

Rethinking ADHD from a Cognitive Perspective

From the TeachADHD website

Introduction

Although diagnoses of ADHD are based on behavioral symptoms of inattention and/or hyperactivity/impulsivity, evidence suggests that children with ADHD also exhibit significant cognitive weaknesses in areas that are essential to daily functioning both at school and at home.

Specifically, research studies indicate that children with ADHD often have problems in:

- *Executive Functions* (for example, planning a project, sustaining attention to task, ignoring irrelevant information)
- *Working Memory* (which is often considered an executive function)
- *Fluency or speed of information processing* (children with ADHD process information more slowly than their peers)

However, it is important to note that many of these cognitive processes are often interrelated. For instance, problems in working memory can negatively affect other executive functions, or slow processing speed may reduce one's ability to recall and organize information.

New or complex tasks use more executive functions. These demanding tasks might include learning a new language or writing an essay.

Executive functions

Executive functions contribute both to successful online, dynamic, moment-to-moment processing of information and to self-regulatory actions that occur over a longer span of time (such as planning and decision-making).

One of the easiest ways to understand the moment-to-moment impact of executive functions on behavior is to think about the role of the conductor in an orchestra. An orchestra is comprised of many different types of instruments (oboe, violin, clarinet, and so on) and each of these instruments can be played independently. It is the conductor's role to dynamically integrate and organize the various elements of the orchestra from moment to moment to achieve his or her musical goal regarding the piece. Similarly, it is the executive functions of the brain that organize an individual's current or ongoing actions and emotions to guide intentional behavior from moment to moment. Hence, individuals with executive function weaknesses often lack organization and focus and have difficulty adapting flexibly to the context or situation.¹²

To understand the role that executive functions play in an individual's behavior that occurs over longer time periods, think about the role of the chief executive officer (CEO) in a large corporation. The CEO acts as the head "decision-maker" by organizing, planning, guiding, and integrating the various actions and decisions of the corporation's departments. Similarly, the executive functions organize an individual's actions and emotions to control intentional behavior, such as planning, decision-making, and monitoring outcomes. Executive functions can be broken down into different sub-functions that each contribute to an individual's ability to act in a goal-directed and intentional manner. These sub-functions include an individual's ability to:

- represent or identify a problem
- develop plans and execute them
- organize self and activities
- inhibit actions and regulate emotions
- resist distractions and control attention
- self-monitor and self-evaluate thoughts and actions

Researchers have examined a range of these interrelated sub-functions in children and adults and found that the ability of children to exhibit executive functions (for example, self-regulating actions and behavior) improves across development. However, even very young children can exhibit executive functions, such as the ability to inhibit an action or regulate emotions.

Executive functions and ADHD

Numerous studies have examined a range of executive functions in children with ADHD. Generally, the findings have shown that ADHD is associated with executive function weaknesses but that these weaknesses do not occur in all individuals with ADHD. However, children with ADHD who have executive function weaknesses exhibit poorer academic outcomes and are more likely to repeat a grade, receive tutoring, and be placed in special education than children with ADHD without executive function weaknesses.

Hence, the presence of executive function weaknesses can have a significant impact on the school success of a student with ADHD. This is not surprising given the importance of executive functions to regulating both academic performance and behavior.

Executive functions regulate both academic performance and behaviour

Executive functioning (for example, planning, self-regulation, working memory) is important to a child's success in both literacy and numeracy. General academic success is associated with a student's ability to self-regulate their learning process (for example, to stay on task and exhibit time management, study skills, planning, and goal-setting).

The strong link between executive functions (that is, self-regulatory behaviors) and academic success is not surprising when one considers the multiple demands of the classroom. For example, listening to a teacher's explanation about a concept requires the student to:

- process and represent the incoming information

- identify the relevant pieces of information
- inhibit irrelevant tangential thoughts and/or ignore environmental distractions
- hold the information in mind while linking it with what one already knows about the topic
- integrate the information and encode this information for later retrieval

As students become older, the classroom demands for planning, organization, goal-setting, and self-monitoring become even greater. Many classroom activities begin to require the integration of multiple skills (for example, reading a book in order to write a book report) and the application of established knowledge to new situations (for example, applying math facts in word problems, applying a mathematical problem-solving strategy to a new type of problem). These types of academic activities place higher demands on executive functions and may be particularly challenging for a child who has poor executive function capabilities. Other examples of executive function weaknesses are detailed in Table 3-1.

Table 3-1: How Executive Function Weaknesses May Manifest in the Classroom

Children may have difficulty with:

- identifying the problem or knowing what the finished product of a task should look like
- planning, executing, and monitoring projects or assignments
- holding directions in mind, especially if the directions are complex or multi-step
- multi-tasking (trying to organize and complete several tasks within a specific time frame)
- resisting or delaying impulses (for example, tendency to blurt out answers rather than resisting the impulse and putting up hand)
- getting started on assignments (that is, difficulty with initiation) despite interest in the work
- setting goals and carrying out steps to achieve goals
- monitoring school work (for example, checking for errors)
- monitoring how their actions affect others in a social context

Educational Implications of Executive Function Weaknesses

- In order to acquire and exhibit self-regulatory behaviors (for example, the ability to plan, monitor school assignments, set goals, and evaluate progress), students may require direct instruction, coaching, and instructional supports.
- Tasks should be analyzed (for example, for task complexity, novelty, number of steps, types of skills required, familiar vs. unfamiliar context) to help teachers understand where students may need support and targeted instruction.
- Executive function weaknesses can occur despite the student exhibiting good ability in specific domains of functioning (that is, achievement in the normal range on standardized tests of reading and/or mathematics). Thus, these executive function difficulties should not be considered to reflect laziness or unmotivated behavior on the part of the student.
- Executive function weaknesses may hinder the student's ability to perform novel and/or complex tasks independently. Therefore, instruction that identifies critical components and action sequences can help students learn "how to learn" and facilitate their ability to

perform complex academic tasks (for example, reading comprehension, written composition).²⁵

Working memory

Working memory is an executive function. It refers to a "mental workspace" in which information is stored and manipulated for brief periods of time in order to perform another cognitive activity. The term "brief periods of time" means just seconds. When information must be stored and used over longer time periods, then it must be transferred to long-term memory for later retrieval.

Working memory also facilitates an individual's ability to control attention and resist distraction during tasks that require sustained effort. Working memory weaknesses have been found to be consistently associated with ADHD as well as with learning disorders and specific language impairment.

Working memory tasks are not the same as short-term memory tasks:

- Short-term memory tasks require an individual to store information (for example, a telephone number) for a short period of time (seconds) and then repeat the information in exactly the same sequence.
- Conversely, working memory tasks require an individual to hold information and manipulate that information to reach a goal. For example, when performing a mental addition task, a student must be able to store or keep "on-line" the relevant information and perform the manipulations (that is, adding the numbers) needed to compute the solution.

One critical feature of working memory is that it has a limited capacity. As a result, tasks demanding the processing of large amounts of information can hinder learning. If students are asked to keep in mind multiple elements of information (for example, a set of complex instructions) while carrying out a task, they may not be able to complete what they set out to do and may fail to simultaneously monitor their performance for errors.

Working memory and attention

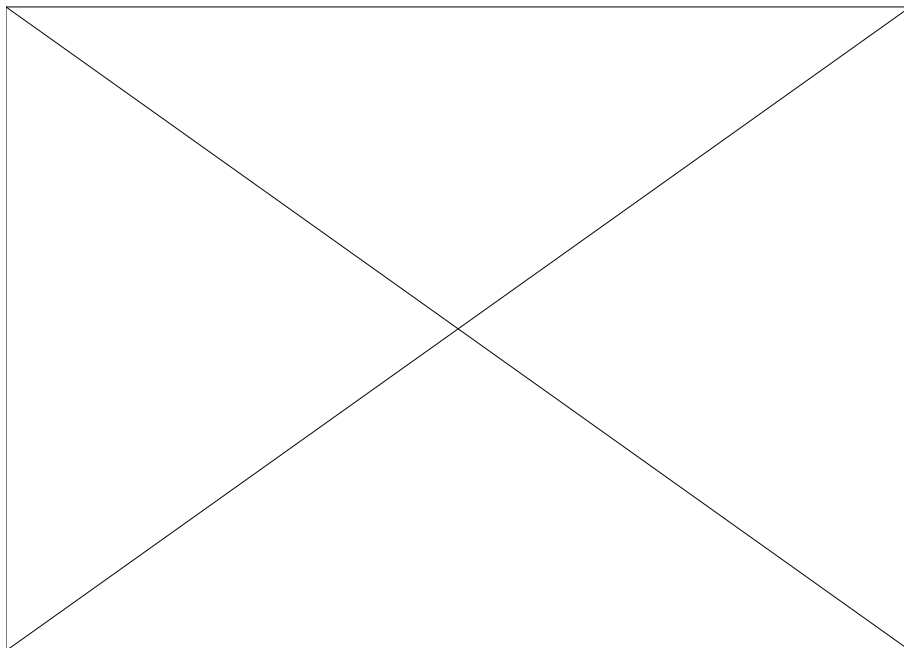
Individuals vary in the capacity of their working memory. There is also an association between performance on working memory tasks and the ability to control attention (that is, individuals who perform poorly on tasks of working memory also tend to perform poorly on tasks that require them to control their attention). Moreover, the general ability of adults to ignore distracting information is compromised when they are asked to simultaneously complete a task that puts high demands on working memory. Another example of the link between working memory and attention control abilities is the "Cocktail Party Phenomenon" (see side for definition).

Working memory and ADHD

Children with ADHD have been found to exhibit moderate to significant weaknesses in working memory. Children with ADHD have been found to exhibit impairments relative to non-ADHD peers on both verbal and non-verbal working memory tasks. Importantly, these weaknesses in children with ADHD cannot be explained by co-existing reading disorders or other comorbid disorders.

Recent studies have shown that working memory and other executive function weaknesses are more strongly related to the symptoms of inattention than to the symptoms of hyperactivity/impulsivity. Hence, children with either the Inattentive or Combined subtypes of ADHD may have difficulty with tasks requiring the maintenance and manipulation of information in mind to perform other tasks. For example, mental computation tasks require the maintenance of the question while performing the computation to arrive at the answer.

In addition, working memory performance is strongly associated with academic success in literacy and numeracy (see following section for information) and thus working memory weaknesses in children with ADHD may have a significant impact on their learning success.



Working memory is a predictor of academic success

Preliminary evidence suggests that working memory deficits are associated with difficulties in behavior and academic achievement in both children with and without ADHD. This indicates that even moderate weaknesses in working memory can affect a child's ability to display appropriate self-regulatory behaviors and achieve academic success. National curriculum assessment measures further reinforce this finding; children with higher scores on measures of working memory were found to achieve better assessment results than those with lower scores.

Working memory and literacy

Working memory performance is strongly associated with reading comprehension skills in elementary and college students. For instance, researchers found that children's performance on working memory tasks is associated with their reading comprehension abilities, independent of component skills (for example, word recognition and verbal ability). These researchers stated that:

"...working memory is a resource that affects an individual's ability to carry out many of the processes associated with construction of text representations."

There is also a strong association between working memory abilities and written expression. For example, one study found that six- and seven-year-old children with high scores on working memory tasks also produced writing samples with greater vocabulary diversity, text coherence, and level of general attainment. The association between working memory and written expression is not surprising when one considers the multiple cognitive demands of the writing process. When writing a text, the student must hold in mind information related to:

- what to write: ideas, words, sentences
- how to write it: grammar, syntax, mechanics
- the purpose of the text: audience, style

Juggling these diverse task demands places a high load on working memory.

Working memory and numeracy

Studies also indicate that there is a strong association between performance on working memory tasks and numeracy skills (such as math computation and problem-solving). Specifically, researchers found that working memory performance is strongly associated with:

- solution accuracy in word problems
- the extent of use of sophisticated strategies for solving math computation problems
- ability to inhibit irrelevant information in word problems

Children with deficits in working memory abilities have been shown to exhibit poorer numeracy skills on national achievement tests, which may be due in part to their use of less efficient strategies for solving computation and/or math problems.

Conversely, children identified by their kindergarten teachers as at risk for weaknesses in core literacy and numeracy (for example, letter knowledge, counting) have been shown to score lower than their non-risk peers on tests of working memory/executive functions. Moreover, these students are also rated by teachers as exhibiting more behavior and attention problems than the non-identified children. Taken together, these findings suggest an association between working memory, executive functions, behavior, and academic achievement that is present very early in a child's life. Thus, efforts should be made to screen for both early cognitive dysfunctions (for

example, in executive functions, working memory, or processing speed) and behavioral difficulties that may hinder a child's academic achievement.

Educational Implications of Working Memory Weaknesses

- Working memory deficits in children may hinder their ability to hold events and/or information (for example, rules) in mind to guide actions.
 - Thus, children may benefit from structured external prompts that indicate appropriate behaviors and routines.
- Working memory weaknesses may also interfere with a child's ability to follow directions and perform complex tasks that require sequential steps (for example, getting a project completed, and organizing homework).
 - To help students perform the steps necessary to complete a task, they can be provided with external cues and action plans. These can be gradually phased out as the student internalizes the sequence.
- Working memory weaknesses may reduce a student's ability to multi-task, independently reflect on actions, monitor progress, and exhibit self-awareness of strengths and needs.
 - In order to facilitate the organization and independent learning skills needed to perform multi-component tasks (for example, math problem-solving, reading comprehension, written expression), students may require guidance, explicit instruction, and practice in self-monitoring and problem-solving strategies.
 - Teaching students how to monitor progress using goal-setting and graphing facilitates achievement across a range of ability levels.

Processing speed

Processing speed refers to the rate at which an individual can process incoming and outgoing information. Students who are slow processors may find it difficult to keep up with classroom demands as they may not catch all the instructions required to complete a task, or they may be slow at copying down information, completing assignments, and retrieving information (for example, math facts) for use in their written and/or verbal responses.

Slow and variable performance of children with ADHD

Contrary to the perception that children with ADHD are "driven by a motor," performances on both neuropsychological and real-world tasks indicate that children with ADHD:

- are often slow at completing tasks, particularly when the tasks are cognitively demanding
- tend to have highly variable speeds of responding

Children displaying inattentive symptoms have been shown to be particularly slow and variable information processors.

Educational Implications of Processing Speed Difficulties

- Children with ADHD may need more time to complete tasks and/or process new information.
- Children with ADHD may take longer than peers to respond to a question and may need longer wait times during questioning.
- Assignments may need to be adjusted in length or quantity to accommodate the slower processing abilities of the student.

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