



Original Article

Relationship between motor coordination, cognitive abilities, and academic achievement in Japanese children with neurodevelopmental disorders



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KEYWORDS

Neurodevelopmental disorders;
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M-ABC2

Abstract *Background/Objective:* Motor coordination impairment is common in children with neurodevelopmental disorders such as autism spectrum disorder (ASD) and attention deficit/hyperactivity disorder (AD/HD). The purpose of this study was to investigate the relationship between motor coordination, cognitive ability, and academic achievement in Japanese children with neurodevelopmental disorders.

Methods: Thirty-four school-age (6–12 years old) children with neurodevelopmental disorders and 34 age-matched typically developing (TD) children were recruited in this study. Correlations between the scores of the Movement Assessment Battery for Children-2 (M-ABC2) and the Kaufman Assessment Battery for Children – Second Edition (K-ABCII) that assesses cognitive abilities, and academic achievement were analyzed.

Results: The children with neurodevelopmental disorders obtained a lower total score and all component scores on M-ABC2 compared to the TD children. In children with neurodevelopmental disorders, M-ABC2 Manual Dexterity score was significantly correlated with K-ABCII Simultaneous Processing ($r = .345$, $p = .046$), Knowledge ($r = .422$, $p = .013$), Reading ($r = .342$, $p = .048$), Writing ($r = .414$, $p = .017$), and Arithmetic ($r = .443$, $p = .009$) scores. In addition, M-ABC2 Balance score was significantly correlated with K-ABCII Learning ($r = .341$,

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$p = .048$), Writing ($r = .493$, $p = .004$), and Arithmetic ($r = .386$, $p = .024$) scores.

Conclusion: These findings stress that it is essential to accurately identify motor coordination impairments and the interventions that would consider motor coordination problems related to cognitive abilities and academic achievement in Japanese children with neurodevelopmental disorders.

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Introduction

Neurodevelopmental disorders such as autism spectrum disorder (ASD), attention deficit/hyperactivity disorder (AD/HD), and specific learning disorder (SLD) frequently co-occur with developmental coordination disorder (DCD) (American Psychiatric Association, 2013). Previous studies have also shown that motor coordination impairments are common in children with ASD (Green et al., 2009; Whyatt & Craig, 2012), AD/HD (Kadesjö & Gillberg, 1998; Piek & Dyck, 2004; Pitcher, Piek, & Hay, 2003; Waternberg, Waiserberg, Zuk, & Lerman-Sagie, 2007), and SLD (Jongmans, Smits-Engelsman, & Schoemaker, 2003; Westendorp, Hartman, Houwen, Smith, & Visscher, 2011). Therefore, it is essential to accurately identify motor coordination problems among children with neurodevelopmental disorders.

DCD impedes the acquisition and execution of coordinated motor skills (American Psychiatric Association, 2013). DCD is more prevalent among boys and occurs in 5–6% of children of 5–11 years of age. DCD is a serious impairment in the development of motor coordination that significantly interferes with academic achievement and daily living skills. Previous studies have shown that motor coordination problems are associated with secondary psychological, emotional, and sociability problems such as depression (Lingam et al., 2012), poor self-image and self-esteem (Cocks, Barton, & Donnelly, 2009; Piek, Baynam, & Barrett, 2006), and psychosocial issues (Dewey, Kaplan, Crawford, & Wilson, 2002).

Motor coordination involves a series of cerebral processes including sensory input, perceptual and cognitive processing, and action production (Vickerman, 2008). Diamond (2000) suggested that motor development may be related to cognitive development, and that the cerebellum and the prefrontal cortex may play a role in motor function and cognition. A recent study revealed a relationship between motor and cognitive skills in typically developing children (Luz, Rodrigues, & Cordovil, 2014; Roebbers & Kauer, 2009; van der Fels et al., 2015). Besides, Luz et al. (2014) detected associations between motor coordination and executive functioning in healthy 9–11-year-old children. Furthermore, previous studies revealed that children with DCD show decreased cognitive abilities (Asonitou, Koutsouki, & Charitou, 2010; Leonard, Bernardi, Hill, & Henry, 2015; Wilson & McKenzie, 1998). Asonitou et al. (2010) found that children with DCD differed from children without DCD and performed at a lower level in motor and cognitive tasks.

Recently, the relationship between motor coordination and academic achievement/cognitive abilities has been

evaluated. Several studies revealed that children with motor coordination problems show poor academic achievement (Lopes, Santos, Pereira, & Lopes, 2013; Roussounis, Gausson, & Stratton, 1987). Studies using regression analysis and focusing on school-aged children found that motor coordination was a predictor of positive academic performance (Fernandes et al., 2016). Moreover, Rigoli, Piek, Kane, and Oosterlaan (2012) found that motor coordination has an indirect effect on academic achievement through working memory in a normative adolescent sample. Thus, it appears that motor coordination is directly related to academic achievement. Indeed, previous research revealed that children with DCD tend to have poor academic achievement. Children with DCD displayed significantly poorer performance in reading, writing, and spelling (Dewey et al., 2002), literacy and numeracy (Alloway, 2007), and mathematics (Pieters, Desoete, Van Waelvelde, Vanderswalmen, & Roeyers et al., 2012), and children with learning disabilities scored lower in gross motor coordination tests (Westendorp et al., 2011). It can thus be concluded that motor coordination problems are directly related to academic achievement.

However, the relationship between specific motor coordination abilities, cognitive abilities, and academic achievement in children with neurodevelopmental disorders has been rarely investigated. Furthermore, no study has examined such relationships in Japanese children with neurodevelopmental disorders. The acquisition of literacy skills varies according to writing systems (Koyama, Hansen, & Stein, 2008). While alphabetic or syllabic scripts such as the English alphabet employ phonographic systems in which a symbol is mapped onto a sound unit (Shaywitz, Shaywitz, Fletcher, & Escobar, 2015), the Japanese writing system uses not only phonographic but also logographic systems in which a symbol is mapped onto either a word or a meaningful unit, such as in Chinese (Higuchi et al., 2015; Koyama et al., 2008; Uno Wydell, Haruhara, Kaneko, & Shinya et al., 2009). In addition, logographic Japanese characters have visual forms that are different from alphabetic letters. Therefore, understanding the relationship between the motor coordination abilities and academic achievement in Japan is essential to promote academic success among Japanese children with neurodevelopmental disorders.

Thus, we conducted a study examining motor coordination problems among Japanese children with neurodevelopmental disorders and the relationship of such impairments with cognitive abilities and academic achievement in Japan. The purpose of this study was to investigate the relationship between motor coordination and both cognitive abilities and academic achievement in Japanese children with neurodevelopmental disorders.

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