in terms of AD/HD, inhibiting impulses until the brain can rationally weigh possible consequences of the activity.

Another area of the brain affected is the basal ganglia. If the frontal lobes are the CEO of the brain, the basal ganglia may be thought in some way as the "secretary" of the brain. The basal ganglia help prioritize input to the "executive" and organize and execute the actions decided on by the frontal lobes.

The third area of the brain different in AD/HD is the cerebellum. Once thought to be involved primarily in muscular coordination and movement, the cerebellum is now recognized to play critical roles in emotion and higher levels of cognition.

It is important to note that these differences are detected when looking at groups of children with and without AD/HD. For a given individual, they may or may not have alterations in these brain areas. So although the brain imaging studies have been very useful in helping us understand the key brain components involved in the illness, they are not currently specific enough to be used diagnostically.

A useful question to ask when assessing the diagnostic utility of an imaging result is: If a child had a clinical history of AD/HD but a normal brain scan, would I not treat? Or, if a child had no symptoms of AD/HD but a brain scan consistent with what is found in groups with AD/HD, would I treat? For me, the answer to both of these questions is "No." So as of the time of this writing, I feel that clinical history remains the gold standard of AD/HD diagnosis.

There are some instances when brain imaging may be useful in the evaluation of AD/HD. For instance, (1) when the AD/HD symptomatology is accompanied by significant neurological abnormalities, (2) when there are comorbid psychotic features, (3) when the presentation is very atypical and unresponsive to conventional treatment approaches, or (4) in the case of identical twins where one has AD/HD and the other does not.

In summary, imaging is currently not of diagnostic utility in AD/HD. However, imaging may help to uncover the core neuropathology of the disease and may be useful in certain clinical situations. Imaging may help educate families and the public that AD/HD is a biological entity, and imaging may some day allow us to subclassify different types of AD/HD which may guide treatment interventions.

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