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Comparison of motor praxis and performance in children with varying levels of developmental coordination disorder

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ABSTRACT

The praxis test is a less well-documented method to determine functional manifestations of childhood dyspraxia. For this study, children aged 6–8 years were recruited as follows: 17 children with DCD, 18 at risk of DCD and 35 without obvious problems in motor coordination. The Movement Assessment Battery for Children (MABC-2) was used to measure motor performance and identify the motor incoordination. This study developed a battery of tests to assess limb praxis using a *praxis imagery questionnaire*, *gesture representation*, and questions about *knowledge of object use*. In the comparison of subtests within the praxis test, significant differences were observed across groups on the *praxis imagery questionnaire* and *gesture representation* tests but not on *knowledge of object use*. Similar results were observed in the correlation analyses, in which a weak relationship between MABC-2 and praxis tests was observed. The DCD group had lower scores on the praxis imagery questionnaire, whereas the group at risk of DCD had lower scores on most gesture production tests. Our study provides a better understanding of the nature of the childhood dyspraxia and sheds light on its effect on motor coordination to identify praxis tests with specific clinical meanings in children with movement disorders.

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1. Introduction

Developmental coordination disorder (DCD) is a common movement disorder, with an estimated prevalence approximately 5%–6% in children aged 5–11 years and a tendency to occur more frequently in boys (American Psychiatric Association, 2013). DCD presents as a collection of motor coordination problems that lead to a disturbance in academic performance and daily life activities. It can easily be missed because it is difficult to identify through neurological examinations (Dunford, Street, O'Connell, Kelly, & Sibert, 2004).

Children with poor motor control commonly have difficulty choosing the appropriate type of motor action and forming a plan of action using the correct muscle activation sequence. These difficulties have been referred to as developmental dyspraxia (Cermak, 1985; Zoia, Pelamatti, Cuttini, Casotto, & Scabar, 2002). The term indicates that the problem lies with “praxis,” i.e., impaired ability to plan and execute movements. The condition is developmental rather than acquired (Bovens & Smith, 1999). Although there is broad agreement that dyspraxia involves a disorder of movement coordination, there is no consensus on a more precise definition.

A survey of health and educational professionals indicated widespread uncertainty about the definitions of and distinction between DCD and dyspraxia (Peters, Barnett, & Henderson, 2001). Furthermore, the rationale for using one term or the

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other in the literature has been unclear. Therefore, DCD and dyspraxia have been regarded as synonymous (American Psychiatric Association, 2013; Gibbs, Appleton, & Appleton, 2007; Missiuna & Polatajko, 1995). However, a recent work by Vaivre-Douret et al. (2011) distinguished between two patterns of “pure” developmental dyspraxia using extensive standardized evaluations: (1) ideomotor and visual-spatial/visual-constructional and (2) mixed dyspraxia with more comorbidities. This study enabled the definition of subtypes of “pure” dyspraxia within a population of DCD children. As Vaivre-Douret et al. (2011) suggested, motor planning and programming are the core problems of children with developmental dyspraxia, and this disorder should not be confused with problems of motor execution.

The most commonly used method to assess limb praxis is observing a child producing or imitating a range of gestures. These gestures can be elicited under different modalities, such as verbal command and imitation (Sinani, Sugden, & Hill, 2011; Zoia et al., 2002). Zoia et al. (2002) found a general delay in the performance of children with DCD. In transitive gestural testing with verbal modality, children with DCD performed consistently worse than their control peers, and the difference in performance tended to increase rather than improve with age. Sinani et al. (2011) found that children with DCD exhibited an impaired ability to produce familiar gestures compared with their normal peers.

Motor imagery has also been considered with reference to gesture production in children with DCD (Sinani et al., 2011; Wilson, Maruff, Ives, & Currie, 2001). Ochipa et al. (1997) developed a praxis imagery questionnaire (Florida Praxis Imagery Questionnaire, FPIQ) to assess individuals’ ability to imagine complex motor acts and then answer questions about those acts based on the internal representation.

Wilson et al. (2001) used the FPIQ to test motor praxis in children with DCD. They found that children with DCD performed slightly but significantly worse than controls on the kinaesthetic subscale of the questionnaire (Wilson et al., 2001). No overall group differences were found for the position, action, or object subjects. Sinani et al. (2011) used the FPIQ to test motor praxis in children with DCD. Their results differed from those of Wilson et al. (2001) in that they found that the age-matched control group performed significantly better than the clinical DCD group for the action and position subscales. They also measured the ability to identify the correct use of an object using a modification of the tested object employed in adult apraxic patients. DCD groups performed similarly to their peers and better than the younger age group (Sinani et al., 2011).

To date, the Movement Assessment Battery for Children (MABC) (Henderson, Sugden, & Barnett, 2007), BOTMP (Polatajko & Cantin, 2005) and TOMI (Stott, Moyes, & Henderson, 1984) have been the mostly frequently used standardized motor assessments to identify children at risk of DCD. The MABC is particularly widely used in research and practice. Different from motor praxis tests, it does not contain assessments of motor planning ability or a program such as motor imagery and gesture representation. As suggested by Vaivre-Douret et al. (2011), the MABC does not enable appreciation of specific neurodevelopmental markers of brain system development because sensory-motor function and motor milestones are regarded as screening indices of general neural integrity and not as indices of neuro-developmental processes. Such test batteries are useful, but interpreting the results regarding motor dyspraxia solely based on motor-based performances is difficult (Vaivre-Douret et al., 2011).

In view of the lack of classification in neurological signs or physical impairment, it is important to understand the nature of praxis problems observed in children with DCD. Compared with their normal peers, children with DCD exhibit an impaired ability to produce familiar gestures, dependent on the type of gesture and presentation modality (Sinani et al., 2011; Zoia et al., 2002). However, the substantial mechanism linking the praxis problems with motor coordination remain unclear. Since motor praxis involves a broad set of activities involving planning and organization, this study focused on the measures involving motor imagery, imitation of gesture and knowledge of object use. By these measures, the purpose of this study was to explore the features of these praxis problems in children with DCD.

From a theoretical perspective, Roy and Square (1985) suggested that praxic function comprises two systems: (1) a conceptual system that provides an abstract representation of the action and (2) a production system that incorporates a sensory-motor component of knowledge (generalized action programs containing information about space, i.e., “the orientation of objects and movements and the positioning of the fingers in a grasp and time,” p. 115) and a perceptual-motor process that enables the individual to organize and execute actions. The praxis tests in the present study were designed to include these two systems. First, the *praxis imagery questionnaire* was used to assess the abstract representation of the action. Second, the *gesture representation* and *knowledge of object use* were employed to assess a production system incorporating a sensory-motor component of knowledge (Roy & Square, 1985). The praxis tests were designed to address issues from previous studies, with a key aim to compare the previously mentioned components of motor praxis and performance in children with different levels of difficulty in motor coordination. Comparisons were also made across the types of gesture representation and the types of modalities. Our study aimed to better understand the clinical characteristics of these components of motor praxis in children with different levels of motor difficulty.

2. Methods

2.1. Subjects recruitment

For this study, 70 children ages 6–8 were recruited from three elementary schools in Kaohsiung city. With the guidance of the Developmental Coordination Disorder Questionnaire–Chinese version (DCDQ-C) (Tseng, Fu, Wilson, & Hu, 2010), teachers were requested to refer children with coordination problems according to their rating of the child’s general motor performance in school. The children with DCD were confirmed on the four criteria of *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.) (DSM-5) (American Psychiatric Association, 2013). To ensure criterion B and C of DSM-5 were

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