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Wisconsin Card Sorting Test performance in children with developmental coordination disorder

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ABSTRACT

The primary purpose of this study was to investigate and compare the executive functions measured by the Wisconsin Card Sorting Test (WCST) between children with developmental coordination disorder (DCD) and age-matched normal controls. A second purpose was to examine the relations between executive functions and school functions in DCD children. Seventy-one children with DCD and 70 children without motor problems were recruited from 14 public schools. Executive functions and school functions were assessed using the WCST, and the School Function Assessment – Chinese Version (SFA-C) respectively. Univariate analyses demonstrated significant between-group differences in five WCST measures. The logistic regression analysis showed differences between two groups on eight SFA-C subscales, and significant correlation between items measured on WCST and SFA-C was also found. The result of the study provides further evidence of impaired sub-domains of executive functions (i.e., mental shifting, flexibility) in children with DCD. The finding also adds to recent investigations into the relationship between executive functions and school functions in DCD. Implications for rehabilitation professionals and recommendations for further research are discussed.

1. Introduction

Developmental coordination disorder (DCD), in the Diagnostic and Statistical Manual of Mental Health Disorder (DSM-IV) of the American Psychiatric Association (American Psychiatric Association, 2000), is one of the commonly reported disorders in school-aged children (Wann, 2007), with prevalence of about 6% of children between the ages of 5 and 11. Such children demonstrate poor motor performance that is not accounted for by age, intellect or neurological disorders, and the impact of this is seen in both academic and daily living activities (APA, 2000). Moreover, DCD may persist into adulthood accompanying behavioral and psychosocial problems (Chen, Tseng, Hu, & Cermak, 2009; Mandich, Polatajko, & Rodger, 2003).

Although the biological markers and etiology are still indistinct, the definite deficits demonstrated by DCD are motor control problems (Tsai, Wu, & Huang, 2008), coordination difficulties (Tsai & Wu, 2008), and perceptual-motor problems (Tsai, Wilson, & Wu, 2008). These children are a heterogeneous group, differing in the extent of their motor difficulties and in

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the extent to which they display other conditions such as attention deficits, speech/articulation difficulties, psychosocial maladjustment, and non-verbal learning disabilities (Chen et al., 2009; Tsai, Pan, Cherng, Hsu, & Chiu, 2009).

Most studies conducted in DCD have emphasized motor competencies (Querne et al., 2008). However, impairments of non-motor functions have also been suggested in DCD who have dyspraxia, in particular, DCD often presents impaired attentional and executive functions (Flouris, Faught, Hay, & Cairney, 2005; Visser, 2003). Praxis involves executive functions for planning purposeful motor behaviors. Consequently, clumsiness could partially result from executive functions deficit demonstrated by children with DCD resulting from early cerebral lesion (Mandich, Buckolz, & Polatajko, 2002). The executive functions include a variety of cognitive and perceptual abilities that serve other behaviors and abilities. There is a consensus around several components of executive functions: control, planned actions, inhibition, and shifting between cognitive strategies. Among the executive functions, concentration deficits and distractibility to external stimuli have been widely reported in children with DCD (Chen et al., 2009; Dewey, Kaplan, Crawford, & Wilson, 2002). However, other executive functions, like abstract reasoning, cognitive flexibility in shifting set, problem solving, and impulsive responding inhibition have not yet been well studied.

Based on the International Classification Framework for Children and Youth (ICF-CY; WHO, 2007), health and functioning interact with and influence activities and participation (Simeonsson et al., 2008). Enhancing functional abilities that could increase activities participation has always been the main goal of occupational therapists working with DCD (Missiuna, Rivard, & Bartlett, 2006), however, most clinicians focus on intervening in the motor functions solely than other diverse functional abilities like executive functions (Pless & Carlsson, 2000; Wilson, 2005). The current study used a population-based sample to investigate the executive functions in children with DCD. Furthermore, the relation between executive functions (health and functioning) and school functions (activities and participation) in DCD was investigated as well. This study also addressed the need to comprehensively evaluate both the executive functions of children with DCD and their activities participation level besides motor performance.

2. Method

2.1. Participants

This study was approved by the Institute Review Board in Kaohsiung Medical University Chung-Ho Memorial Hospital, and the parental consents were all obtained before the study started. Children with DCD formed a heterogeneous group, so different assessment might not yield identical results in diagnosing such children with DCD. Therefore, a two-step sampling procedure was used to more efficiently identify children with motor coordination problems (Chen et al., 2009; Wright & Sugden, 1996). Participants were recruited from 7- to 11-year-olds in 14 elementary schools in the metropolitan Kaohsiung area. Letters describing the study, consent form, Developmental Coordination Disorder Questionnaire 2007 (DCDQ'07; Wilson, Kaplan, Crawford, & Roberts, 2007), and Chinese guidelines in using DCDQ'07 were sent to the participating parents. One thousand six hundred and twelve children of the 3360 questionnaire (47.9%) were returned with completed data. One hundred and ninety-nine children who scored below 55 (Wilson et al., 2007) on the DCDQ'07 were selected and received further motor testing. Children with a diagnosis of developmental disabilities, neurological disorders, genetic disorders or previous history of brain injury were excluded.

Each of the 199 children was examined with the Move Assessment Battery for Children-Second Edition (MABC-2; Henderson, Sugden, & Barnett, 2007) and Bruininks–Oseretsky Test of Motor Proficiency – 2nd edition (BOT-2; Bruininks & Bruininks, 2005). Children were diagnosed with DCD if they were scored in the deficient range on one of the six motor measures: at or below the 5th percentile on the MABC-2, or at or below the 40 (15th percentile) (Wang, Tseng, Wilson, & Hu, 2009) on the BOT-2 Fine Manual Control, Manual Coordination, Body Coordination, Strength and Agility Composite or the BOT-2 Total Motor Composite standard score.

2.2. Measures

2.2.1. Instrument used to measure executive functioning

A short form of the Wisconsin Card Sorting Test (WCST-64; Kongs, Thompson, Iverson, & Heaton, 2000) was developed to assess abstract reasoning and the ability to shift cognitive strategies in response to changing environmental contingencies. It also has also become one of the most widely used neuropsychological measures of executive function (i.e., impulsive responding inhibition, problem solving, and working memory; Butler, Retzlaff, & Vanderpioeg, 1991). WCST-64 was used in the present study to shorten the administration time for most individuals. The WSCT was also well validated in clinical groups and had sound reliabilities (generalizability coefficient > 0.70) (Greve, Ingram, & Bianchini, 1998; Kongs et al., 2000; Perrine, 1993). In addition, convincing evidence has supported the comparability of the standard WCST and WCST-64 in various populations including neurologic and psychiatric samples (Love, Greve, Sherwin, & Mathias, 2003; Sherer, Nick, Millis, & Novack, 2003).

The WCST-64 consists of four stimulus cards and 64 response cards that depict figures of varying forms, colors and numbers. The subject was asked to match a deck of 64 response cards with whichever one of the four stimulus cards he or she thought it matches. Subjects were not informed of the correct sorting principle, nor were they told when the category would shift during the test. Once the subject had made 10 consecutive "correct" matches to the initial sorting category, the sorting