Research in Developmental Disabilities 34 (2013) 3727–3735

Contents lists available at ScienceDirect

Research in Developmental Disabilities

The effect of a cognitive task on the postural control of dyslexic children

Maria Pia Bucci [a,*], Christophe Loic Gerard [b], Emmanuel Bui-Quoc [c]

[a] UMR 676 INSERM-Université Paris Diderot, Hôpital Robert Debré, 48 Boulevard Sérurier, 75019 Paris, France
[b] Service de Psychopathologie de l'enfant et de l'adolescent, Hôpital Robert Debré, 48 Boulevard Sérurier, 75019 Paris, France
[c] Service d'Ophtalmologie, Hôpital Robert Debré, 48 Boulevard Sérurier, 75019 Paris, France

ARTICLE INFO

Article history:
Received 24 May 2013
Received in revised form 18 July 2013
Accepted 22 July 2013
Available online 7 September 2013

Keywords:
Children
Posture
Dual-task
Attention

ABSTRACT

We explore the influence of a secondary cognitive task on concurrent postural control in dyslexic children. Seventeen children with dyslexia (DYS) were compared with thirteen non-dyslexic children (NDYS). Postural control was recorded in Standard Romberg (SR) and Tandem Romberg (TR) conditions while children, in separate sessions, have to fixate on a target and name simple objects appearing consecutively on a computer screen. The surface, the length and the mean speed of the center of pressure were analyzed; the percentage of correct responses to the cognitive task was also measured. DYS are significantly more unstable than NDYS. The secondary cognitive task significantly decreases the postural stability in DYS only. For both children postural performances in the TR condition is significantly worse than in the SR condition. The percentage of wrong responses to the cognitive task is significantly higher in DYS. Postural instability observed in DYS supports the hypothesis that there is a deficit of automatic integration of visual information and postural control in these children. This result is in line with the U-shaped non linear model showing that a secondary task performed during a postural task leads to an impaired postural stability probably due to focus attention on the cognitive task.

1. Introduction

Dyslexia is a neurobiological disorder characterized by a difficulty in reading acquisition despite adequate intelligence, conventional education and motivation (American Psychiatric Association, 1994). Frank and Levinson in 1973 were the first to suggest a cerebellar-vestibular impairment in dyslexia population. These authors examined 115 children with dyslexia and they found that 97% of them showed neurological signs of cerebellar-vestibular deficiency as positive Romberg test, difficulty in tandem walking, articulatory speech disorders, hypotonia, and several dysmetric deficits (finger-to-nose, heel-to-toe, writing and drawing). Nicolson and Fawcett (1999) also observed balance and motor coordination impairment in children with dyslexia and they hypothesized that dyslexia is characterized by a cerebellar deficit. Several subsequent studies examining postural performances in dyslexia population. For instance, Poblano et al. (2002) and Ramus (2003) reported impaired postural control in dyslexia but only in some cases, suggesting that the impairment was not strictly correlated with dyslexia but that it could co-occur with other types of developmental disorders in line with the finding from Rochelle and Talcott (2006). Stoodley, Fawcett, Nicolson, and Stein (2005) examined in children with dyslexia the balancing ability (with the right and the left foot) and they found that many dyslexics were significantly less stable than the control

* Corresponding author at: UMR 676 Inserm - Université Paris Diderot, Hôpital Robert Debré, 48 Bl Sérurier, 75019 Paris, France. Tel.: +33 0140035362.
E-mail address: mariapia.bucci@gmail.com (M.P. Bucci).

0891-4222/$ – see front matter
http://dx.doi.org/10.1016/j.ridd.2013.07.032

children. They suggested that several factors, including cerebellum deficiency and the magnocellular immaturity could be at the origin of such impaired balancing in dyslexia.

In everyday life postural control is naturally part of dual or multiple tasks and several studies examined in children with dyslexia the quality of postural control when child is asked to accomplish a secondary task needing focus of attentional resources. Nicolson and Fawcett (1990) reported that postural stability in children with dyslexia was affected by a secondary task which shifts attention from the primary postural one. These authors suggested that dyslexic subjects need to invest more attentional resources than non-dyslexic subjects to control their balance when two tasks are performed simultaneously. Recent studies from Quercia's group (Quercia, Demougeot, Dos Santos, & Bonnetblanc, 2011; Vieira, Quercia, Michel, Pozzo, & Bonnetblanc, 2009) have suggested that children with dyslexia have a postural deficiency syndrome constituting an impairment of postural control accompanied by a deficit affecting proprioceptive and visual information. Interestingly, a vibration of the ankle muscles impaired stability more strongly in dyslexic than in non-dyslexic children, independently of the attentional task; in the condition without vibration, the attentional performance of dyslexics was significantly impaired with respect to the non-dyslexic group of children. Furthermore, these authors have shown that a cognitive task, such as reading single words, impairs postural stability in children with dyslexia and that the attentional performance of such a population was significantly impaired when compared to the non-dyslexic group of children. Our group (Legrand, Bui-Quoc, Doré-Mazars, Lemoine, Gerard, & Bucci 2012) reported also that when reading text silently children with dyslexia were significantly more unstable than non-dyslexic children. In line with the U-shaped non-linear interaction model of Lacour, Bernard-Demanze and Dumitrescu (2008) these results suggest that the attention used for the cognitive task could be responsible for the loss of postural control in children with dyslexia and that such children could have a lack of integration of multiple sensorimotor inputs.

The goal of this study is to further explore the effect of a cognitive task (naming a simple object, similar to the task previously used by Laufer, Ashkenazi, & Josman, 2008) on the postural control in children with dyslexia in 2 different postural conditions (Standard Romberg and Tandem Romberg), the latter being more challenging than the former.

Our driven hypothesis, based on previously cited works regarding the dyslexic population, is that in comparison to control children, children with dyslexia would show poor postural control during a baseline condition, in particular in the more complex postural condition (being the Tandem Romberg condition). Furthermore, a dual-task condition, in which the attention is engaged for correctly accomplishing the cognitive task (see Olivier, Cuisinier, Vaugoyeau, Nougier, & Assaiante, 2007; Olivier, Cuisinier, Vaugoyeau, Nougier, & Assaiante, 2010), could lead to a worst postural control at least in dyslexic children.

2. Materials and methods

2.1. Subjects

Seventeen children with dyslexia participated in the study. Children with dyslexia were recruited from a pediatric hospital where they had been referred for a complete evaluation of their dyslexia with an extensive examination, including neurological/psychological and phonological capabilities. For each child, the time required to read a passage of text, text comprehension, and the ability to read words and pseudowords were evaluated using the L2MA battery (Chevrie-Muller, Simon, & Fournier, 1997). This is the standard test developed by the Applied Psychology Centre of Paris (Centre de Psychologie Appliquée de Paris), and is used throughout France. Inclusion criteria were scores on the L2MA which were more than two standard deviations from the mean, and a normal mean intelligence quotient (IQ, evaluated using the WISC-IV), namely between 80 and 115. The mean age of the children with dyslexia was 10.8 ± 0.4 years, the mean IQ was 105 ± 9, and the mean reading age was 8.5 ± 0.5 years. Children with dyslexia had no sign of hyperactivity or developmental coordination disorder (DCD). Diagnostic and Statistical Manual of Mental Disorders Fourth Edition (DSM-IV) was used to exclude hyperactive children (American Psychiatric Association, 1994). A selected age-matched control group (mean age: 10.7 ± 0.6 years) of thirteen non-dyslexic children was chosen. These children had to satisfy the following criteria: no known neurological or psychiatric abnormalities, no history of reading difficulty, and no visual stress or difficulties with near vision. IQ and reading measurements were not available for these children, but their scores for French (reading, comprehension and spelling), mathematics and foreign languages were all beyond the mean scores for their respective classes. Recruitment of controls based on school performance alone has been used by other researchers.

All children tested underwent an ophthalmological examination accompanied by orthoptic evaluation of their visual functions (mean values shown in Table 1).

Visual acuity was normal ($\geq$20/20) for all children in both groups. All children had normal binocular vision (60 s of arc or better), as evaluated with the TNO (Netherlands Organisation of Applied Scientific Research Test of stereoacuity), see Table 1 for details. The near point of convergence was normal for both groups of children tested ($\leq$5 cm). In addition, an orthoptic evaluation of vergence fusion capability using prisms was carried out at near distances. The phoria that is defined as deviation kept latent by the fusion mechanism (Von Noorden & Campos, 2002) is measured by the cover-uncover test. It was within the normal range for all children tested (-4 pD and -2 pD in non-dyslexic and dyslexic children, respectively). The divergence and convergence amplitudes were significantly smaller in the dyslexic group than in the non-dyslexic children. An ANOVA showed a significant main effect of group ($F_{(1,28)} = 22.38$, $p < 0.0001$ and $F_{(1,28)} = 5.16$, $p < 0.03$, for divergence and convergence amplitude, respectively).