Research in Developmental Disabilities 32 (2011) 2773–2779

Contents lists available at ScienceDirect

Research in Developmental Disabilities

The relationship between gross motor skills and academic achievement in children with learning disabilities

Marieke Westendorp *, Esther Hartman, Suzanne Houwen [1], Joanne Smith, Chris Visscher

Centre for Human Movement Sciences, University Medical Centre Groningen, University of Groningen, Section F, P.O. Box 196, 9700 AD Groningen, The Netherlands

ARTICLE INFO

Article history:
Received 24 May 2011
Accepted 24 May 2011
Available online 22 June 2011

Keywords:
Fundamental movement skills
Primary-school-age
Reading
Spelling
Mathematics

ABSTRACT

The present study compared the gross motor skills of 7- to 12-year-old children with learning disabilities ($n = 104$) with those of age-matched typically developing children ($n = 104$) using the Test of Gross Motor Development-2. Additionally, the specific relationships between subsets of gross motor skills and academic performance in reading, spelling, and mathematics were examined in children with learning disabilities. As expected, the children with learning disabilities scored poorer on both the locomotor and object-control subtests than their typically developing peers. Furthermore, in children with learning disabilities a specific relationship was observed between reading and locomotor skills and a trend was found for a relationship between mathematics and object-control skills: the larger children's learning lag, the poorer their motor skill scores. This study stresses the importance of specific interventions facilitating both motor and academic abilities.

1. Introduction

It is generally agreed that there is a relationship between motor ability and cognitive development. Research has shown that well-developed gross motor capacities facilitate children's cognitive functioning (Burns, O'Callaghan, McDonell, & Rogers, 2004; Bushnell & Boudreau, 1993; Murray et al., 2006; Piek, Dawson, Smith, & Gasson, 2008) and more specifically their academic abilities in reading, language, and mathematics (Son & Meisels, 2006; Viholainen et al., 2006). From a neuropsychological perspective, there are several explanations for the co-occurrence of motor and cognitive performance. First of all, motor and cognitive functions are coupled through using the same brain structures (Diamond, 2000). For example, the cerebellum is involved in both motor and cognitive functions and the pre-frontal cortex plays an important role in cognitive functioning as well as in motor performance through the strong neural connections between these two brain areas. Dysfunction of these brain structures or the neural pathways may express itself in motor problems as well as in cognitive problems (Diamond, 2000). A second explanation is that motor and cognitive functions seem to follow a similar developmental timetable with an accelerated development between 5 and 10 years of age (Ahnert, Bös, & Schneider, 2003; Anderson, 2002; Gabbard, 2008). A final factor that may account for the co-occurrence of motor and cognitive functions is that both functions have several common underlying processes for example sequences (Hartman, Houwen, Scherder, & Visscher, 2010), monitoring and planning (Roebers & Kauer, 2009; Sergeant, 2000).

* Corresponding author. Tel.: +31 050 363 9033; fax: +31 050 363 3150.
E-mail addresses: m.westendorp@med.umcg.nl (M. Westendorp), e.hartman@med.umcg.nl (E. Hartman), s.houwen@rug.nl (S. Houwen), j.smith@med.umcg.nl (J. Smith), c.visscher@med.umcg.nl (C. Visscher).
[1] Now at the University of Groningen, Department of Special Needs Education and Child Care, The Netherlands.

0891-4222/$ – see front matter
doi:10.1016/j.ridd.2011.05.032

As gross motor proficiency is assumed to foster academic abilities (Son & Meisels, 2006; Viholainen et al., 2006), it is especially important that children with problems in academic achievement have sufficient proficiency in gross motor skills. Children who have major problems in academic skills are children with learning disabilities (LD). These children have deficits in one or more domains of academic achievement, such as reading disorders, mathematical disorders, and/or disorders of written expression (American Psychiatric Association, 2000). In addition, children with LD generally have poor gross motor skills compared to their typically developing peers (Woodard & Surburg, 2001; Zhang, 2001). Using the Test of Gross Motor Development-2 (TGMD-2; Ulrich, 2000), Woodard and Surburg (2001) found that children with LD ($n = 22$), aged between 6 and 8 years obtained lower scores on both TGMD-2 subtests than typically developing children. Furthermore, Zhang (2001) found a small sample of 6–10 year-olds with LD ($n = 7$) that also scored poorer on the locomotor subtest and average on the object-control subtest relative to the normative TGMD-2 data. Both studies, however, had small sample sizes and focused on a general relation between motor performance and LD, without taking into account that LD is a heterogeneous condition including reading disorders, mathematical disorders, and/or disorders of written expression (American Psychiatric Association, 2000). Vuijk, Hartman, Mombarg, Scherder, and Visscher (2011) suggest that the relationship between motor skills and LD may in fact vary depending on the different areas of academic performance (i.e. reading, spelling, and mathematics) and the kind of motor skill. If this is the case then, it is important to investigate the specific relations between the different subsets of gross motor skills (i.e. locomotor skills and object-control skills) and the different domains of academic performance (i.e. reading, spelling, and mathematics) in children with LD rather then a general relation between LD and motor performance.

To date, research examining the relationship between different subsets of gross motor skills and the different domains of academic achievement in children with LD is limited. A study of children with dyslexia (i.e. a specific reading disorder) showed they scored lower on the balance test of the Movement Assessment Battery for Children (Movement ABC; Henderson & Sugden, 1992) than their typically developing counterparts. No differences were found on the other Movement ABC items and the TGMD-2 (Getchell, Pabreja, Neeld, & Carrio, 2007). Another study on children with reading disorders aged 9–10 years has shown that children who experienced more reading difficulties scored lower on the Movement ABC balance test than children with less reading difficulties (McPhiliphs & Sheehy, 2004). Furthermore, a recent study of Vuijk et al. (2011) studied the motor skills of 7- to 12-years-old children with LD with co-morbid developmental disorders like Attention Deficit Hyperactivity Disorder or Autism Spectrum Disorders. This study revealed positive correlations (i.e. the lower the motor skill performance, the larger the learning lag) between balance and mathematics and between ball skills and reading, using the Movement ABC.

To summarise, studies examining specific relationships between motor skills and academic performance in children with LD are limited, were mainly restricted to children with reading disorders, and showed inconsistent results. The present study, therefore, examined a large sample of children with LD on whether specific relationships exist between different subsets of gross motor skills and the different domains of academic performance. Understanding the specific relationship between gross motor skills and academic achievement in children with LD will provide valuable insight for the field of special education. It could be utilized in the development of intervention programs for this population, since evidence suggest that gross motor performance facilitates academic abilities (Son & Meisels, 2006; Viholainen et al., 2006). Successful implementation of such programs could indeed contribute to reducing the gross motor problems and may stimulate the development of academic abilities in children with LD during their primary-school-years.

The aims of present study were twofold. Initially, we sought to identify differences in gross motor performance in a large sample of primary-school-age children with LD and typically developing children. The main goal was to investigate in children with LD whether specific relationships between different subsets of gross motor skills (i.e. locomotor skills and object-control skills) and different domains of academic performance (i.e. reading, spelling, and mathematics) could be established.

2. Materials and methods

2.1. Participants

We recruited 144 children, aged between 7 and 12 years old, all with confirmed learning disabilities from two primary special-needs schools located in the northern Netherlands. Forty children were subsequently excluded because their individual school files stated they were also diagnosed with Attention Deficit Hyperactivity Disorder or Autism Spectrum Disorders. The final study sample comprised 104 children (69 boys and 35 girls) with a mean age of 10.1 years (SD 1.4; range 7–12). Based on the information provided in their individual school files, the children's mean intelligence quotient was 89.9 (SD 7.6; range 80–114). All children were Caucasian.

To collect gross motor skill reference values for the LD group, we recruited 104 aged-matched typically developing peers (61 boys and 43 girls) with a mean age 10.1 years (SD 1.4; range 7–12) attending two mainstream schools in the same region. The children's grade level was appropriate to their age. The two groups (children with LD and typically developing children) did not statistically differ from each other on gender ($F(1,207) = 1.308$, $p = .254$).

The parent(s) provided informed consent for their children's participation and all procedures were in accordance with the ethical standards of the Faculty of Medical Sciences of the University Medical Centre Groningen, University of Groningen.