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Developmental coordination disorder: Exploration of a cerebellar hypothesis

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Abstract

This study explored the hypothesis of a specific cerebellar dysfunction in children with developmental coordination disorder (DCD): motor adaptation. The performance of a group of children with DCD (3 girls and 6 boys) was compared to that of a control group (5 girls and 6 boys) on a measure of motor adaptation, the prism adaptation test (PAT). Children were between 6 years 11 months and 11 years 10 months of age. Between-group differences were only found for PAT variables related to throwing accuracy, the DCD group being more variable and less accurate than the control group. While no between-group differences were found for the adaptation variables, individual data analysis revealed that only three children in the DCD group obtained normal adaptation variables. While these findings do not confirm the hypothesis of a cerebellar dysfunction, they also do not refute it. It is possible that the poor throwing accuracy of the DCD group masked the findings for some of the PAT variables. Further exploration of the function of the cerebellum among children with DCD is needed.

PsycINFO classification: 2330

Keywords: Developmental coordination disorder; Motor adaptation; Prism adaptation; Cerebellum

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1. Introduction

Ball throwing, bicycle riding, and printing are motor-based activities typically acquired in early childhood. However, for children with developmental coordination disorder (DCD), the acquisition of such childhood activities often presents an insurmountable challenge. Despite decades of research on DCD, the nature and mechanisms underlying the coordination deficits of these children are still poorly understood. While some neurological dysfunction hypotheses have been proposed (see Sigmundsson, Ingvaldsen, & Whiting, 1997; Wilson, Maruff, Ives, & Currie, 2001), to date, cerebellar function, known to have a specific role in motor coordination and motor learning and adaptation (Thach, 1998), has not been specifically examined. The purpose of this study was to explore a specific cerebellar function among children with DCD: motor adaptation.

2. Cerebellar function

The cerebellum is a complex neurological structure containing more than half of the brain's total number of neurons (Ghez & Thach, 2000). It is part of various neural networks involved in both motor and non-motor processes. The cerebellum has long been recognized for its role in motor control and coordination, more specifically in the smooth coordination of the sequence, force, and timing of muscle contractions involved in postural control and motor actions (Barlow, 2002; DeMyer, 1998; Ghez & Thach, 2000). More recently, it has been demonstrated that the cerebellum also plays an important role in motor learning and adaptation, precursors of motor control (Allen, Buxton, Wong, & Courchesne, 1997; Ito, 1993; Parkins, 1997; Thach, 1998).

2.1. The cerebellum and motor control and coordination

A *Neurological screening examination* typically serves to identify cerebellar dysfunction. Classic neurological signs of dysfunction include dysmetria, hypotonia, dysdiadochokinesis, and terminal tremors. The signs exhibited depend on the lesion size and site, or clinical syndrome (DeMyer, 1998; Snell, 1997).

The impact of cerebellar dysfunction on motor coordination has been researched extensively through behavioral studies. These studies have contributed to the identification of the diverse roles and functions of the cerebellum and have provided various tasks that are known to differentiate patients with cerebellar dysfunctions from others; among these are finger tapping tasks and fast aiming tasks. In finger tapping tasks, participants are required to produce a rhythmic pattern with their fingers in response to a stimulus. The performance of patients with cerebellar dysfunctions has been shown to be more variable than that of any other groups of patients (e.g., Ivry & Keele, 1989). In fast aiming tasks, participants are required to produce cyclical movements between targets while producing correct movement distances. In a study conducted by Hore, Wild, and Diener (1991), the main outcome of patients with cerebellar lesions was overshooting of the target.

2.2. The cerebellum and motor adaptation

Motor adaptation involves the modification of a learned motor action in response to perceived changes in environmental context (Barlow, 2002; Shumway-Cook & Woollacott,