Research in Developmental Disabilities 34 (2013) 4073–4084

Contents lists available at ScienceDirect

Research in Developmental Disabilities

The effect of visual therapy on the ocular motor control of seven- to eight-year-old children with Developmental Coordination Disorder (DCD)

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ARTICLE INFO

Article history:
Received 18 July 2013
Accepted 20 August 2013
Available online 19 September 2013

Keywords:
DCD
Ocular motor control
Visual therapy

ABSTRACT

The aims of this study were to determine the extent of ocular, motor control problems and the effect of visual therapy on such problems, among seven- to eight-year-old children diagnosed with DCD. Thirty-two, children with a mean age of 95.66 months (SD ± 3.54) participated in the study. The MABC was used to classify children into DCD categories (<15th, percentile) while the Sensory Input Systems Screening Test and QNST-II, were used to evaluate ocular motor control. A two-group pre-test–post-test, cross-over design was followed with a retention test two years, thereafter to determine the lasting effect of the visual therapy, intervention. The 18-week visual therapy programme was executed once a week, for 40 min during school hours, after which the two groups were, crossed over. Percentages of ocular motor control problems ranging, between 6.25% and 93.75% were found in both the groups before participating, in the visual therapy programme, with the highest percentage problems found, in visual pursuit with the left eye. Visual therapy contributed to a, significant improvement of 75–100% in visual pursuit, fixation, ocular, alignment and convergence, with significant lasting effects ($p < 0.001$). Visual therapy is recommended for children with DCD experiencing poor, ocular motor control.

1. Introduction

Motor deficiencies and ocular motor control problems can appear to cause severe problems in the development of children (Wilson, 2005; Zoia, Castiello, Blason, & Scabar, 2005). Vision is the primary source with which 80–90% of all information from the environment is perceived, moves through the brain, and to which the body must pay attention (Saladin, 2007). The development and improvement of perceptual and motor skills such as spatial orientation, coordination (hand–eye, foot–eye, hand–foot–eye coordination), balance, and body awareness are dependent on an effective visual system as well as good eye muscle control (Cheatum & Hammond, 2000; Pienaar, 2008; Willoughby & Polatajko, 1995). If there is any faulty input of information by way of the visual system, the reaction of the motor output to such information will also be faulty, could lead to motor deficiencies, poor concentration and, indirectly, to a low self-image (Lefebvre & Reid, 1998; Peens & Pienaar, 2007; Pienaar, 2008).

Approximately 20–30% of all children attending school do, in fact, display ocular motor control problems (Auxter, Pyfer, & Huetting, 1997; Ciuffreda, 2002; Orfield, Basa, & Yun, 2001). Ocular motor control describes the ability of the three pairs of

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http://dx.doi.org/10.1016/j.ridd.2013.08.036

skeletal eye muscles (rectus lateralis and medialis, rectus superior and inferior, and the superior and inferior oblique) to work together in a synchronised and coordinated way to ensure correct movement of the eyes (Lane, 2005). If problems with ocular motor control do occur, this will lead to accommodation, fixation, convergence, visual pursuit, and ocular alignment problems, which again, in turn, may have an influence on the child's academic and sport performance (Bouchard & Tetreault, 2000; Lane, 2005; Lefebvre & Reid, 1998). It thus, appears that well-functioning eye muscles are important for effective functioning of the visual system.

Poor motor coordination is described as "Developmental Coordination Disorder" (DCD). The Diagnostic and Statistical Manual (DSM-IV) of the American Psychiatric Association (APA, 2000), defines the term DCD to identify children with motor clumsiness, or any problems or limitations with the development of motor coordination, which is considerably lower than the child's chronological age. The motor coordination problems must also interfere with academic performance as well as daily activities. Furthermore, these children must have normal intelligence, with no signs of neurological conditions (such as, for example, cerebral palsy or muscular dystrophy) or physical disturbances (APA, 2000). The occurrence of DCD in children between the ages of five and 11 years is estimated at between 3% and 22% worldwide (Alloway & Archibald, 2008; APA, 2000; Cardoso & Magalhães, 2009; Hoare & Larkin, 1991; Wilson, 2005), while Pienaar (2004) reported an occurrence of 36.4% in children living in the North West Province of South Africa.

Children who are diagnosed with DCD are described as a heterogeneous group regarding underlying problems because they do not only display coordination and perceptual-motor dysfunctions, but display developmental limitations such as ocular motor control, attention deficit, as well as learning-related problems (Hoare & Larkin, 1991; Peens & Pienaar, 2007; Piek & Dyck, 2004). Various researchers link certain neuromotor problems as well as sensory-neurological processing problems such as visual problems, sensory problems, kinaesthetic problems, and reflex problems to DCD (Alloway & Archibald, 2008; Piek & Dyck, 2004; Willoughby & Polatajko, 1995).

Vision therapy can be described as individualised intervention for the improvement of the binocular system, ocular motor control, visual processing, visual-motor skills, and/or perceptual-cognitive deficiencies (AAO, 2011; Adler, 2002; Ciuffreda, 2002; Helveston, 2005; Orfield et al., 2001; Scheiman et al., 2005). The aim of vision therapy, according to Ciuffreda (2002) and Shainberg (2010), is to improve visual deficiencies by establishing a stable binocular system, which then further integrates the ocular motor system with the head (hand–eye coordination), neck (proprioceptive information), and the rest of the body (body awareness, spatial orientation, and muscle tone). During vision therapy, use is made of lenses, prisms, and specialised visual devices (Adler, 2002; Hurst, van de Weyer, & Smith, 2006; Orfield et al., 2001; Scheiman et al., 2005).

Various researchers (AAO, 2011; Adler, 2002; Auxter et al., 1997; Helveston, 2005; Scheiman et al., 2005) are of the opinion that vision therapy does improve visual deficiencies such as binocular skills, ocular motor control, visual attention, visual perception, and visual processing skills. This improvement of ocular motor control can contribute to the improvement of the child's motor skills as well as academic skills such as reading, writing, spelling, and mathematical abilities (Helveston, 2005; Orfield et al., 2001). Cheatum and Hammond (2000) are, furthermore, of the opinion that remediation of ocular motor control contributes to the improvement of fine motor skills (reading, cutting, and writing), gross motor and perceptual skills (balance, hand–eye and foot–eye coordination, spatial orientation), and visual skills. The case study of Hurst et al. (2006) on an eight-year-old child with motor planning problems (dyspraxia) indicated that vision therapy of eight months improved the ocular motor control, gross motor skills, and academic skills of the child, while another case study on a 10-year-old boy with motor development deficiencies showed a positive influence on ocular motor control and motor skills (Dudley & Vasché, 2010).

Literature indicates that the success percentage of vision therapy on ocular motor control skills such as accommodation, fixation, convergence, and pursuit appears to be between 70% and 100% (Adler, 2002; Ciuffreda et al., 2008; Ciuffreda, 2002; Grisham, 1988; Scheiman et al., 2005). It would, however, appear that there is no research on the effect of vision therapy on the ocular motor control of children with DCD. The aims of this study were therefore to determine the extent of ocular motor control problems and the effect of vision therapy on ocular motor control problems among seven- to eight-year-old children diagnosed with DCD.

2. Materials and methods

2.1. Research design

A two-group pre-test–post-test cross-over design was followed with a retention test two years thereafter to determine the lasting effect of the visual therapy intervention.

2.2. Participants

This study is a follow-up on a research project undertaken in 2006. During the project in 2006, two Grade 1 classes from each of three mainstream primary schools, in the Potchefstroom area, North-West Province, South Africa were randomly selected to take part in the project. The total number of learners identified for the research project was 101 (48 boys and 53 girls between the ages of six and seven years). The distribution of the learners identified was representative within the different population groups (37 white, 50 black, and 12 children of colour). Of this group who took part in the first part of the project in 2006, 49 learners (20 boys and 29 girls) without DCD and 52 learners (28 boys