

## DSM-IV: ADHD AND EXECUTIVE FUNCTION IMPAIRMENTS\*

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ABSTRACT

Attention-deficit/hyperactivity disorder (ADHD) is a medical condition that first appears in childhood, affecting 6% to 8% of children. In more than 60% of cases, impairments of ADHD extend into adulthood as well. Since it was first described 100 years ago, conceptualization of ADHD has gradually shifted from focus on hyperactive and impulsive behaviors to recognition of cognitive impairments as the central and most persistent symptoms of the disorder. Current research suggests that ADHD is essentially a developmental impairment of the brain's executive functions—the management system of the brain's cognitive operations. This article reviews the phenomenology of currently recognized symptoms of ADHD and suggests that there is 1 important executive function impaired in ADHD that is not included in the *Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV)* criteria for the disorder: impairments in regulation of emotion.

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**I**n recent years, researchers have begun to recognize that attention-deficit/hyperactivity disorder (ADHD) is not simply a problem with paying attention, as in listening to a speaker, but rather a developmental impairment of a complex range of executive functions (EFs).<sup>1-3</sup>

There is not yet full agreement regarding exactly which functions should be classified as EFs. The general consensus is that they include a wide range of central control processes of the brain that connect, prioritize, and integrate other functions needed for self-management.<sup>4</sup> Executive functions appear to be centered in the prefrontal cortex, though other brain regions such as portions of the cerebellum are also involved.

EF can be compared to a symphony orchestra made up of very fine musicians, but without a conductor to organize and integrate the musicians' individual efforts. The problems with ADHD are not with those parts of the brain that would correspond to, per se, the individual musicians, but in the management system that controls and manages activities and integrates them moment by moment. The term "executive functions" refers to this management system, which facilitates the use of our mental functions for managing the multiple tasks of daily life.

The brain's EFs begin to develop in early childhood as the prefrontal cortex develops, then continue through adolescence into young adulthood. Parallel to the gradual development of EF, parents, teachers, and other people in a child's environment gradually escalate their expectations for the child to exercise an increasing level of self-management, ranging from the simple tasks of dressing and self-care to more complex responsibilities including managing multiple study courses in high school or driving a motor vehicle.

Some impairments of EFs can occur at the most basic levels of behavior management: difficulty with self-control of actions and verbalization may manifest as hyperactivity or extreme impulsivity in the earliest school years or before. Other impairments of EF are more subtle, impacting memory, organizing, and

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planning abilities that are not developed or expected until much later, sometimes not until later elementary school grades or in junior high or high school.

Sometimes parents intervene so much to help their adolescents stay organized and on task that ADHD impairments are masked until the teen moves away from home, possibly to attend college. When the youth then enters a situation where such parental scaffolding is unavailable, he or she may experience much difficulty.

### IMPLICATIONS OF DEVELOPMENTAL THEORY ON ADHD DIAGNOSIS AND ASSESSMENT

This emerging developmental view of EF impairments carries important implications for understanding age of onset of ADHD. The *Diagnostic and Statistical Manual of Mental Disorders, fourth edition* (DSM-IV) stipulation that some symptoms of ADHD should be manifest by age 7 years makes little sense in this context. The suggestion of Barkley and Biederman that the age of onset criterion should be broadened to recognize that many ADHD impairments are not manifest until years later is fully consistent with this view.<sup>5</sup>

Ramifications of this emerging understanding for diagnosis and assessment are significant. Whereas ADHD was formerly diagnosed on the basis of overt disruptive behavior demonstrated in childhood, understanding of the disorder as an impairment of EF requires a wholly different approach to assessment.

Executive functions are largely cognitive, covert, interactive, and not easily isolated for laboratory testing. Self-report from the patient as well as from others who know the patient is probably the most effective means of assessment. Of particular importance is information regarding the patient's capacities in performing complex, everyday tasks that involve multiple cognitive functions. Clinical interviews can elicit reports of the patient's abilities and limitations in dealing with management of these complex daily tasks. Data can then be compared with the normal range of performance by others of the same age and developmental level.

Assessment of ADHD should take into account 2 important characteristics of ADHD symptoms: they are dimensional and situation specific. ADHD symptoms are dimensional in that virtually everyone suffers some impairment in these functions at times; however, occasional occurrence of ADHD symptoms is not enough to warrant diagnosis. It is only when ADHD

symptoms are persistent and pervasive in at least 2 domains of activity, (eg, at school or work and at home) that those symptoms should be considered sufficient for diagnosis of ADHD.

The situational variability of ADHD can be difficult to understand. Most persons with ADHD have a few domains of activities for which they have no difficulty paying attention, and in which EF impairments are absent. It may be that they have chronic difficulty with ADHD symptoms in many areas of their lives, but in areas of intense interest, such as painting or playing sports, the symptoms are absent. Although this phenomenon of "can do it here, but not most anyplace else" makes it seem as if ADHD is a simple problem of willpower, clinical evidence suggests otherwise.

When a person with ADHD is asked how he or she can concentrate so well on one particular activity, but have great difficulty sustaining attention on most everything else, patients often respond, "It's just a matter of what interests me. If the task is intrinsically interesting to me or if it is an emergency, then I can usually pay attention to it quite well. If it is not interesting to me, then I usually can't pay attention, even when I recognize that it would be important for me to do so." One patient referred to this problem as "impotence of the mind."

People with ADHD find it much more difficult to make themselves pay attention unless the task is one that is immediately interesting to them. An understanding of the impairments experienced by persons with ADHD requires detailed clinical inquiry of individual patients regarding their performance in a variety of tasks; absence of impairment in a few specific domains does not rule out ADHD diagnosis if the impairments are chronically present in most other areas of functioning.

Following is a description of impairments elicited from children, adolescents, and adults diagnosed with ADHD according to the DSM criteria utilizing clinical interview methods. These have been compared with reports of normal controls matched for age group and socioeconomic status. Comparisons between the ADHD-diagnosed and the nonclinical samples in each age group have yielded reports of impairments that can be recognized in 6 clusters:

1. **Activation:** Difficulty in organizing tasks and materials, estimating time, and prioritizing tasks,

and trouble getting started on work tasks. Patients describe difficulty with excessive procrastination, even with very important tasks.

2. **Focus:** Difficulty focusing, sustaining focus, and shifting focus from one task to another. Some patients report that they are easily distracted not only by things that are going on around them, but also by thoughts in their own minds.

In addition, focusing on reading is difficult for many people with ADHD. Words are generally understood as they are read, but often have to be read over again in order for the meaning to be understood. Persons with ADHD often report that they read similarly to how those without ADHD read when they are very tired. They can comprehend the words as they read them, but the meaning does not stay in their minds.

3. **Effort:** Difficulty with regulating alertness, sustaining effort, and processing speed. Many people with ADHD report that they can perform short-term projects well, but have much more difficulty with sustained effort over longer periods of time. They also find it difficult to complete tasks on time, especially when required to do expository writing. Many also experience chronic difficulty regulating sleep and alertness. Often they report, "I cannot shut my head off and get to sleep when I want to. I have to wait until I am absolutely exhausted. Then I sleep heavily and have great difficulty waking up. During the day, I am OK as long as I am moving around or talking a lot. But if I have to sit still for a long time to read, listen to a meeting or lecture, or to do paperwork, my eyelids often get so heavy that I can barely keep myself awake."

4. **Emotion:** Difficulty managing frustration and modulating emotions. DSM-IV does not recognize any symptoms related to the management of emotion as an aspect of ADHD. Yet, many with this disorder describe difficulties managing frustration, anger, worry, disappointment, desire, and other emotions in order to complete the task

at hand. They speak as though these emotions, when experienced, take over their minds as a computer virus invades a hard drive, making it impossible for them give attention to anything else. They find it very difficult to get the emotion into perspective, to put it to the back of their minds, and to get on with what they need to do. This cluster of EF impairment is discussed further below.

5. **Memory:** Difficulty utilizing working memory and accessing recall. Very often, people with ADHD will report that they have adequate or exceptional memory for things that happened long ago, but have great difficulty remembering where they just put something or what they were about to say. They may find it difficult to remember what they put aside while attending to other tasks.

In addition, people with ADHD often complain that they cannot recall what they have learned when they need it. For example, a student may study intensively for an exam, be quizzed on the information immediately after study, and demonstrate clear knowledge of the material. But on the next day, that student may be unable to recall large portions of what they knew very well the night before. In people with ADHD, there appears to be an inadequate "search engine" of the brain, to activate stored memories, integrating these with current information as needed to guide thoughts and actions. These problems with recall of learned material and with recalling one task or thought after putting it aside for another are examples of the impairments of working memory, an important EF impaired by ADHD.

6. **Action:** Difficulty monitoring and regulating self-action. Many persons with ADHD, even those without problems of hyperactive behavior, report chronic problems in regulating their actions. They note that they often are too impulsive in what they say or do, and often also in the way they think, jumping too quickly to inaccurate conclusions. Such impulsivity can be quite problematic at any age.

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Persons with ADHD often report problems with monitoring the situation in which they are interacting. They often fail to notice when other people are puzzled or hurt or annoyed by what they have just said or done and thus fail to modify their behavior in response to specific circumstances. Often they also report chronic difficulty in regulating the pace of their actions, in slowing down or speeding up as needed for specific tasks.<sup>2,6</sup> Many children, adolescents, and adults with ADHD report the 6 clusters of impairments as chronic, more often than persons without ADHD.

The clusters are not mutually exclusive categories, but tend to overlap and are often interactive. Each cluster might be thought of not as a unitary variable, but as different aspects of related functions. Some might arrange these symptoms into 8 clusters, others into 5. Nevertheless, EF impaired in ADHD is complex and multifaceted. In more than 50% of cases ADHD is also complicated by additional psychiatric or learning disorders. Not only is it possible for people with ADHD to have another disorder, but over the course of their lifetime it is 2 to 5 times more likely.<sup>7,2</sup>

The complexity of the phenomenology of ADHD symptoms is matched by the complexity of its neurophysiological underpinnings. Denckla described this complexity of the brain substrates for ADHD:

ADHD is a label for a heterogeneous group of dysfunctions related to each of several nodes along the attentional/intentional network...from...cerebellum up to and including prefrontal cortex...includes neural substrates of activation, orientation, motivation and vigilance as these connect with and influence executive function...<sup>8</sup>

## ADHD AND REGULATION OF EMOTION

Although the high rates of comorbidity among ADHD and many other psychiatric disorders are well documented, there is uncertainty about whether it might be accounted for by constraints of the current nosology. One particular area of interest is the regulation of emotion. It has been reported that many patients with ADHD also have chronic problems with regulation of irritability, depression, and/or anxiety. Often this is seen as the individual having 2 separate disorders because diagnostic criteria for 2 or more disorders are met.

Perhaps the situation may not be that simple. One example is provided in problems with regulation of emotion.

Children with ADHD have been recognized as having an extraordinarily high incidence of oppositional defiant disorder (ODD), a pattern of behavior characterized by numerous symptoms of negativistic mood and difficulties in modulation of anger. Various studies have reported incidence of ODD among children with ADHD between 42% and 61%. Likewise, depressive (36%-38%) and anxiety disorders (3%-30%) have been reported to have very high incidence among individuals with ADHD.

Numerous investigators have reported that persons with ADHD tend to have chronic problems in regulating emotions. Wender's Utah Criteria for ADHD include "affective lability," "hot temper," and "overreacts" among symptoms of ADHD. Conners' widely used Parent Rating Scale cites "easily frustrated" as one of its 12 most accurate items for identifying ADHD in children. Conners' Adult Attention Deficit Disorder (ADD) Rating Scales include 4 items related to emotional regulation, eg, "down on self," "short-fuse," and "set off easily," in the ADHD Index, which comprises the 12 most accurate items for identifying adults with ADHD. The Brown ADD Scales for Children and for Adolescents and Adults indicated that for individuals with ADHD, responses to items related to emotional regulation had a high positive correlation with other symptoms of ADHD. These clinical data obtained from various samples suggest that problems in emotional regulation may be an aspect of the core problems of persons with ADHD that has simply been overlooked in the DSM-IV criteria for ADHD.

This is not to say that all problems of people with ADHD in regulating their emotions are simply due to the disorder. Some persons with ADHD have extreme difficulties in emotional regulation, problems much more severe than most others with ADHD. These individuals may well warrant diagnosis with ODD, a depressive disorder, an anxiety disorder, or a mood disorder. However, it is possible that some people with ADHD currently diagnosed as having one of these comorbid disorders may, in fact, have a lesser degree of impairment in regulating emotion, or a different type of problem in this domain, one that might more appropriately be seen as one more aspect of their ADHD.

This might be compared with the problem of ADHD and reading disorder. Many individuals with

ADHD report that they have chronic impairment in their ability to recall adequately what they have read, even just moments after reading. These individuals are reporting a problem with reading, but, in itself, this would not constitute a specific reading disorder. The core problem in reading disorder (dyslexia) is severe impairment in phoneme recognition—in the ability to recognize how the specific letter combinations that comprise words are pronounced. Those diagnosed with a reading disorder are those whose minds have severe difficulty in making the connections between how a word sounds and how it appears on the page.

Many people with ADHD have adequate phoneme recognition while still having significant chronic difficulty in remembering what they have just read and in integrating their recall from one word, sentence, or paragraph to another. This problem of reading comprehension is secondary to impairment of working memory; it can be understood as an aspect of the EF impairments of ADHD.

Returning to the example of the orchestra, we might now say that EF impairments of ADHD are comparable to an impaired conductor, while the specific impairments of a comorbid disorder might be compared to specific orchestra musicians who are impaired. Here we suggest that in people with ADHD, some of the problems in emotional regulation currently attributed to comorbidity, might, instead, be a core aspect of their ADHD.

A number of imaging studies have presented suggestive data relevant to this issue. Simpson et al<sup>9</sup> reported that changes in cerebral blood flow within the medial prefrontal cortex indicate a dynamic balance between focused attention and subjective anxiety. Mayberg et al<sup>10</sup> have shown reciprocal imaging changes in the subgenual cingulate and right prefrontal cortex that occur with transient and chronic changes in negative mood. Pochon et al<sup>11</sup> used functional magnetic resonance imaging to observe an emotional gating process by which cortical functions can decrease limbic and paralimbic activity to facilitate cognitive cortical functions. There is still much more to be learned about these processes, but the studies lend support to the notion of important bidirectional interactions between EFs of the brain and emotion processes that have important implications for understanding the complex impairments of ADHD.

## CONCLUSION

ADHD is a complex cognitive disorder, affecting all age groups of both genders. ADHD is increasingly being recognized as a developmental impairment of EFs of the brain. The disorder is dimensional and symptom manifestation is situation specific. It is not easily assessed by observation; extensive patient interviews are essential to diagnosis. ADHD is implicated in many psychiatric disorders, which are now categorized as comorbidities, but some of these, eg, regulation of emotion, may be a core component of the disorder itself.

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