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Unique handwriting performance characteristics of children with high-functioning autism spectrum disorder

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ABSTRACT

Knowledge about the handwriting performance characteristics of children with autism spectrum disorder (ASD) is scarce, despite this skill's importance for their academic and social participation. The objective was to compare the handwriting process and product characteristics of children with high-functioning autism spectrum disorder (HFASD) to those of typically developing children to determine the best means of differentiation between the groups. Participants were 60 children, aged 9–12 years; 30 of them were diagnosed with HFASD, and 30 were aged and gender-matched typically developed controls. All participants performed three graded writing tasks on an electronic tablet, which is part of a computerized handwriting evaluation system (ComPET). Their paragraph copying product was then evaluated using the Hebrew Handwriting Evaluation (HHE). Significantly inferior handwriting performance among children with HFASD was found in both handwriting process and product measures. Significant correlations between these measures, supplemented with discriminant analysis and regression analysis results, emphasize unique handwriting performance dynamics among children with HFASD. Evaluation of the characteristics of both the handwriting process and product of children with HFASD may provide a more comprehensive picture of individual deficits. Identifying performance features may lead to more focused and adapted intervention and enhancement of school participation among these children.

1. Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that includes a wide range of complex developmental disabilities. According to the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association [APA], 2013, 5th ed.), ASD involves impaired social interaction and communication, deficits in developing and maintaining relationships, repetitive behaviors, restricted interests, ritualized behaviors, behavioral inflexibility and impaired sensory processing. The severity of the disorder ranges from very low to very high functioning in terms of both the autism symptoms and the intelligence level (APA, 2013).

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Children with High-Functioning Autism Spectrum Disorders (HFASD) have both social deficits and repetitive and stereotyped behaviors. However, they are distinguished from other children with ASD by their relative preservation of linguistic and cognitive development (Volkmar & Lord, 2007). Consequently, individuals with HFASD may function well in literal contexts but may face difficulty using language in a social context (Klin, McPartland, & Volkmar, 2005). Therefore, many children with HFASD are able to use language skills in order to communicate, are capable of participating in typical school activities and participate independently in activities of daily living such as self-care and following classroom routines.

As a result, these children are often integrated into regular school and classroom settings, where they are required to perform various academic tasks such as reading and writing. Handwriting is one of the most important activities in which school aged children engage and is identified by the International Classification of Functioning, Disability and Health—Children and Youth Version, within the Activities and Participation Domain of Health (ICF-CY; World Health Organization, 2007). Despite considerable technological developments, the role of handwriting as a contributing factor to individuals' general perceptual and fine motor skills is being recognized in recent years. As a result, there is a broader call to refrain from abandoning this skill development (Sülzenbrück, Hegele, Rinkenauer, & Heuer, 2011). Indeed, among school-aged children, handwriting is a critical activity necessary for participation in school activities such as class assignments and exams, and is required for 30–60% of the school day (McHale & Cermak, 1992). Good handwriting is considered to be crucial for academic progress, social and communicative development, and development of self-esteem (Cornhill & Case-Smith, 1996; Feder & Majnemer, 2007).

Handwriting is a skill that is assessed relative to both the written product and the handwriting process. The handwritten product may be measured in terms of "readability" or "legibility" which can be measured in two different ways. One is by global evaluation scales, where the written product is used to evaluate legibility by comparison to a group of standard handwriting samples previously classified as "readable" to "unreadable" (Rosenblum, Weiss, & Parush, 2003). Alternatively, more analytically-based evaluations, which consider specific "readability" criteria that can be objectively defined, may be used to measure the concept of readability. These criteria are based on the assumption that a relationship exists between the general appearance, i.e., the readability, and certain performance criteria. The criteria encompassed in the written product, including letter-form, size, slant, spacing and line-straightness, are the result of a consensus of researchers who developed analytic writing scales (Bruinsma & Nieuwenhuis, 1991; Rosenblum, Weiss, et al., 2003).

A functional writing product should be both legible and performed in a reasonable amount of time. Therefore, many handwriting evaluations include a segment that determines writing speed. This is typically calculated either by recording the amount of time required to write a specific text, or by the amount of text reproduced within a specific time period (Rosenblum, Weiss, et al., 2003). While analyzing the written output is important, examining the handwriting process as well may yield further valuable information about the writer's handwriting characteristics. The handwriting process involves, for example, changes in force, direction, velocity and acceleration (Rosenblum, Parush, & Weiss, 2003).

The development of computerized technology over the past thirty years has enabled quantitative measurement of the handwriting process as an alternative to relying solely on assessment of the written product. Additionally, such computerized measurement and analysis can relate to a different set of variables, such as time, space and pressure, during the actual writing activity. Similarly to other skilled performance, the production of legible handwriting requires movement patterns that can be reproduced with little variability in time and space (Longstaff & Heath, 1997). Since a skilled movement is characterized by precise organization in time and space, as well as by appropriate force regulation, documentation of the spatial, temporal and pressure measures while writing supplies important information of the degree of handwriting proficiency.

Previous results have shown that a combined analysis of the both handwriting process and the product allows the discovery of unique characteristics of children with neurodevelopmental diseases such as Attention Deficit Hyperactive Disorders (ADHD) (Rosenblum, Epsztein, & Josman, 2008) and developmental coordination disorders (e.g., Rosenblum, Aassy Margieh, & Engel-Yeger, 2013). These findings may lead to better insight of their possible underlying performance mechanism.

Hans Asperger was the first to describe 'atrocious handwriting' in three of his four original cases of children with the condition later known as Asperger syndrome (Frith, 1991). While translating Asperger's work, Frith described, general handwriting difficulties, as well as identified difficulties with pen control and visual perception. In addition, several impairments in handwriting quality including size, alignment, and spacing were mentioned. Later on, Mayes and Calhoun (2003) also described weakness in writing among school aged children with ASD who have high intelligence. Recent studies that evaluated handwriting quality using standard handwriting assessment instruments reported poor handwriting legibility among children with ASD.

The Test of Legible Handwriting, a holistic measure of overall legibility, did not reveal significant differences between children with ASD and with typical development (TD) (Cartmill, Rodger, & Ziviani, 2009). However, such differences were observed in a more recent study by Fuentes et al. that incorporated the Minnesota Handwriting Assessment (Fuentes, Mosotofsky, & Bastian, 2009; Reisman, 1993). This study found that children with ASD scored significantly lower than their TD peers on the legibility component of the test. Using the Evaluation Tool of Children's Handwriting (ETCH) (Amundson, 1995), Myles et al. (2003) reported that children with ASD produced significantly less legible letters compared to TD, and Henderson and Green (2001) found that only 50% of the written words were legible among children with Asperger syndrome.