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# Examining the cognitive profile of children with Developmental Coordination Disorder

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ABSTRACT

*Background:* While primarily a motor disorder, research considering the cognitive abilities in children with Developmental Coordination Disorder (DCD) is limited; even though these children often struggle academically.
*Aims:* The present study aimed to characterise the IQ profile of children with and without DCD, and to identify whether children with DCD exhibit specific cognitive weaknesses.
*Methods and procedures:* 104 children participated in the study. Fifty-two children (mean age, 9 years) with a diagnosis of DCD were matched to 52 typically-developing children by age and gender. Cognitive ability was assessed using the Wechsler Intelligence Scale for Children (WISC-IV).
*Outcomes and results:* Children with DCD performed poorer than their peers on processing speed and working memory measures. Individual analyses revealed varied performance in the DCD group across all cognitive indices, despite displaying Full-Scale IQs in the typical range. Discriminant function analyses show processing speed and working memory performance predicted only 23% of between-group variability.
*Conclusions:* Children with DCD present with a heterogeneous cognitive profile, lending support to individual case analyses in research and when designing educational assistance plans. The motorically-demanding nature of the WISC-IV processing speed tasks raises specific concerns about using this index of the IQ assessment in this population. Research and practical implications are raised.



## What this paper adds?

Intellectual (cognitive) abilities are assessed in research and clinical practice. A link between cognitive and motor skill is often reported in the typically-developing literature, but little is known about the cognitive profile of children with Developmental Coordination Disorder (DCD). This paper provides a comprehensive assessment of a range of cognitive abilities, using the popular Wechsler scales. For the first time, it shows that children with DCD perform poorly on only the processing speed and working memory measures, in comparison to their peers. However, the motor demands of processing speed tasks can in part explain these results. Moreover, a heterogeneous cognitive profile was identified in the DCD group. Analysis of individual differences shows that children with DCD do not present with a distinct IQ profile. This suggests that attention should be paid to individual case analyses in order to understand the relationship between motor skill and IQ. The paper

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addresses the risk of identifying DCD on the basis of an IQ profile, and encourages all practitioners to adhere to the standard diagnostic procedures identified in the DSM-5.

## 1. Introduction

Intellectual functioning is assessed across clinical, educational and research settings. It is often examined during the diagnostic process of neurodevelopmental disorders to eliminate global developmental delay; and to confirm that any specific behavioural characteristics of a disorder are not better explained by low measured IQ (Castles, Kohnen, Nickels, & Brock, 2014). For example, the diagnostic criteria for Developmental Coordination Disorder (DCD) specify that movement difficulties must be below the level expected for the individual's age and cannot be accounted for by intellectual disability (APA, 2013). Practitioners typically administer a battery of tests examining intellectual abilities to guide their overall assessment of a child with a movement difficulty. Moreover, in education practice, identifying specific cognitive profiles (i.e. strengths and weaknesses) can help to guide strategies for educational assistance and provide a way of monitoring intervention outcomes.

Smits-Engelsman and Hill (2012) recognised that a cut-off IQ score of 70–80 is often used when diagnosing DCD in clinical practice, or confirming a diagnosis of DCD for research purposes: consistent with the DSM-5 diagnostic criteria. Yet, surprisingly, a recent review of 176 studies published on DCD in the last 5 years, identified that only 30% specifically tested IQ (Smits-Engelsman, Schoemaker, Delabastita, Hoskens, & Geuze, 2015). A large proportion of studies failed to control for IQ and instead presume that recruitment from a mainstream school means cognitive abilities will be within the average range. Thus, research appears to lend little focus to the role of IQ in DCD. However, the literature suggests that cognitive development and motor performance are intertwined and follow a similar developmental trajectory (Anderson, Anderson, Northam, Jacobs, & Catroppa, 2001; Smits-Engelsman & Hill, 2012). Early theories by Piaget (1952) also stressed that the cognitive and motor systems work together from a young age, as children learn about their surroundings from interacting with, and manipulating objects; and more recently, a systematic review of research on typically-developing children aged 4–16 years, highlighted that better motor skill was commonly associated to stronger performance in cognitive tasks (Van der Fels et al., 2015). Therefore, an understanding of this relationship in DCD may prove to be important for education practice and the diagnostic process. Especially since the difficulties experienced by children with DCD often extend beyond motor ability, and problems in academic achievement are often reported Dewey, Kaplan, Crawford, & Wilson, 2002; Kirby & Sugden, 2007). Yet, despite being a condition with an estimated prevalence between 2 and 5% (Kirby & Sugden, 2007; Lingam, Hunt, Golding, Jongmans, & Emond, 2009), to our knowledge, no study has systematically investigated the full range of cognitive abilities and whether specific IQ/cognitive profiles exist in a DCD population.

Intelligence scales, such as the widely used Wechsler scales (Wechsler, 2003), provide a comprehensive assessment of cognitive abilities. The Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV, 2003) provides a measure of Full Scale IQ (FSIQ), which is derived from performance on ten subtests that comprise four key indices: Verbal Comprehension (VCI), Perceptual Reasoning (PRI), Working Memory (WMI) and Processing Speed (PSI). Using these indices, or at the subtest level, researchers have attempted to delineate the pattern of cognitive function and its relation to the behavioural characteristics often shown in many neurodevelopmental disorders often seen in the classroom, such as: Autism Spectrum Disorder (ASD, Charman et al., 2010; Mayes & Calhoun, 2008; Oliveras-Rentas, Kenworthy, Roberson, Martin, & Wallace, 2012), dyslexia (Moura, Simoes, & Pereira, 2014), or Attention Deficit-Hyperactivity Disorder (ADHD; Hagberg, Miniscalco & Gillberg, 2010; Parke, Thaler, Etcoff, & Allen, 2015). In support of the WISC-IV, practitioners argue that its most beneficial feature is to generate cognitive profiles to help determine educational placement (Pfeiffer, Reddy, Kletzel, Schmelzer, & Boyer, 2000).

Studies that have partly assessed IQ/cognitive ability in DCD, using the Wechsler scales, present a mixed and inconclusive account. In comparison to typically-developing children and those with known attention problems, children with DCD have been identified as performing lower on FSIQ (Kaplan, Wilson, Dewey, & Crawford, 1998). However, the authors did not consider performance at the index or subtest level. While general processing deficits are often reported in a DCD population (Piek, Dyck, Francis, & Conwell, 2007; Wilson & McKenzie, 1998), Loh, Piek, and Barrett (2011) found no difference between children with DCD, children with ADHD, and a typically-developing control group in processing speed (using WISC-IV, PSI). This finding should, however, be considered as exploratory due to the small sample size (eleven participants per group). In addition, Loh et al. (2011) reported lower PRI in children with DCD in comparison to VCI, but, of note, the authors opted to use the short form of the WISC-IV, thus excluding WMI and one subtest from each of the VCI and PRI.

In a group known to have a heterogeneous behavioural profile, a more thorough assessment of individual differences is required, considering whether a profile of strengths and weaknesses is present across the cognitive indices. Therefore the purpose of the present study was to clarify two questions at a group and individual level, using a popular method of assessment for research and clinical purposes (WISC-IV; Wechsler, 2003):

(1) Do children with DCD present with notable weaknesses in any of the four WISC-IV indices (or subtests) in comparison to age-matched controls?
(2) Does one (or more) of these area(s) of weakness appear primary to DCD?