Research in Developmental Disabilities 35 (2014) 110–116

Contents lists available at ScienceDirect

Research in Developmental Disabilities

Development and validation of the computerized bilateral motor coordination test

Chin-Kai Lin [a,*], Huey-Min Wu [b]

[a] *Program of Early Intervention, Department of Early Childhood Education, National Taichung University of Education, 140 Min-Shen Road, Taichung 40306, Taiwan*

[b] *Research Center for Testing and Assessment, National Academy for Education Research, No. 2, Sanshu Road, Sanxia District, New Taipei 237, Taiwan*

ARTICLE INFO

Article history:
Received 30 August 2013
Received in revised form 22 October 2013
Accepted 22 October 2013
Available online 16 November 2013

Keywords:
Motor coordination
Validity
Bilateral motor integration
Projected action

ABSTRACT

The purpose of this study was to explore the validity of computerized scaling of bilateral, motor coordination in children 4–6 years of age. There were 623 children with an average age of 5, years and 2 months (standard deviation = 6 months) that participated. The 290 girls (46.5%) and 333, boys (53.5%) were from a purposive sample taken from public and private kindergartens in Taiwan. The computerized bilateral motor coordination test included two subtests, bilateral coordination, movements and projected actions. The motion analysis, with mark position and contour motion, was, used to collect important variables from the subtests. Using the judgments of the experts as the, criterion standards, the accuracy, sensitivity, and specificity of the tool were calculated to evaluate the, validity of the computerized bilateral motor coordination test. The accuracy, sensitivity, and, specificity of the bilateral coordination movement subtests were on average 83.9%, 86.4%, and 83.1%, respectively. The accuracy, sensitivity, and specificity of the projected action subtests were on average, 90.5%, 88.1%, and 90.4%, respectively. The computerized bilateral motor coordination tests showed, an average accuracy of 86.3%, a sensitivity of 87.0%, and a specificity of 85.8%. The computerized, bilateral motor coordination test could be a valuable tool when used to identify problems of bilateral, motor coordination and in permitting early intervention to remedy these problems.

1. Introduction

Motor coordination is defined as the body's activation of the proper muscles required for purposeful, controlled, accurate and quick movements (Desrosiers, Rochette, & Corriveau, 2005). Bilateral coordination is defined as the ability to use both sides of the body in a skillful and integrated way (Magalhaes, Koomar, & Cermak, 1989). Bundy, Lane, and Murray, believing that bilateral coordination also involves repeated and continuous sequences of actions and projected actions, introduced the concept of bilateral integration sequencing (Bundy, Lane, & Murray, 2002).

Some developmental disorders may demonstrate motor coordination impairments, such as autism (Fournier, Hass, Naik, Lodha, & Cauraugh, 2010), ADHD (Piek, Pitcher, & Hay, 1999), developmental coordination disorder (DCD) (Huh, Williams, & Burke, 1998), developmental delay or learning disability (Cermak, Trimble, Coryell, & Drake, 1990). The children with motor coordination impairment are usually described as clumsy. Lack of bilateral coordination may result in low performance in

* Corresponding author. Tel.: +886 422015451; fax: +886 422183380.
E-mail addresses: linchinkai97@gmail.com, ckl@ms3.ntcu.edu.tw (C.-K. Lin).

0891-4222/$ – see front matter
http://dx.doi.org/10.1016/j.ridd.2013.10.026

basic motor skills (e.g., balance, ball playing skills or dexterity) (Poulsen, Johnson, & Ziviani, 2011), activities of daily life, academic performance (Cardoso & Magalhaes, 2009), voluntary movements, sports or rhythmic activities. When such children move awkwardly in relation to their peers, they may also suffer from low self-esteem (Cocks, Barton, & Donelly, 2009). For children, bilateral coordination is an extremely important element of their development.

There are four types of bilateral movements: symmetrical bilateral, asymmetrical bilateral, alternating bilateral and skilled bilateral. Symmetrical bilateral movements are synchronized movements performed by two sides of the body or both hands. In such movements, the two hands must move the same distance and in the same direction, as in clapping (Huh et al., 1998). Two examples of children's games that involve bilateral symmetrical movements are jumping rope and swinging. A child on a swing has to flex and extend both arms at the same time. Asymmetrical bilateral movements are asynchronous movements by two sides of the body in different directions or at different speeds (Huh et al., 1998). Examples of such movements include using a hula hoop, peeling an apple and cutting paper. Alternating bilateral movements are movements that alternate between the two sides of the body. An example of such a movement is playing a drum set. Finally, skilled bilateral movements are action sequences that are dynamic, fast, continuous and projected. These movements require anticipation of time and space. Ball sports are examples of skilled bilateral movements.

There are three basic axial planes in human movement, including sagittal plan, frontal plane, and transversal plane (Cael, 2010). The sagittal plane is from the front to the rear and divides the body into left and right halves. The frontal plane is from the right side to the left side or from the left side to the right side and divides the body into the anterior and posterior. The transversal plane divides the body into superior and inferior parts. Examples of movements in sagittal plan, frontal plane, and transversal plane are walking forward and backward, jumping to the left and right sides, and jumping up and down, respectively. Most of the skilled bilateral movements are complex movements across three axial planes, such as dancing, or gymnastics.

Tools used to evaluate coordination mainly consider continuity, rhythm, speed, quality of movement, accuracy and movement planning (Desrosiers et al., 2005). Items traditionally used to evaluate bilateral movement include jumping in place, Jumping Jacks (symmetrical stride jumps), throwing, kicking and catching a ball (Bruininks, 2005; Henderson & Sugden, 1992).

The most commonly used tools in Taiwan to evaluate motor coordination are the movement assessment battery for children (M-ABC) (Watter, 2006) and the Bruininks-Oseretsky test of motor proficiency (BOTMP) (Bruininks, 2005). M-ABC and BOTMP can be used to diagnose children with DCD, a sensory integration dysfunction, or a high level of clumsiness. The sensory integration and praxis test (SIPT) (Ayres, 1989) is designed to evaluate one's ability to perform bilateral integration and sequencing via two of its 17 sub-tests: bilateral motor coordination and sequencing praxis. SIPT is seldom administered in the health care and educational systems in Taiwan, as SIPT is expensive and few practitioners are SIPT-certified.

In past studies, motor coordination scores were usually measured by observing the time required to complete an action or the number of times the subject can complete an action. As a result, errors may occur when the researcher's view is obscured or when information is lost (e.g., error in counting). Advanced technology has allowed the use of image analysis software to assess movement. If a subject can be observed at different angles, visual blocking can be eliminated. Image analysis can also increase the accuracy of counting and obtain more information, such as height and angle. Using the computer to analyze the complex information also results in a fast, accurate diagnosis.

Currently, there are no standardized tests to evaluate bilateral coordination of children in Taiwan, nor is there normative data by which to screen children's bilateral motor function. This study sought to develop a set of computerized tools to evaluate children's bilateral motor function. The purpose of this study is to explore the validity of the computerized scaling of bilateral motor coordination in children aged 4–6 years. This study expects to develop the computerized scaling system of software that could assist clinical clinicians in automatically identifying subjects with motor function deficiencies.

2. Methods

2.1. Participants and procedures

The study was conducted from August 2010 to July 2011. In this study, 623 children with an average age of 5 years and 2 months (standard deviation = 6 months) participated. The 290 girls (46.5%) and 333 boys (53.5%) were from a purposive sample taken from public and private kindergartens in Taiwan. There were 201 4-year-olds (99 girls and 102 boys), 226 five-year-olds (106 girls and 120 boys) and 196 six-year-olds (85 girls and 111 boys). None of the children had any history of neural or orthopedic illness. The demographic information is listed in Table 1.

Table 1
Sample by age and sex.

Age (years)	Boys	Girls	Total
4	102 (50.7%)	99 (49.3%)	201
5	120 (53.1%)	106 (46.9%)	226
6	111 (56.6%)	85 (43.4%)	196
Total	333 (53.5%)	290 (46.5%)	623