



## Full Length Article

# Sensory and motor differences in Autism Spectrum Conditions and developmental coordination disorder in children: A cross-syndrome study

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## ABSTRACT

Recent research has shown that Developmental coordination disorder (DCD) can present with some similar symptomology as Autism Spectrum Conditions (ASC). This paper therefore explored the similarities and differences in coordination and sensory responsivity between DCD and ASC. 77 children took part: 42 (35 male, 7 female) with ASC (ages 7–21; mean age 12.23 years), 26 (19 male, 7 female) with DCD (ages 7–21; mean age 11.07 years) and 9 (2 male, 7 female) with ASC and DCD (ages 8–15; mean age 12.27). All groups completed a battery of validated parent report measures online that included motor coordination (DCDQ), sensory responsivity (SPC-R) and social communication measures (AQ). Results showed no significant differences in coordination, and some significant differences in sensory responsivity between ASC and DCD (increased visual and auditory responsivity and decreased proprioception). Exploratory analysis showed that these differences showed good validity in identifying the diagnosis of ASC and DCD. These results elucidate the underlying causes of motor coordination difficulties in both conditions. Specifically, ASC coordination difficulties appear linked to visual processing impairments, whilst DCD coordination difficulties appear to be linked to spatial processing. This may aid better diagnosis and intervention for these conditions.

## 1. Background

Successful social integration and communication requires both eloquent conversation skills and the ability to identify, comprehend and execute non-verbal language. Without such skills learning, socialising, behaviour and emotional well-being can be greatly impacted (Lindsay & Dockrell, 2012; Ratcliffe, Wong, Dossetor, & Hayes, 2015). Thus, in addition to verbal language skills, communication also requires assimilating sensory information from the immediate environment, such as vocal tone, eye contact, facial gesture and posture; planning and executing reciprocal movement effectively (Hannant, Tavassoli, & Cassidy, 2016). Without the ability to carefully process and act upon such information, social understanding, awareness and crucially acceptance can become challenging. Current diagnostic criteria for Autism Spectrum Conditions (ASC) include difficulties with social communication and interaction in addition to unusual motor movement and sensory responsivity (DSM-5, APA, 2013). Since the first pioneering studies of ASC by Kanner (1943) and Asperger (1944), atypical movement and ‘clumsiness’ has been observed in these individuals. A

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plethora of research has since demonstrated movement abnormalities in ASC (such as Berkeley, Zittel, Pitney, & Nichols, 2001; Green et al., 2009; MacNeil & Mostofsky, 2012). Moreover, recent findings suggest that the motor impairment present in ASC correlates with the severity of symptoms and may be a marker of the condition (Dziuk et al., 2007; Hilton et al., 2007; Jansiewicz et al., 2006; MacDonald, Lord, & Ulrich, 2013; Hannant, Cassidy, Tavassoli, & Mann, 2016). Whilst some research goes further, suggesting that autism is primarily a movement disorder (Leary & Hill, 1996; Nayate, Bradshaw, & Rinehart, 2005; Whyatt & Craig, 2012). However, studies have also shown that similar difficulties in social integration and awareness can also occur in individuals with motor impairments without ASC, such as those with a Developmental Coordination Disorder (DCD) (Cantell, Smith, & Ahonen, 1994; Cassidy et al., 2016; Cummins, Piek, & Dyck, 2005; Kadesjö & Gillberg, 1998; Mandich, Polatajko, Macnab, & Miller, 2001; Wang, Tseng, Wilson, & Hu, 2009). This study therefore explores the similarities and differences in coordination, sensory responsivity and social behaviours between ASC and DCD children.

### 1.1. Motor coordination in autism spectrum conditions

Motor coordination difficulties have frequently been observed in ASC (Asperger, 1944; Berkeley et al., 2001; Green et al., 2009; Kanner, 1943; MacNeil & Mostofsky, 2012; Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998) and are thought to be present from early infancy. For example, head lag in infants (defined as the head lagging behind the trunk in a pull-to-sit position) (Flanagan, Landa, Bhat, & Bauman, 2012), and persistent asymmetry when lying from as young as 6 months old (Teitelbaum, Teitelbaum, Nye, Fryman, & Maurer, 1998). Reports also indicate significant parental concerns of motor development between 1 and 2 years of age (Chawarska et al., 2007). Indeed, a prevalence rate of definite motor impairment within ASC has been estimated, using assessments of coordination, to be approximately 80% with 10% borderline (Green et al., 2009; Miyahara et al., 1997). A high level of impairment in motor coordination is also noted in a range of other studies (such as Kopp, Beckung, & Gillberg, 2010; Ming, Brimacombe, & Wagner, 2007; Page & Boucher, 1998; Whyatt & Craig, 2012). In addition to high prevalence rates of motor coordination difficulties in ASC, individuals with ASC have been reported to have motor skills often falling to 1.5 SDs below the mean when compared to typically developing counterparts (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010).

Motor coordination difficulties are thought to play a fundamental role in social integration and as such have been observed in ASC research. For example, individuals with ASC have been found to have significant impairments in skilled social gestures such as imitation (Mostofsky et al., 2006). Moreover, studies have significantly correlated motor skills with the severity of autism symptoms (Dziuk et al., 2007; Hilton et al., 2007; Jansiewicz et al., 2006; MacDonald et al., 2013). These studies suggest that impairments in motor coordination interfere with the facilitation of meaningful, goal directed interactions both socially, in the form of non-verbal communication such as expression, proxemics and joint attention, and with the environment.

### 1.2. Motor coordination in developmental coordination disorder

Since first being recognised as ‘clumsy child syndrome’ in 1975 (Gubbay, 1975; DSM-3, APA, 1987) DCD has been in the prodigious position of having a number of labels including dyspraxia (Denckla, 1984), ‘Physical awkwardness’ (Wall, Reid, & Paton, 1990) and specific developmental disorder of motor function (WHO, 1992). For the purposes of this paper DCD terminology will be used to help eliminate any confusion with regards to the terminology and DCD enigma (Gibbs, Appleton, & Appleton, 2007). DCD is a pervasive neurodevelopmental disorder which impacts on the maturation and development of motor coordination. DSM-5 Criteria (APA, 2013) define DCD as having “motor skill deficit that significantly or persistently interferes with activities of daily life appropriate to the chronological age”. However, DCD often entails on-going social and academic frustration and can also lead to mental health challenges (Cairney, Rigoli, & Piek, 2013; Gagnon-Roy, Jasmin, & Camden, 2016; Kirby, Sugden, & Purcell, 2014).

Children and adults with DCD have also been shown to have significantly more ASC associated symptoms than those without DCD (Kadesjö & Gillberg, 1998; Cassidy et al., 2016). Children with DCD generally have significantly lower scores on attention and learning and are less confident with physical and social skills (Dewey, Kaplan, Crawford, & Wilson, 2002; Schoemaker & Kalverboer, 1990). Adolescents with DCD have been found to have fewer social hobbies and pastimes and lower academic ambitions (Cantell et al., 1994). A child’s motor ability has been found to be a significant predictor of social behaviour (Cummins et al., 2005).

The prevalence rate of DCD is varied (Kadesjö & Gillberg, 1998; Lingam, Hunt, Golding, Jongmans, & Emond, 2009; Tsiotra et al., 2006), however the European Academy of Childhood Disability (Blank, Smits-Engelsman, Polatajko, & Wilson, 2012) estimates between 5 and 6% are the most frequently quoted within the literature. In all children with this condition it is generally recognised that motor coordination difficulties fall below 1.5 SDs from the mean, with 1SD also considered as needing support in many instances (EACD recommendations, 2012; Sugden & Chambers, 2003; Tsai, 2009).

### 1.3. Similarities between autism spectrum disorders and developmental coordination disorder

Children with ASC or DCD are characterised with varying degrees of persistent symptoms of motor coordination and social integration impairment. However, motor coordination is intrinsically linked to sensory feedback, such as the visual and proprioceptive feedback required when planning and executing the motor function of reaching for a cup (Brooks, 1983). Consequently, deficiencies in sensory guidance are likely to play a pivotal role in the development and maintenance of motor coordination difficulties and are also observed in both ASC and DCD. Atypical sensory responsivity in ASC has been extensively researched and widely recognised since original studies first described sensory ‘intrusions’. The presence of sensory responsivity problems in ASC is high, with 80–95% of children with ASC having sensory difficulties (Caminha & Lampreia, 2012; Tomchek & Dunn, 2007). Additionally,

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