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Review

Attention deficit hyperactivity disorder and developmental coordination disorder: Two separate disorders or do they share a common etiology.

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ABSTRACT

Attention deficit hyperactivity disorder (ADHD) has been described as the most prevalent behavioral disorder in children. Developmental coordination disorder (DCD) is one of the most prevalent childhood movement disorders. The overlap between the two conditions is estimated to be around 50%, with both substantially interfering with functioning and development, and leading to poorer psychosocial outcomes. This review provides an overview of the relationship between ADHD and DCD, discussing the common presenting features, etiology, neural basis, as well as associated deficits in motor functioning, attention and executive functioning. It is currently unclear which specific motor and cognitive difficulties are intrinsic to each disorder as many studies of ADHD have not been screened for DCD and vice-versa. The evidence supporting common brain underpinnings is still very limited, but studies using well defined samples have pointed to non-shared underpinnings for ADHD and DCD. The current paper suggests that ADHD and DCD are separate disorders that may require different treatment approaches.

Contents

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1. Introduction

Attention deficit hyperactivity disorder (ADHD) is characterized by developmentally inappropriate activity levels, impulsivity, and inattention [1,2]. ADHD is a highly comorbid condition [3], with approximately 50% to 90% of these children also meeting criteria for another psychiatric diagnosis [4,5]. These co-occurring disorders have been noted to be as important as ADHD in predicting the long-term psychosocial outcome of the individual child [6], as comorbidity greatly influences the presentation, complicates treatment and significantly increases the burden of ADHD [5].

ADHD has also been highly associated with motor problems. While for some it may reflect the inability to control activity levels and impulsivity, for many it more closely resembles the presence of a movement disorder referred to as developmental coordination disorder (DCD). The connection between ADHD and DCD has been recognized for several decades [e.g.,7] and the overlap between both disorders is estimated to be around 50% [3,8–12]. DCD is defined as a marked impairment in the learning and execution of movement skills given the person's chronological age and opportunity for skill acquisition and use, that significantly and persistently interferes with activities of daily living and impacts on academic/school productivity, pre-vocational and vocational activities, leisure and play [1]. Careful observation across different contexts is required to ascertain if lack of motor competence is attributable to distractibility, hyperactivity and impulsiveness rather than to DCD. If criteria for both disorders are met, a dual diagnosis can be given [1,13].

The Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5) now classifies both ADHD and DCD as neurodevelopmental disorders. They both have an early onset, long-term course, higher male/female ratio, genetic influences and multiple associations in altered brain function [1,14]. ADHD has been described as the most frequent child neuropsychiatric disorder [15,16], and one of the most investigated conditions in child and adolescent mental health [17,18]. DCD is also a frequently occurring disorder and represents one of the most prevalent childhood movement disorders [13,19,20].

Evidence of functional impairment in domains such as daily life functioning, academic achievement and interpersonal relations is also important for both diagnoses. When ADHD and DCD co-occur, the outcome tends to be more severe than when each disorder occurs alone [11,12]. In a follow-up study at 22 years of age, [21] compared individuals who were identified with ADHD with and without DCD at age 7 years, and age-matched controls. The combination of ADHD and DCD appeared to carry a poor psychosocial prognosis, including remaining symptoms of ADHD, antisocial personality disorder, alcohol abuse, criminal offending, reading disorders, and low educational level compared to ADHD without DCD [21].

Although the link between ADHD and DCD in terms of motor, attentional, hyperactive and impulsive problems has been discussed in various reviews [22,23] and studies [24–29], the neurological basis and its association with cognitive and motor problems has rarely been addressed. Numerous morphometric and neuroimaging studies have been conducted in individuals with ADHD, and have identified brain regions with abnormalities which may explain their cognitive and motor deficits [30–33]. Contrary to ADHD, there are few studies, with small sample sizes and divergent findings, investigating the neurobiology of DCD [34–36]. The aim of this review is to investigate whether ADHD and DCD appear to be separate disorders or different manifestations of one underlying etiology. Furthermore, the current paper provides an overview of the relationship between ADHD and DCD, focusing on the most prominent difficulties of each disorder, attention and executive functioning and motor skills, respectively.

Two hypotheses were formulated. The first proposes that ADHD and DCD are separate disorders, which would imply that different treatment approaches should be used. The second, alternative hypothesis proposes that ADHD and DCD are different manifestations of one underlying etiology, possibly suggesting common treatment strategies for both disorders. Considering the high degree of overlap between these disorders, that they both interfere with functioning and development, and that they have a significant social impact, it is important to understand the relationship between the two in order to guide intervention strategies.

2. Material and methods

This review was based on a search of the published papers relating to these topics. Several electronic databases (e.g., PubMed, Medline) were searched, as well as textbooks on ADHD, DCD and similar topics [1,2]. The relevant publications were carefully reviewed for information relating to the motor skills, attention and executive functioning of both disorders and the possible neural mechanisms underlying this relationship. The review begins with a discussion of the phenomenological features followed by the motor problems and cognitive deficits of ADHD and DCD, and their respective neurological basis. The clinical implications of the relationship between ADHD and DCD and the importance of further research in the area are highlighted.

3. Phenomenological features

3.1. Prevalence

ADHD and DCD affect about 5% of children [1,16]. However, estimates of prevalence for both disorders vary considerably, which may be explained by methodological characteristics of studies, such as source of information, diagnostic criteria, type of assessments, cut-offs and references used [13,37–39]. Comorbid DCD in individuals with ADHD occurs in approximately 50% of cases [12,38,39] and the rate is similarly high in those with severe and moderate variants of the disorder [40]. Furthermore, studies investigating DCD have found that almost half meet the criteria for ADHD [3].

3.2. Gender

The incidence of ADHD and DCD amongst genders has been debated. Both disorders are more frequently identified in males than females, with rates varying from 2:1 to 7:1 in children [1,13,16]. It is hypothesized that under diagnosis of both disorders in females may potentially explain this difference. In ADHD, females have been found to be more likely than males to display inattentive features [1]. This may lead to fewer referrals to health services and inclusion in clinical samples as childhood symptoms of impulsivity and hyperactivity are those that are often visible, whereas, inattention may be less overt. Arnold [41] suggested that girls with ADHD could be preferentially treated in "nonclinical" ways (i.e., they are not referred to medical services) by the teachers, parents and community, or their needs could be overlooked or they have less need, or a combination of these. This may also occur for females with DCD. Additionally, lower rates of participation in active play have been found in females from typically developing samples and has been attributed to psychosocial and physiological factors [42], ultimately reducing the opportunity for observation of movement patterns and the identification of possible motor difficulties in this gender.