

ADHD and Neuropsychology: Developmental Perspective, Assessment, and Interventions

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Amrina Bhullar¹, Krishan Kumar¹ and Akshay Anand²

Childhood mental disorders consist of neurodevelopmental, emotional, and behavioral disorders that have an impact on the psychological and social well-being of the child. These disorders usually persist into adulthood. Children diagnosed with these disorders are more likely to experience a compromised developmental trajectory, with an increased need for medical and disability services.

Attention deficit hyperactivity disorder (ADHD) is the most common neurodevelopmental disorder diagnosed in childhood. It's a complex behavioural disorder whose symptoms emerge in the developmental period of a child, before age 14. It may consist of symptoms of *inattention* such as difficulty sustaining attention on play and other activities, not listening when spoken to, trouble organizing, being easily distracted, and so on. *Hyperactivity* may consist of the inability to sit in one place, excessive talking, fidgeting, and interrupting conversations and activities. ADHD can be a combination of both inattention and hyperactivity.

If untreated, ADHD difficulties often result in dropping out of school and college, indulging in substance intake to self-remedy symptoms and engaging in illegal delinquent activities, most of them are not able to achieve on par with their capabilities and have decreased life satisfaction. Therefore, identification, diagnosis, and effective treatment of ADHD are extremely important.

Usually, while diagnosing ADHD clinicians take the help of major diagnostic manuals like DSM-5 which have behaviorally oriented diagnostic criteria and is the most widely used nomenclature, newer models suggest incorporating neuropsychological models for diagnosis, assessment, and intervention due to evidence showing implications of deficits in executive functioning in ADHD.¹

Cognitive Functioning in ADHD

There are many models suggesting deficits in cognitive functioning in children as well as adults with ADHD. Initially,

the research highlighted the role of executive functioning in ADHD, where the deficits were similar to the people who have suffered trauma to the prefrontal cortex and later on the involvement of behavioral inhibition and emotional regulation in the cognitive etiology of ADHD were found. Overall, research has shown that people diagnosed with ADHD have deficits in the following cognitive/neuropsychological functioning:

- Working memory
- Reaction time
- Response inhibition/impulse control
- Intelligence.

The performance of these cognitive tasks improves with age as adults perform better than children with ADHD. This difference in functioning can be due to the fact that adults might be in remission and perform better due to enhancement in cognitive functions due to experience. Overall, the research supports the inability to regulate the default mode network as central to ADHD etiology.²

Dual-Pathway Model of ADHD

Neuroimaging studies propose the hypothesis that two pathways are associated with ADHD symptoms: the fronto-dorsal striatal circuit is responsible for cognitive dysfunction, and the fronto-ventral striatal circuit is responsible for motivational dysfunction.

¹Department of Psychiatry, Postgraduate Institute of Medical Education and Research, Chandigarh, India

²Neuroscience Research Lab, Department of Neurology, Postgraduate Institute of Medical Education and Research, Chandigarh, India

Corresponding Author:

Krishan Kumar, Department of Psychiatry, Postgraduate Institute of Medical Education and Research, Chandigarh 160012, India.
E-mail: keshusony@rediffmail.com



Cognitive functions implied here are working memory system, attention regulation, response inhibition, and motivational deficits such as preferring small immediate rewards in comparison to large delayed responses. These two pathways may have a functional overlap between them which means improvement in one function may cause improvement in other.

Structural and Functional Brain Differences in ADHD

Hemodynamic and magnetoencephalography studies have shown differences in neural activity of the brain of people with ADHD in comparison with the normal population during the administration of neuropsychological tests. MRI and diffusion tensor imaging studies have also shown changes in the gyrification, brain volume, cortical thickness, surface area, and white matter integrity of different cerebral regions, in both children and adults with ADHD when compared to the normal population. Abnormalities in the prefrontal cortex, basal ganglia, and corpus callosum have also been implicated in ADHD.³

Research on Adults with ADHD

The studies have found that approximately 40%–50% of children diagnosed with ADHD will experience the symptoms in adulthood as well. Children as well as adults with ADHD have problems related to the reward system and decision-making. In cognitive tasks of gambling children and adults with ADHD performed poorly in comparison to healthy controls and their performance did not improve over time. These findings are similar to the people who have features of psychopathic deviation.⁴

In addition to the executive function deficits mentioned above, research on adult ADHD highlights the involvement of the following functions:

- Cognitive flexibility
- Time perception
- Verbal memory and fluency
- Planning and problem-solving
- Concept formation.

However, deficits in these functions in children and adults in not mutually exclusive.⁵ Delay-related behaviors are one of the transdiagnostic predictors for decreased functionality among adults with ADHD and also mediate the psychological health of a person.⁶

Neuropsychological Assessment and Interventions for ADHD

Neuropsychological assessment can help in diagnosis, highlight strengths and weaknesses of persons with ADHD

and can be used to design and implement interventions. It is also useful to objectify the complaints of the patients which further enhances adherence to treatment.

Various tests/assessment tools used to measure cognitive functions involved in ADHD are as follows:

The Test of Variables of Attention (TOVA), Cambridge Neuropsychological Test Automated Battery (CANTAB), Stroop Test, Wisconsin Card Sorting test (WCST), Trail Making Test (TMT), Behavioural Assessment of Dysexecutive Syndrome (BADS), N-Back Test (a subset of NIMHANS Battery of Neuropsychological Assessment), NEPSY-2 (subtests from the Attention/Executive Functioning domains, which include Animal Sorting, Auditory Attention/Response Set, Clocks, Design Fluency, Inhibition; Inhibition, and Statue), Rey Osterrieth Complex Figure (ROCF), Neuropsychological Assessment Battery (NAB) Attention Module, Weschler's Adult Intelligence Scale (WAIS), and Weschler's Intelligence Scale for Children (WISC).

Interventions for ADHD Relevant to Neuropsychological Functioning

Interventions which are designed to improve neuropsychological functioning may be beneficial in reducing ADHD symptoms severity and improve functioning in various aspects of living. The following interventions are most relevant to the disorder:

Neurofeedback: Enhancing self-regulation of brain activity through neurofeedback will lead to improved cognitive and behavioral control that is deficient in individuals with ADHD. The results of studies evaluating neurofeedback for ADHD are mixed.

Cognitive training: Cognitive training for ADHD is premised on the notion that the strengthening of brain networks implicated in ADHD through exposure to tasks related to impaired cognitive functions leads to the strengthening of those cognitive functions. Cognitive training focuses on cognitive deficits like attention, working memory, inhibitory control, and so on. Cognitive training is usually delivered via computer programs where task difficulty is increased across sessions to continually challenge the patient at the boundaries of his competence.

Physical exercise: Physical exercises, especially aerobic exercise has shown to improve the neuropsychological functioning and symptoms of ADHD.

Non-invasive brain stimulation: Procedures such as tDCS and TMS have been shown to be helpful in improving cognition and clinical symptoms of ADHD.

Cognitive functional occupational therapy (Cog-Fun): The intervention focuses on the development of metacognitive skills useful in daily functioning like self-awareness and strategic behaviors. This intervention aims to help patients to increase participation in important occupations and enhance their quality of life.

Cognitive behavior therapy: This therapy focuses to change irrational thought patterns that prevent patients from staying on task or getting things done

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