

# **The Role of Executive Functions in Attention Deficit Hyperactivity Disorder and Learning Disabilities**

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Attention Deficit Hyperactivity Disorder (ADHD) appears to be a disorder of self-control or executive functions. The executive functions of the brain allow one to coordinate and apply one's skills, knowledge and abilities in an effective and efficient manner. While ADHD is, by definition, a disorder of behavioral regulation, individuals with ADHD also typically have trouble with the regulation of cognitive and learning skills. Seeing ADHD as a disorder of executive function or regulation clarifies many of the confusing aspects of its diagnosis and presentation, including why it may look different in different individuals and why children with ADHD are often inconsistent in their behavior and performance. Understanding the role of executive functions in ADHD can also lead to better interventions.

Attention Deficit Hyperactivity Disorder (ADHD) often presents a confusing picture to parents and teachers. Why is one child who has been diagnosed with ADHD impulsive, another disorganized, another forgetful, and another hyperactive? Who do so many children diagnosed with ADHD also have learning difficulties? Why do many of these children appear capable of performing a task on one day, while unable to do the same task the next? Why do many of the behaviors associated with ADHD appear to change with age? Understanding the role of executive functions and their role in ADHD and learning can help explain these apparent inconsistencies and paradoxes.

## **What are Executive Functions?**

"Executive functions" is a term that describes a number of regulatory or control functions of the brain. Executive functions are involved in control of behavior, as well as control over cognitive and learning skills. These functions allow a person to coordinate and apply his or her knowledge, skills and abilities in order to attain a specific goal. Cognitive skills, such as language skills, pertain to how much someone knows, or what they can do. In contrast, executive functions determine how and when you apply your cognitive abilities and knowledge.

Executive functions can be thought of as the brain's control board. These critical functions include the ability to control and focus attention, to inhibit impulsive responses, to formulate goals and plans, to develop effective and efficient strategies for problem solving, and to monitor and check one's performance (and behavior) and to make corrections and changes when necessary. When students plan out a long-term assignment or study for a test they are using their executive functions to organize information and develop strategies for accomplishing these multifaceted tasks. Executive functions also come into play for activities as seemingly straightforward as cleaning up your room or interacting appropriately with your peers (i.e., focusing attention, organizing, and inhibiting impulsive behavior).

What we know about executive functions comes from studies in cognitive psychology, and from the neurosciences, or studies of the brain. Cognitive psychology studies how people process information, how we learn and how memory works. Executive control functions have been shown to be critical for human learning and memory (Lyon & Krasnegor, 1996).

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Neuropsychological and neurological studies have shown that executive functions are primarily controlled by the frontal lobes of the brain. The frontal lobes, and the executive functions they control, are not static. Like all parts of a growing child, the frontal lobes of the brain continue to develop throughout childhood and adolescence and even into early adulthood. As this part of the brain develops, so do the various executive functions so important for independent functioning.

## **Helping to Understand ADHD**

Research and clinical experience indicate that ADHD is primarily a problem with self-regulation or executive functioning. For example, Barkley has argued that ADHD is a disorder of inhibition and self-control (Barkley, 1997). Other neuropsychological studies have shown that individuals with ADHD have deficits in control functions presumed to be the responsibility of the frontal lobes of the brain (e.g., Grodzinsky & Diamond, 1992). Brain imaging studies have supported this interpretation, finding differences in the frontal lobes of subjects diagnosed with ADHD (e.g., Zametkin, 1990).

Understanding ADHD as a disorder of executive functioning can help explain why it manifests differently in different individuals. In general, if ADHD is a problem with self-regulation, it is going to look different depending on the nature or personality of the individual and what the individual is being asked to regulate. For example, active children who have trouble regulating their activity level at times when they need to, such as in a classroom, will appear hyperactive. Another child might not be overactive, but might have trouble controlling his or her attention in school and seem to be daydreaming or unfocused. This child would be diagnosed with the inattentive type of ADHD. Both children have trouble with self-regulation, though their behaviors appear to be quite different. The first has trouble regulating his or her activity level, while the second has trouble regulating his attention.

The ways in which the regulation difficulties seen in ADHD affect an individual's behavior depend on a number of factors. One critically important factor to look at is the whole individual who is diagnosed with ADHD, including their personality, temperament, other abilities and strengths and weaknesses. All these factors will impact on their ability to cope with their problems with self-regulation. An individual's strengths can mediate, or lessen the effect of the regulation deficit. For example, a student with ADHD who has exceptional language skills may have much less trouble organizing written assignments than a student with ADHD who only has average language skills.

Another critical factor that influences the way ADHD appears involves the demands or expectations placed on the individual. While a child with ADHD is engaged in an activity they enjoy, they will not have difficulty focusing their attention and regulating their behavior. The same child however, will be restless and distractible when asked to perform a more routine task that is perceived as uninteresting. This explains one of the commonly reported aspects of ADHD such as when a child is said to have no problems paying attention while watching TV or playing a video game, though his or her teacher notices attentional problems in school. When the child with ADHD is playing, his or her attention is captured or controlled by the activity, sometimes to the point where it is difficult to shift the child's attention. However, when engaged in activities seen as less engaging or interesting, his or her attention is more likely to be captured by any other interesting event in the environment, and the child appears distractible. In both cases, the child's attention is less self-controlled than it is controlled by the external situation. While it is normal for all children to prefer play to work, the difference lies in the degree of difficulty a given child has in making the necessary adjustment to the different demands of play and work situations. Children with ADHD have far more difficulty with shifting, attending and regulating than other children.

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Parents often question why ADHD behaviors seem to change as their child develops. This is often because of the changing environment and different demands placed on the child at different ages. In elementary school, there tends to be more structure and less emphasis is placed on organizational ability. When they enter middle school, students are expected to work more independently and develop higher levels of organization and planning in order to complete assignments. A bright child with ADHD and associated executive difficulties may be able to do well in elementary school because the organizational difficulties are not as apparent, given the level of structure and support most children receive. However, when the same child reaches middle school and the expectations for organization increase dramatically, that child may then struggle far more than a child without executive function deficits.

Another factor influencing regulation difficulties is the individual's experience with a specific situation or demand, and whether he or she has learned any compensatory strategies. Children who have established certain routines, for getting dressed, for doing homework, or for cleaning up their rooms, will manage the task far better than the child who tackles these tasks in a new or different way every time. Adults with ADHD who have been taught how to use date books or planners have learned an effective compensatory strategy for dealing with some aspects of their organizational problems. The implication is that, while the executive deficits associated with ADHD do not necessarily go away, the individual with ADHD can learn strategies to moderate the effect of their disability.

## **Executive Functions and Learning Disabilities**

Many children with ADHD also have school or learning problems. While some may have problems unrelated to ADHD (such as a phonological-based reading disability), the percent of children with ADHD who also have learning problems is much greater than in the population at large. Studies have estimated that 33 to 50 percent of students diagnosed with ADHD have concomitant learning disabilities (DuPaul, 1994). Learning problems appear to be particularly common in the inattentive subtype of ADHD, which is characterized by both attention and organizational deficits. Again, understanding the role of executive functions in learning and learning disabilities can help us to understand why this is so.

Research on human information processing, as well as neuropsychological studies of learning, has pointed to the importance of control processes in learning and memory (Lyon & Krasnegor, 1996). Learning is an active process that places emphasis on the student's ability to organize information. In other words, the student must understand what is most important about the new information to be learned and relate it to information he or she has already learned.

One way of thinking about learning is to think about the brain as a "filing cabinet." Children are asked to learn, or "file away," incredible amounts of new information in school. Children who have trouble focusing on the main ideas, or who have trouble organizing information, will have much greater difficulty filing away new lessons or skills in a systematic manner than children who are more focused and organized. When some event or information is particularly meaningful and/or interesting to us, it is usually easily remembered without much effort. However, when the information is arbitrary (less meaningful or interesting), such as math facts or the irregular spelling of many English words, something must be done to make it more memorable. Using the filing cabinet metaphor, the student needs to file the information in a systematic manner such as color-coding, cross-referencing and alphabetizing. In school, the student needs to relate new material to previously learned material and to note main ideas and relationships, which many students without learning disabilities do automatically, without even consciously thinking about it. On the other hand, the student with ADHD, who has organizational and attentional problems, often struggles with exactly this kind of learning.

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This difficulty with organization and learning strategies also helps to explain the inconsistencies typically seen in many students diagnosed with ADHD. Not only do they often have trouble learning new material, but their executive deficits can also result in problems trying to access or remember previously acquired knowledge and skills. To continue the filing cabinet metaphor, when a student with organizational problems learns new information it is like a file which has been tossed into a filing cabinet in a haphazard manner. It will be difficult to find the file you want to locate. Furthermore, individuals with poor executive functions also tend to search for information in a disorganized manner. The result is that one time they may access the information quickly and easily, while another time it may take much longer to come up with it, or they may not locate it at all. This accounts for the confusing inconsistency often seen with children with ADHD, where one day they seem to know all their spelling words or math facts, yet the next day they forget them. This inconsistency is often interpreted as being due to the student's motivation, when in reality it is a reflection of his or her organizational and other executive weaknesses.

Students with ADHD also frequently have problems applying the skills they have learned. They particularly struggle with written language and long-term assignments. These difficulties are often due to their executive deficits. They have poor planning skills, have trouble organizing all the components necessary for written assignments, and often approach tasks using ineffective or inefficient strategies. When a student has trouble selecting the best strategy for approaching a task, performance is often inconsistent and speed may vary in completing the task. While such students may sometimes act impulsively and finish too quickly (and often inaccurately), other times they are slower than their classmates or don't finish assignments in the time allotted. They may have the appropriate knowledge or skills, but are approaching the task using an inefficient strategy, thus making it more difficult, and therefore more time consuming, than it need be.

## **Implications for Intervention**

Once the behavioral and learning problems associated with ADHD are understood as being related to a more general problem with executive functioning or self-regulation, the implications for intervention become clear. If a child has trouble with self-control, then the first step should be modifying the external environment to provide more control. For the child with ADHD who has behavior problems, parents and teachers can establish a behavior modification program, which provides the appropriate cues, supports and reinforcements that help the child regulate his or her behavior. Individuals with regulation deficits generally do best in well-structured environments with established routines, and where there are clear and consistent behavioral expectations, which include rewards for desired behaviors and consequences for when behavioral expectations are not met. Behavioral programs must be individualized to suit the child's specific behaviors and needs, and are best devised by a behavior management specialist.

The goal is for children with behavioral problems related to impaired self-regulation to develop some measure of behavioral control. Good behavioral management programs essentially teach the child appropriate behaviors to replace maladaptive ones. These appropriate behaviors become more ingrained over time, and external reinforcers and cues can often be phased out. Many books about ADHD describe the principles behind such programs in terms accessible to parents (e.g., Parker, 1988; Barkley, 1987).

External supports are also crucial for children with executive-related learning difficulties. Such students do best when placed in structured classrooms with well-organized and flexible teachers. Presenting information in a way that captures the student's interest, and hands-on or participatory learning can help the child sustain his or her attention. Additional ways a teacher can assist a student with ADHD to better organize and learn new material include: relating new

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material to prior knowledge and experience, using graphic organizers (also called semantic maps or webs) which represent main ideas and relationships visually for the student, and teaching in thematic units, where new material and skills are presented in the context of a topic of interest to the students.

The eventual goal is to teach students compensatory strategies to allow them to study better, manage time and organize themselves on their own. Academic supports and appropriate instructional methods for students with executive-based learning difficulties can help them acquire good study habits and organizational skills. Explicit instruction in study skills, how to plan for assignments and manage time, etc., can also be taught to students directly. Again, many books on ADHD suggest ways to help students with school-related difficulties (e.g., Dowdy, et al., 1998; Parker, 1992).

## **Conclusions**

ADHD appears to be a disorder of self-control or executive functions. The executive functions of the brain allow one to coordinate and apply one's skills, knowledge and abilities in an effective and efficient manner. While ADHD is, by definition, a disorder of behavioral regulation, individuals with ADHD also typically have trouble with the regulation of cognitive and learning skills. Seeing ADHD as a disorder of executive function or regulation clarifies many of the confusing aspects of its diagnosis and presentation, including why it may look different in different individuals and why children with ADHD are often inconsistent in their behavior and performance. Understanding the role of executive function in ADHD can also lead to better interventions.

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