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Fine motor deficiencies in children with developmental coordination disorder and learning disabilities: An underlying open-loop control deficit

B.C.M. Smits-Engelsman [a,b,*], P.H. Wilson [c], Y. Westenberg [b,d], J. Duysens [d,e]

[a] *Nijmegen Institute for Cognition and Information (NICI), University of Nijmegen, P.O. Box 9104, 6500 HE Nijmegen, The Netherlands*
[b] *HSBB, Institute for Post-Bachelor and Master Studies, Unit Healthcare and Social Work, P.O. Box 90116, 4800 RA Breda, The Netherlands*
[c] *Department of Psychology and Disability Studies, RMIT University, GPO Box 2476V, Melbourne, Victoria, 3001 Australia*
[d] *Sint Maartens Kliniek-Research, P.O. Box 9011, 6500 GM Nijmegen, The Netherlands*
[e] *Department of Biophysics, Radboud University Nijmegen, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands*

Abstract

Thirty-two children with Developmental Coordination Disorder (DCD) and learning disabilities (LD) and their age-matched controls attending normal primary schools were investigated using kinematic movement analysis of fine-motor performance. Three hypotheses about the nature of the motor deficits observed in children with LD were tested: *general slowness hypothesis*, *limited information capacity hypothesis*, *and the motor control mode hypothesis*. Measures of drawing movements were analyzed under different task conditions using a Fitts' paradigm. In a reciprocal aiming task, the children drew straight-line segments between two targets 2.5 cm apart. Three Target Sizes were used (0.22, 0.44, and 0.88 cm). Children used an electronic pen that left no trace on the writing tablet. To manipulate the degree of open-loop movement control, the aiming task was performed under two different control regimes: discrete aiming and cyclic aiming. The kinematic analysis of the writing movements of the 32 children with DCD/LD that took part in the experimental study confirmed that besides learning disabilities they have a motor learning problem as well. Overall, the two groups did not

* Corresponding author. Tel.: +31-24-361-5754; fax: +31-24-361-6066.
E-mail address: engelsman@nici.kun.nl (B.C.M. Smits-Engelsman).

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differ in response time, nor did they respond differently according to Fitts' Law. Both groups displayed a conventional trade-off between Target Size and average Movement Time. However, while movement errors for children with DCD/LD were minimal on the discrete task, they made significantly more errors on the cyclic task. This, together with faster endpoint velocities, suggests a reduced ability to use a control strategy that emphasizes the terminal control of accuracy. Taken together, the results suggest that children with DCD/LD rely more on feedback during movement execution and have difficulty switching to a feedforward or open-loop strategy.

PsycINFO classification: 2330; 3250
Keywords: Learning disabilities; Developmental coordination disorder; Children; Fitts' law; Motor learning

1. Introduction

Prevalence studies indicate that at least 50% of children with a learning disability (LD) are identified with concomitant Developmental Coordination Disorder (DCD) (e.g., Jongmans, Smits-Engelsman, & Schoemaker, in press; Kaplan, Wilson, Dewey, & Crawford, 1998; Sugden & Wann, 1987). This relationship between poor motor coordination and LD may signal an increased vulnerability of neural networks that are responsible for integrating sensori-motor information (Waber et al., 2000). In this study, we investigate several competing hypotheses to account for this relationship. We provide preliminary evidence that deficits in the transition from closed- to open-loop (motor) control may explain the motor coordination difficulties of this comorbid group (DCD/LD).

While recent accounts of DCD have been varied, there is a consensus that these children experience information processing deficits across a range of perceptual modalities – visuospatial, kinaesthetic, and crossmodal (Wilson & McKenzie, 1998). Of these deficits, visuospatial processing appears to be the most pronounced, perhaps reflective of difficulties representing the visuospatial coordinates of prospective actions, or accurate feedforward models (e.g., Wilson, Maruff, Ives, & Currie, 2001). Whether similar or different patterns of deficit exist in children with a comorbid diagnosis of LD/DCD remains unclear. In view of the dynamic interplay between processing centres in the CNS, a different set of motor control difficulties may underlie the impaired performance of these children at the motor output level.

From an information processing perspective, we consider three primary hypotheses in this study that might explain the motor difficulties observed in children with DCD/LD: *general slowness*, *limited capacity*, and *motor control mode* hypotheses. With respect to the first, one common observation is that children with DCD/LD are slower overall in performing both cognitive and motor tasks (Jongmans et al., in press). Indeed, it has been recognized that temporal processing impairment could account for some of the perceptual-motor and cognitive symptoms often associated with learning disorders (Habib, 2000). Thus, children with DCD/LD may need more