

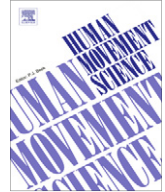


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# Motor imagery skills of children with Attention Deficit Hyperactivity Disorder and Developmental Coordination Disorder

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## ARTICLE INFO

### Article history:

Available online 22 November 2012

### psycINFO classification:

2330

### Keywords:

Attention Deficit-Hyperactivity Disorder  
Developmental Coordination Disorder  
Motor imagery

## ABSTRACT

Up to 50% of children with ADHD experience motor impairment consistent with DCD. Debate continues as to whether this impairment is linked to inattention or is a genuine motor deficit. This study aimed to determine whether (1) inattention was greater in ADHD + DCD than in ADHD alone and (2) motor imagery deficits observed in DCD were present in ADHD + DCD. Four groups aged 7–12 years—ADHD, combined type, with motor impairment (ADHD + DCD;  $N = 16$ ) and alone (ADHD;  $N = 14$ ), DCD ( $N = 10$ ) and typically developing comparison children ( $N = 18$ ) participated. Levels of inattention did not differ between ADHD groups. On an imagined pointing task, children with DCD did not conform to speed accuracy trade-offs during imagined movements, but all other groups did. However, on a hand rotation task, both the ADHD + DCD and DCD groups were less accurate than the non-motor impaired groups, a finding not explained by differences in IQ, age, or working memory capacity. Overall, there was evidence

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that children with ADHD + DCD experience genuine motor control impairments indicating the impact of motor impairment in ADHD and its causal risk factors require more study. Motor impairment in ADHD should not be dismissed as a by-product of inattention.

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## 1. Introduction

Attention-Deficit Hyperactivity Disorder (ADHD) occurs in up to 12% of children, has a negative impact on social, behavioral and educational domains, and many of its symptoms are now believed to persist into adulthood (Biederman & Faraone, 2005). As a result, ADHD has been studied extensively and we know much about the presentation of the disorder. One interesting finding regarding ADHD is its high comorbidity or co-occurrence with other developmental disorders in childhood, including Developmental Coordination Disorder (DCD) (Dewey, Kaplan, Crawford, & Wilson, 2002). DCD is defined by the American Psychiatric Association (APA) as an impairment in motor skills, not attributable to a known neurological or physical medical condition, that significantly interferes with a child's activities of daily living and/or academic achievement (APA, 1994). DCD, or motor impairment, is commonly observed in a large proportion of children with ADHD. Pitcher, Piek, and Hay (2003) found that approximately 50% of a sample of children with ADHD, regardless of subtype, had definite or borderline motor impairment. In an earlier study, the same authors had found approximately two-thirds of their ADHD sample was experiencing motor problems (Piek, Pitcher, & Hay, 1999). Despite research showing that children with both ADHD and DCD are likely to experience more long-term negative outcomes in a range of domains than children with either disorder alone (Rasmussen & Gillberg, 2000; Tervo, Azuma, Fogas, & Fiechtner, 2002), DCD in children with ADHD is often overlooked in the clinical context as more prominent behavioral issues involving impulsivity and hyperactivity overshadow the motor issues (Gillberg, 2003).

Although the motor impairment observed in both ADHD and DCD appears to be similar, it is not clear if they stem from the same underlying aetiological risk factors (Sergeant, Piek, & Oosterlaan, 2006). Some researchers argue that the motor impairment present in ADHD is a result of the child's increased inattentiveness and working memory deficits rather than being a genuine motor deficit (Barnett, Maruff, & Vance, 2005; Ferrin & Vance, 2011). Indeed, the American Psychiatric Association, in the 4th edition of their Diagnostic and Statistical Manual (DSM-IV, APA, 1994), suggests that the motor difficulties of children with ADHD are "usually due to distractibility and impulsiveness, rather than to motor impairment" (p. 54) in the differential diagnosis section for DCD. Support for this comes from studies that have demonstrated a link between the severity of inattentiveness and motor impairment (Piek et al., 1999; Tseng, Henderson, Chow, & Yao, 2004); research showing that children with ADHD on stimulant medication do not display the same response time slowing that is apparent in those not on medication (Klimkeit, Mattingley, Sheppard, Lee, & Bradshaw, 2005), and recent research showing that neurological soft signs, including those involving fine motor movements, are related to spatial working memory deficits (Ferrin & Vance, 2011).

In contrast, other studies support the presence of a genuine motor deficit in children with ADHD + DCD, unrelated to inattentive symptomatology. Pitcher et al. (2003) found that an ADHD + DCD group was significantly more impaired on a manual dexterity task than both ADHD only and control groups, who did not differ. Interestingly, there were no significant differences in the inattentive symptomatology of the two ADHD groups, indicating that the poor manual dexterity of the ADHD + DCD group could not be attributed to increased inattentiveness. Miyahara, Piek, and Barrett (2006) used distractor tasks to determine whether an increased attentional load would result in poorer motor performance in children with ADHD, but found that there was no decrease in performance as attentional demands increased. Due to these conflicting findings, it remains unclear whether the motor impairment observed in ADHD stems from the same underlying causal risk factors as that in DCD – this is confounded by the fact that we do not yet know exactly what is causing DCD itself, with

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