



Handwriting features of children with developmental coordination disorder – Results of triangular evaluation



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ABSTRACT

Developmental coordination disorders (DCD) is one of the most common disorders affecting school-aged children. The study aimed to characterize the handwriting performance of children with DCD who write in Arabic, based on triangular evaluation.

Participants included 58 children aged 11–12 years, 29 diagnosed with DCD based on the *DSM-IV* criteria and the *M-ABC*, and 29 matched typically developed controls. Children were asked to copy a paragraph on a sheet of paper affixed to a digitizer supplying objective measures of the handwriting process. The handwriting proficiency screening questionnaire (HPSQ) was completed by their teachers while observing their performance and followed by evaluation of their final written product.

Results indicated that compared to controls, children with DCD required significantly more on-paper and in-air time per stroke while copying. In addition, global legibility, unrecognizable letters and spatial arrangement measures of their written product were significantly inferior. Significant group differences were also found between the HPSQ subscales scores. Furthermore, 82.8% of all participants were correctly classified into groups based on one discriminate function which included two handwriting performance measures.

These study results strongly propose application of triangular standardized evaluation to receive better insight of handwriting deficit features of individual children with DCD who write in Arabic.

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1. Introduction

Developmental coordination disorders (DCD), previously labeled as 'Clumsiness', is one of the most common disorders affecting school-aged children and is characterized by motor impairment that interferes with a child's activities of daily living and academic achievement (Cairney, Hay, Faught, Flouris, & Klentrou, 2007; Wann, 2007). DCD is diagnosed according to four *DSM-IV* criteria. Criterion A: A marked impairment in the development of motor coordination. Criterion B: The marked impairment interferes with academic achievement or activities of daily living. Criteria C and D restrict the diagnosis to coordination disorders not due to a medical condition or beyond difficulties bounded by mental retardation (American Psychiatric Association, 1994). According to criteria A and especially B of the *DSM-IV*, handwriting difficulties may be a

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manifestation of motor coordination deficits among school aged children and hence constitute a key point for their diagnosis of DCD (Barnett, 2006).

Despite technological progress, handwriting still constitutes an important activity among school aged children and is required for during 30–60% of the school day (McHale & Cermak, 1992; Rosenblum, Parush, & Weiss, 2003; Rosenblum, Weiss, & Parush, 2003). Proficient handwriting is essential for note taking and other daily use in adulthood (e.g., Piolat, Olive, & Kellogg, 2005). In recent years, a call to refrain from abandoning handwriting skill development is being heard, due to its contribution to shaping individuals more general perceptual and fine motor skills (Sülzenbrück, Hegele, Rinkenauer, & Heuer, 2011).

School is an appropriate environment for evaluating handwriting through actual performance toward improving writing abilities (Graham et al., 2008). Due to their developmental coordination deficits, children with DCD may be challenged with writing difficulties particularly with the mechanical production of letters and words on paper.

Previous studies have indicated that handwriting problems and specifically the inability to automatically and effortlessly produce legible letters at the appropriate pace may be the initial sign of a child being at risk for developing inadequate composition skills (Berninger & Amtmann, 2003). Consequently, it was found that letter production automaticity is the single best predictor of composition length and quality among elementary school children (Graham, Berninger, Abbott, Abbott, & Whitaker, 1997) and during high school and college years (Berninger, Rutberg, Abbott, Garcia, & Anderson-Youngstrom, 2006; Connelly, Campbell, MacLean, & Barnes, 2006; Jones, 2004; Peverley, 2006).

Children with DCD are at particular risk for handwriting deficiency (O'Hare, 2004; O'Hare & Khalid, 2002) that may be a key component of their academic achievements and self-esteem (Feder & Majnemer, 2007). However, standardized tools and studies concerning this population's handwriting performance are scarce (Blank, Smits-Engelsman, Polotajko, & Wilson, 2012). Thus, important information is lost and the possibility for developing secondary socio-emotional implications among this population increases (Kirby, Edwards, Sugden, & Rosenblum, 2010; Rosenblum & Weintraub, 2007). Following the *DSM-IV* criteria, the purpose of this study was to obtain better insight of the features of handwriting performance among children with DCD who write in Arabic.

Arabic handwriting is compiled of a variety of fonts. Similarly to Hebrew language, Arabic is written from right to left and contains 28 sound based letters. Three of the letters are used as "long vowels" whereas "short vowels" can be created by adding specific underscore and over-score diacritical signs. Twenty two of the 28 letters encompass four different morphological forms for the beginning, middle and end of the word. An additional form is used when the letter appears following a non-joinable letter. The remaining six letters have two morphological forms each, one for a letter appearing at the end of a word and the other as a non-joinable letter (Eviatar, Raphiq, & Ganayim, 2004).

Most of the Arabic alphabet letters are written consecutively in a cursive style according to grammatical rules derived from their position within the word. There are six letters that do not join the left side of a sequential letter within a word. This rule requires forming a space within the words as well as the standard space between words required when writing.

In order to detect handwriting performance characteristics of children who write in Arabic, a triangular evaluation approach was implemented in the study.

This study used the handwriting proficiency screening questionnaire (HPSQ) (Rosenblum, 2008) a practical questionnaire-based assessment for collecting information in schools. In addition, handwriting process and product evaluations were implemented in order to obtain improved characterization of the handwriting performance features. Therefore, the study aim was to compare handwriting characteristics of children with DCD who write in Arabic to those of typically developed children. An additional aim was to discover whether significant correlations occurs between varied handwriting characteristics in each group and to detect which handwriting measures best differ between the groups.

2. Methods

2.1. Participants

The study included 58 children, aged 11–12 from mainstream public schools of the Arabic speaking population in the northern region of Israel. The study group included 29 children diagnosed with DCD, according to the *DSM-IV* criteria (American Psychiatric Association, 1994) and who scored below the fifth percentile according to the Movement Assessment Battery for Children (M-ABC) (Henderson, Sugden, Barnett, & Smits-Engelsman, 1992) previously validated among Israeli children (Engel-Yeger, Rosenblum, & Josman, 2010).

Awareness and knowledge of DCD among parents and teachers of children in this age group as a whole and among minority groups in particular is insufficient. Therefore, the primary diagnosis was given by an expert school based occupational therapist and approved by a pediatrician.

The control group included 29 children with typical development (TD) based on their parents report and M-ABC scores and matched for age, gender and school. Children with known emotional disorders, autistic disorders, physical disabilities, or neurological diseases were excluded from the study. All participants were native Arabic speakers and writers for at least four years, attended school, and reported no hearing or vision difficulties. Both groups included 24 boys and five girls with no significant age differences found between the two groups (DCD: $M = 10.9 \pm 7.46$ Controls: $M = 10.11 \pm 7.5$).

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