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Postural responses to a suprapostural visual task among children with and without developmental coordination disorder

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A B S T R A C T

We sought to determine the effects of varying the perceptual demands of a suprapostural visual task on the postural activity of children with developmental coordination disorder (DCD), and typically developing children (TDC). Sixty-four (32 per group) children aged between 9 and 10 years participated. In a within-participants design, each child performed a signal detection task at two levels of difficulty, low (LD) and high difficulty (HD). During performance of the signal detection tasks we recorded positional variability of the head and torso using a magnetic tracking system. We found that task difficulty had a greater effect on task performance among the TDC group than among children with DCD. Overall positional variability was greater the DCD group than in the TDC group. In the TDC group, positional variability was reduced during performance of the HD task, relative to sway during performance of the LD task. In the DCD group, positional variability was greater during performance of the HD task than during performance of the LD task. In children, DCD may reduce the strength of functional integration of postural activity with the demands of suprapostural visual tasks.

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1. Introduction

Developmental coordination disorder (DCD) is characterized by poor performance in activities of daily living (ADL), and in academic achievement that requires motor coordination that is not associated with any pervasive developmental disorder, with neurological impairment, physical problems, or intellectual disabilities (American Psychiatric Association, 2000). Between the ages of 5 and 11 years the prevalence of the DCD diagnosis is between 3% and 22% (American Psychiatric Association, 2000; Hoare & Larkin, 1991; Wright & Sugden, 1996). In a 10-year follow-up study (Losse et al., 1991) indicated that the majority of children with DCD still manifest motor coordination difficulties through adolescence and into adulthood. Notwithstanding the prevalence is relatively high and that those children does not outgrow their status, the etiology of DCD remains uncertain.

In children with DCD, motor skill ability is below that of age-matched typically developing children (TDC). Children with DCD demonstrate a wide spectrum of motor coordination difficulties that include unstable stance, awkward running pattern, poor handwriting, drawing, and scissoring. Previous research has reported group differences in the control of postural motion while standing on a force plate (Geuze, 2003; Przysucha & Taylor, 2004; Tsai, Wu, & Huang, 2008) or in a swinging room (Wann, Mon-Williams, & Rushton, 1998) when comparing children with DCD to TDC group. More importantly, Geuze (2003) and Tsai et al. (2008) found that the differences in postural motion between the two groups was more noticeable in

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more challenging conditions (e.g. eyes closed vs. open, and one-leg vs. two-leg stance). Geuze and Börger (1993) and Vaessen and Kalverboer (1990) suggested that group differences in such measures may be exacerbated in dual task protocols.

In healthy adults and typically developing children, the magnitude of standing body sway is often modulated by variations in the ocular demand of suprapostural visual tasks. Stoffregen, Riley, Hove, Bonnet, & Bardy (2007) compared body sway in healthy adults during performance of a cognitive task (mental arithmetic) and a visual perceptual task (signal detection) that were matched for subjective mental workload. They found that body sway was greater during mental arithmetic than during signal detection. By contrast, sway was not affected by variations in the difficulty of purely cognitive tasks (easy vs. hard mental arithmetic). Chang, Wade, Stoffregen, Hsu, and Pan (2010) compared sway in children with and without autism spectrum disorder (ASD). Children with ASD tended to sway more than typically developing children; however, both groups reduced their sway during performance of a demanding visual task, relative to sway during a less demanding visual task.

To date, few studies have examined relations between postural control and the performance of simultaneous non-postural tasks in children with DCD. Laufer, Ashkenazi, and Josman (2008) asked participants to vocalize items (i.e. ball and table) displayed on a screen during stance. They reported that both DCD and TDC increased postural motion while engaged in a task compared to sway during quiet stance (no task). This finding may be questionable because the task they used required a vocal response; speech articulation tends to increase measured postural motion (Yardley, Gardner, Leadbetter, & Lavie, 1999). This issue is also problematic for other previous studies (Cherng, Liang, Chen, & Chen, 2009; Tsai, Pan, Cherng, & Wu, 2009). In the present study, we eliminated this problem by using visual tasks that did not require spoken responses.

In the present study, children with and without DCD performed easy and hard visual tasks while standing. We made several predictions. First, we predicted that overall sway would be greater in the DCD group than in the TDC group. Second, in the TDC group we predicted that sway would be reduced during performance of a more demanding visual task, relative to sway during performance of a less demanding visual task. Third, contrary to the findings of Chang et al. (2010) in children with ASD, we predicted that DCD children would not exhibit a reduced effect of visual task difficulty on postural sway.

2. Method

2.1. Participants

The study protocol was approved by the University of Minnesota Institutional Review Board. All participants and their parents gave written informed consent. There were 32 children (17 boys, 15 girls) between the age of 9 and 10 years (mean = 9.40, SD = 0.50) in DCD group while 32 age-matched (mean = 9.21, SD = 0.42) counterparts (17 boys, 15 girls) in TDC group. Table 1 illustrates that no significant differences were present between the DCD and TDC group for age, height, weight, and BMI. In addition, no significant group differences were found for IQ and the attention deficit and hyperactivity disorder-Diagnostic Teacher Rating Scale (ADHD-DTRS, Dupaul, Power, AnastoPoulos, & Reid, 1998). All participants' IQ scores were greater than 80 and all were free from a diagnosis of ADHD.

The percentile range for total impairment score for the Movement Assessment Battery for Children (MABC, Henderson & Sugden, 1992) was 26th to 79th percentile for the TDC group and 1st to 3rd percentile for the DCD group. The MABC scores are illustrated in Table 2 and show scores for the DCD group were significantly higher than the TDC group for total impairment score, manual dexterity, ball skill, and both static and dynamic balance.

2.2. Apparatus

We monitored postural activity using a magnetic tracking system (Flock of Birds, Ascension Technologies, Inc., Burlington, VT). One sensory was attached to a helmet worn by participants. A second sensor was attached (using cloth medical tape) to the skin at the seventh cervical vertebrae (i.e. between the shoulder blades). Each sensor was sampled at 60 Hz in each of six degrees of freedom. The emitter was placed 60 cm behind on a stand at approximately the participants' waist height.

2.3. Assessments

The Movement Assessment Battery for Children (MABC) is designed to identify children with motor coordination problems. This tool is popular for evaluation and identification of the DCD in research and clinical contexts (Geuze,

Table 1
Demographic data for the TDC and DCD group. The data are group means and standard deviations.

Measure	DCD (17 boys, 15 girls) Mean (SD)	TDC (17 boys, 15 girls) Mean (SD)
Age (years)	9.40 (0.50)	9.21 (0.42)
Height (cm)	139.75 (7.00)	140.19 (6.42)
Weight (kg)	38.92 (11.90)	38.00 (9.00)
BMI (kg/m^2)	19.61 (4.43)	19.20 (3.83)
IQ	99.50(15.69)	101.68(15.98)
ADHD-DTRS	2.01 (1.12)	2.13 (1.17)

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