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Handwriting performance and underlying factors in children with Attention Deficit Hyperactivity Disorder

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ABSTRACT

Preliminary evidence suggests that handwriting difficulties are common to children with Attention Deficit Hyperactivity Disorder (ADHD). However, the nature of the task-specific impairments is needed to be clarified. The aim of this study was to describe handwriting capacity in ADHD children without DCD and identify underlying factors of performance by use of outcome-oriented assessments and a digitizing tablet. Twenty-one children with ADHD (8.59 ± 1.25 years) and 21 match controls (8.5 ± 1.08 years) were recruited. Children with ADHD scored lower than controls on Tseng Handwriting Problem Checklist and writing composite of Basic Reading and Writing Test, indicating the ADHD group wrote less legibly. The ADHD group spent more on-paper time to copy 50 Chinese characters and exhibited more writing time during the writing process. The ADHD group scored significantly lower on tasks demanding upper limb and eye–hand coordination and visual-motor integration compared with controls. Furthermore, motor skill and visual-motor integration were positively correlated with the legibility. Motor skill was negatively correlated with writing time, in-air time, and in-air trajectory.

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1. Introduction

Attention Deficit Hyperactivity Disorder (ADHD) is the most common neurobehavioral disorder in childhood (DSM-IV, American Psychiatric Association, 1994). The core symptoms of ADHD as defined by DSM-IV are inattention, impulsivity and hyperactivity. However, motor difficulties have also been reported in this population (Fliers et al., 2008; Pitcher, Piek, & Hay, 2003; Stray et al., 2009). Poor fine motor coordination in children with ADHD has been reported and a high percentage of ADHD children have difficulty with handwriting and penmanship has been noted (Barkley, 1998; Harvey & Reid, 2003; Piek, Pitcher, & Hay, 1999).

The importance of handwriting for performance in school has been well documented. Although students' use of computers to process work is very popular, legible handwriting skill is still very important for them nowadays. Limited writing performance directly affects students' functional performance in academics, and results in poor self-esteem, and poor self-acceptance (Mather & Roberts, 1995). Weintraub and Graham (2000) reported that children's gender, finger functioning, and visual-motor status resulted in the correct classification of 77% of the 5th grade participants as good or poor handwriters.

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Further, according to Tseng and Chow (2000), for the normal speed handwriters, age and upper-limb speed and dexterity were two significant predictors. However, age, visual-motor abilities, and visual processing were critical predictors for the slow handwriters. It is widely believed that performance components associated with handwriting include motor planning, eye-hand coordination, visual-motor integration, kinesthetic, and in-hand manipulation (Schneck & Amundson, 2010).

Typical handwriting difficulties for the students are poor legibility, taking longer to finish written class assignments, and the lack of automaticity of handwriting. Handwriting difficulties become apparent when the written work is difficult to read or when children write too slowly to record sufficient quantities of work (Ziviani & Wallen, 2006, chap. 11). Therefore, handwriting quality and quantity could translate into legibility and speed respectively. To identify underlying possible factors relating to poor handwriting is helpful for intervention. Traditional studies of handwriting are restricted to observational outcome-oriented tests. However, computer and digitizer-based technology has led to the development of an innovative approach to handwriting evaluation. That is, a digitizing tablet could provide an insight into the writing process during the actual performance of a written task.

Research on the handwriting in ADHD is relatively scarce. In the study of Tucha and Lange (2001), children with ADHD showed poorer handwriting legibility and accuracy compared to the typical controls when they withdraw from medication by using a digitizing tablet with a wireless pen. Moreover, decreased fluency was identified while children with ADHD were treated on medication (Tucha & Lange, 2004). Brossard-Racine, Majnemer, Shevell, Snider, and Be'linger (2011) argued that poor handwriting legibility and slow writing speed were common in children newly diagnosed with ADHD and were associated with motor abilities. Although preliminary evidence suggests that handwriting difficulties are common to children with ADHD, the factors predicting these task-specific impairments remain to be clarified in this population (Brossard-Racine, Majnemer, Shevell, & Snider, 2008). The core characteristic of developmental coordination disorder (DCD) involves a marked impairment in the development of the motor coordination. This impairment has a negative impact on activities of daily life and academic achievement through poor handwriting skills (Fliers et al., 2008). Many studies have also observed a high co-occurrence of ADHD with DCD (Brossard-Racine et al., 2008, 2011; Flapper, Houwen, & Schoemaker, 2006; Fliers et al., 2008). Pitcher et al. (2003) found poorer fine motor performance in children with both ADHD and DCD than in children with only ADHD. Therefore, previous studies observed children of ADHD with handwriting difficulties may, in part, be due to the co-occurrence of ADHD with DCD, which was not ruled out (Brossard-Racine et al., 2011; Flapper et al., 2006; Piek et al., 1999). The underlying mechanism of the association of ADHD and motor coordination problems remains unclear. However, the handwriting performance of ADHD children without DCD has not been studied and this gap deserves to be filled.

The present study aimed to compare the handwriting performance of ADHD children without DCD to typical developing children by using observational outcome-oriented handwriting assessments as well as with the help of an objective computerized handwriting assessment tool. The purpose of this study was to examine (a) differences in the handwriting performance between children with ADHD and match controls, (b) differences in the motor and perceptual abilities between the two groups, and (c) the relationships between motor and perceptual abilities and handwriting legibility and speed. We hypothesized that ADHD children without DCD would show poorer writing performance than controls. On motor and perceptual tests, ADHD children without DCD would perform more poorly than controls.

2. Methods

2.1. Participants

Data were obtained from a sample of twenty-one children with ADHD (17 male, 4 female; mean age 8.59 ± 1.25 years) and 21 match controls (12 male, 9 female; mean age 8.5 ± 1.08 years) from grade 1 to grade 4. Both groups were matched in age and intelligence quotient (IQ). The ADHD group consisted of children diagnosed with ADHD according to DSM-IV criteria (American Psychiatric Association, 1994), 10 children with a diagnosis of ADHD combined type, 5 children as the hyperactive-impulsive type, and 6 children as the inattentive type. Children with ADHD were recruited through referral by psychologists, pediatric psychiatrists, and through advertisement by Naivety ADHD Taiwan Association. The Chinese version of the Swanson, Nolan and Pehlam version IV scale parent form (SNAP-IV) was used to confirm the diagnosis (Gau et al., 2008). Children with known epilepsy, severe anxiety, or psychotic disorders except conduct disorder and oppositional defiant disorder were excluded from the study. It has been recommended that children scoring at or below the 5th percentile on the Movement Assessment Battery for Children, 2nd edition (M-ABC-2) have significant motor coordination difficulties and may require intervention; children scoring at or below the 15th percentile on M-ABC-2 are thought to have significant motor coordination difficulties, and should be followed and re-assessed periodically to determine if intervention is required (Henderson, Sugden, & Barnett, 2007). Participants who scored below the 15th percentile on the M-ABC-2 were excluded in this study. All children were right-handed. Nine children with ADHD children taking Methylphenidate (MPH) had been off medication for at least 24 h before starting the experimental task. None of the ADHD children was on medication during the experiment.

2.2. Measuring instruments

2.2.1. IQ test and the rating scale

The Chinese version of the Test of Nonverbal Intelligence, 3rd edition (C-TONI, 3rd ed.) was translated from the third version of TONI (Brown, Sherbenou, & Johnsen, 1997) and standardized for children from the ages of 4 years to 16 years

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