
Handwriting Performance, Self-Reports, and Perceived Self-Efficacy Among Children With Dysgraphia

Batya Engel-Yeger, Limor Nagauker-Yanuv, Sara Rosenblum

KEY WORDS

- agraphia
- handwriting
- psychomotor performance
- self-efficacy
- task performance and analysis

OBJECTIVE. This study examined the relationships between children's self-reports on their handwriting performance, their actual handwriting process and product, and wider motor-perceived self-efficacy.

METHOD. Twenty-one children with dysgraphia and 21 typically developing children copied a paragraph on an electronic tablet as part of a Computerized Penmanship Evaluation Tool. Handwriting product was evaluated by the Hebrew Handwriting Evaluation. Participants completed the Children's Questionnaire for Handwriting Proficiency (CHaP) and the Perceived Efficacy and Goal Setting System (PEGS).

RESULTS. The study group's CHaP scores significantly correlated with handwriting process, product measures ($r_s = .46-.59$, $p_s = .034-.005$), and PEGS scores, all of which were significantly poorer compared with those of the control participants.

CONCLUSIONS. Children are aware of their handwriting deficits and are able to report them. Children's reports may contribute to the identification of dysgraphia and facilitate their participation in occupational therapy intervention and in class.

Engel-Yeger, B., Nagauker-Yanuv, L., & Rosenblum, S. (2009). Handwriting performance, self-reports, and perceived self-efficacy among children with dysgraphia. *American Journal of Occupational Therapy*, 63, 182-192.

Batya Engel-Yeger, PhD, is Lecturer, Occupational Therapy Department, Faculty of Social Welfare and Health Sciences, University of Haifa, Mount Carmel, Haifa, Israel 31905; batya@research.haifa.ac.il

Limor Nagauker-Yanuv, MA, is Graduate Student, Department of Occupational Therapy, Faculty of Social Welfare and Health Sciences, University of Haifa, Mount Carmel, Haifa, Israel.

Sara Rosenblum, PhD, is Senior Lecturer, Department of Occupational Therapy, Faculty of Social Welfare and Health Sciences, University of Haifa, Mount Carmel, Haifa, Israel.

Skilled handwriting is an essential activity for school-age children that allows them to write within a reasonable time and to create a readable product through which thoughts and ideas can be communicated (Erhardt & Meade, 2005; Rosenblum, Weiss, & Parush, 2003). Although skilled handwriting is required for 30% to 60% of an average child's school day (McHale & Cermak, 1992), 10% to 30% of school-age children struggle with this activity and, in fact, have handwriting difficulties (Karlsdottir & Stefansson, 2002). Skilled handwriting is a complex activity that entails an intricate blend of cognitive, kinesthetic, and perceptual-motor components (Bonny, 1992; Reisman, 1993).

Handwriting difficulty, or *dysgraphia*, was defined by Hamstra-Bletz and Blote (1993) as a disturbance or difficulty in the production of written language related to the mechanics of handwriting. Two main outcomes have been used to assess and define poor handwriting: product legibility and performance time (Rosenblum et al., 2003). Several studies have found that dysgraphia is most commonly manifested as problems with legibility and slow writing speed. Thus, children with dysgraphia require more time to fulfill handwriting assignments in class (Feder & Majnemer, 2007; Graham, Struck, Santoro, & Berninger, 2006). Moreover, studies on such children's handwriting process indicated that their movements were less mature, their performance was less accurate in space and time, and they required more in-air time (between letters and words) than typically developing writers (e.g., Rosenblum, Weiss, & Parush, 2004; Smits-Engelsman, Van Galen, & Shoemaker, 1998; Van Galen, Portier, Smits-Engelsman, & Shoemaker, 1993).

In addition to legibility and timing deficits, observations by clinicians have revealed that children with dysgraphia erase more, complain about fatigue or hand pain, and are unwilling to write and do their homework (Benbow, 1995; Cornhill & Case-Smith, 1996; Feder, Majnemer, & Synnes, 2000; Tseng & Chow, 2000). All of these signs may be considered to represent a category of physical and emotional well-being (for more details, see Rosenblum, 2008; Rosenblum et al., 2003).

The implications of such deficits for children's well-being need to be considered in light of the central role of handwriting activities for school-age children (Laszlo & Bairstow, 1984; O'Hare, 2004). A child who is struggling with handwriting will find it difficult to keep pace with class assignments or to satisfy parents' expectations (Sovik, Arntzen, & Karlsdottir, 1993). Indeed, several authors have indicated that handwriting difficulties influence children's academic achievements for two main reasons. First, difficulty in the mastery of the mechanical aspects of handwriting, which is a transcription ability, may interfere with higher-order processes required for the composition of text (Berninger & Graham, 1998; Berninger & Hooper, 2006) and, hence, influence the quality and quantity of the written product (Graham, 1990). Second, teachers tend to give higher marks for neatly written papers than for those in which legibility is poor (Briggs, 1980; Chase, 1986; Graham, Harris, & Fink, 2000; Hughes, Keeling, & Tuck, 1983). Moreover, some children who have difficulty mastering handwriting skills may respond by simply giving up, having developed a mindset that they cannot write or compose text (Berninger & Graham, 1998). It thus appears that poor penmanship may influence perceptions about children's competence as writers.

Despite the serious implications of handwriting deficiency for children's academic achievements and well-being, to the best of our knowledge, no data on the subject exist in the literature on children's perceptions or awareness of their handwriting performance. It appears that one reason for this lack of available information is the absence of a standardized tool to use for such purposes. Moreover, according to the client-centered approach, which stresses the need to consider the individual's assessment of his or her own abilities, children's self-reports of their abilities may serve as authentic data on their functioning, maximize their involvement in treatment, and improve treatment efficacy (Law, Baptiste, & Mills, 1995; Northen, Rust, Nelson, & Watts, 1995; Pollock, McColl, & Carswell, 1999).

Based on the client-centered approach, the Children's Questionnaire for Handwriting Proficiency (CHaP) was constructed. It is an adaptation of the Handwriting Proficiency Screening Questionnaire (HPSQ; Rosenblum,

2008), which was designed for use by teachers or therapists to pinpoint handwriting deficiency among school-age children.

Both the HPSQ and the CHaP include the three dimensions of handwriting deficiency described previously: legibility (Items 1, 2, 10), performance time (Items 3, 4, 9), and physical and emotional well-being (Items 5, 6, 7, 8). Hence, information can be gathered both from the teachers and from the children's self-reports on their handwriting performance in terms of those three aspects.

Another question that has not received sufficient attention in the literature concerns the influence of handwriting deficiency on perceived self-efficacy in relation to motor activities among children with dysgraphia. *Self-efficacy* refers to one's internal belief about one's ability to successfully perform a given task rather than to the actual level of the skill itself (Bandura, 1982, 1986). According to Bandura (1990), perceived self-efficacy constitutes the basis for a person's choice about whether or not to attempt a certain task. The person's evaluation of the amount of challenge and energy involved in performing the task may influence the decision to take part in the task and to persist when difficulties arise. High perceived self-efficacy leads to taking on a certain activity, whereas low perceived self-efficacy leads to avoidance (Bandura, 1990).

Among children with dysgraphia, the difficulties in writing may lead to lower perceived self-efficacy and to avoidance of this activity. In the school context, students receive persuasive information from others that can influence their sense of self-efficacy about participating in certain activities (Schunk & Pajares, 2001). Given that writing plays a major role in this context, the negative cycle of handwriting difficulties and low perceived self-efficacy among children with dysgraphia may be perpetuated in relation to their writing abilities as well as other academic abilities. This relationship was reported in previous studies, which found significant relationships between student self-beliefs and academic outcomes and, more specifically, between self-efficacy and the amount of success achieved in certain tasks (Berry & West, 1993). For example, Schunk and Gunn (1986) found that school-age children who believed in their ability to use strategies that were learned to succeed in an exam indeed received higher scores compared with children who doubted their ability to succeed.

Because handwriting has a central occupation in the experiences of school-age children, it is important to have a tool for assessing children's self-reports. An inability to write as desired or to fulfill the expectations of others may affect children's self-efficacy regarding handwriting activity (Feder & Majnemer, 2007). In turn, perceived self-efficacy can mediate outcomes in a wide range of activities (Bandura,

1977). Thus, inadequate handwriting may affect many areas of life, resulting in a loss of self-confidence (Sassoon, 1997).

The Perceived Efficacy and Goal Setting System (PEGS; Missiuna, Pollock, & Law, 2004) is an instrument that enables children with disabilities, such as developmental coordination disorder (DCD), to reflect on their ability to perform everyday occupations requiring motor performance in the home, school, and community environments. Given that handwriting may be related to children's global motor performance and that handwriting deficiencies also characterize children with DCD (American Psychiatric Association, 1994), PEGS may assist in evaluating the impact of handwriting on children's general perceived motor efficacy.

Considering the complex characteristics of handwriting, the aims of the current study were threefold:

1. To examine the differences between children with dysgraphia and typical peers, as expressed in children's self-reports on their handwriting performance;
2. To examine the relation between children's self-reports on their writing performance and their actual handwriting skills (as manifested in process and product measures); and
3. To examine the relation between children's self-reports on their writing performance, their actual handwriting skills, and their wider perceived self-efficacy regarding motor performance in class and in daily living.

Exploring these areas will enable us to elaborate our knowledge about the relation between the activity of handwriting and children's participation in school and in daily living. Through this exploration, the concurrent validity of the CHaP will also be established. Table 1 summarizes the description of independent variables and dependent variables, their definitions, and evaluation instruments.

Methods

Participants

Participants were 42 second and third graders in mainstream schools in Israel, including 21 children with dysgraphia and 21 typically developing children with no handwriting deficiencies. The children were divided into the two groups according to the cutoff score of the HPSQ (Rosenblum, 2008; Rosenblum, Jessel, Adi-Japha, Parush, & Weiss, 1997), which was completed by their teachers. Exclusion criteria included developmental delays, positive neurological findings, chronic diseases and syndromes, learning disabilities, uncorrected vision impairments, and treatment with medications (as reported by the parents) that affect the functioning of the nervous system. All children were recruited through an advertisement calling for participation in a study to evaluate children's handwriting performance and self-perception. Parents who agreed to their child's participation in the study were asked to fill out the demographic questionnaire.

Instruments

Demographic Questionnaire. We composed the demographic questionnaire, which included data on family sociodemographic status, child's health status, medications, treatments, and paramedical therapies.

HPSQ. The HPSQ (Rosenblum, 2008; Rosenblum et al., 1997) is a 10-item questionnaire that was developed to identify school-age children with handwriting difficulties. The 10 items cover the most important indicators of handwriting deficiencies in the following three domains (Alston, 1983; Cornhill & Case-Smith, 1996; Rubin & Henderson, 1982):

Table 1. Description of Independent Variables and Dependent Variables, Their Definitions, and Evaluation Instruments

	Variable Name	Definition	Instruments That Operationalize the Construct for This Study	
Independent variables	Dysgraphia vs. typical writing abilities	Handwriting difficulties in the production of written language	Handwriting Proficiency Screening Questionnaire	
Dependent variables	Children's self-reports on their handwriting performance	Children's reports based on their perceptions or awareness of their handwriting performance	Children's Questionnaire for Handwriting Proficiency	
	Actual handwriting skills	Handwriting process	Temporal, spatial, and pressure measures for each written segment and performance over the entire paragraph	Computerized Penmanship Evaluation Tool
		Handwriting product	Legibility/clarity expressed in number of erased letters, unrecognizable letters, spatial arrangement of the written text	Hebrew Handwriting Evaluation
	Perceived self-efficacy regarding motor performance in class and in daily living	Children's perceived ability to perform everyday occupations requiring motor performance	Perceived Efficacy and Goal Setting System	

legibility (Items 1, 2, 10), performance time (Items 3, 4, 9), and physical and emotional well-being (Items 5, 6, 7, 8). The items are worded so as to be directly answerable by teachers from their observations of children as they are writing in the classroom; for example, “Does the child often erase while writing?” The items are scored on a 5-point Likert scale, ranging from 0 (*never*) to 4 (*always*), with higher scores indicating poorer performance. The final score is computed by summing the scores of all the 10 test items. The questionnaire’s content validity, internal consistency, interrater, and test–retest reliability have been established (see Rosenblum, 2008, for more details)

CHaP. The CHaP is in the development stage. It includes the same 10 items as the HPSQ, covering legibility, performance time, and physical and emotional well-being, but it is directed toward the child. For example, the child is asked, “Is your handwriting illegible at times?” or “Do you often erase while writing?” The items are scored on the same 5-point Likert scale, with a higher score representing more difficulties in handwriting performance.

In a study under way with 230 children to establish the CHaP’s reliability and validity, the internal reliability was found to be .77. The current study found the Cronbach’s alpha of this questionnaire to be .79, showing a moderate internal consistency. Further details about the questionnaire’s concurrent and construct validity will be forthcoming.

Computerized Penmanship Evaluation Tool. The Computerized Penmanship Evaluation Tool (CompPET—previously referred to as POET; Rosenblum, Parush, & Weiss, 2003a) is a standardized and validated handwriting assessment that uses a digitizing tablet and online data collection and analysis software. It was developed for the purpose of collecting objective measures of the handwriting process (see Rosenblum et al., 2003, for more details; Figure 1).

In the current study, a paragraph-copying task (Figure 2) was performed on A4-size lined paper affixed to the surface of an Intuos II x–y digitizing tablet (404 × 306 × 10 mm; WACOM, Co., Ltd., Saitama, Japan), using a wireless electronic pen with a pressure-sensitive tip (Model GP–110). This pen is similar in size and weight to regular pens commonly used by children and thus does not require them to change the grip they would ordinarily use or otherwise affect their handwriting performance (see Figure 1).

Displacement, pressure, and pen tip angle were sampled at 100 Hz by means of a 1300 MHz Pentium M® laptop computer. The CompPET system analyzes each writing segment. The primary outcome measures consisted of temporal, spatial, and pressure measures for each segment as well as performance over the entire paragraph. The temporal measures included the total time taken to complete the entire

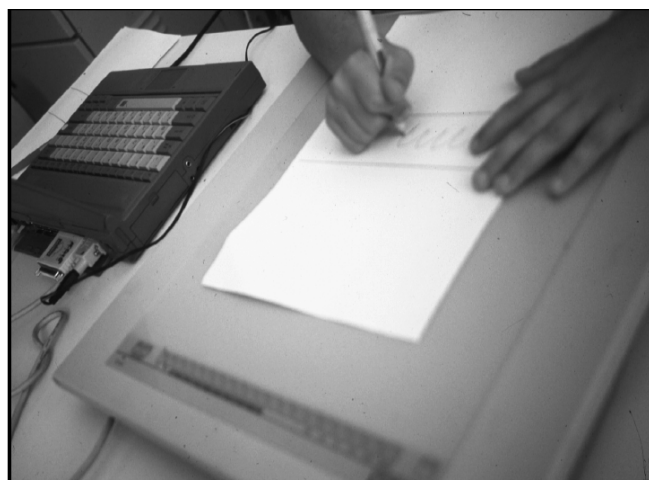


Figure 1. Computerized Penmanship Evaluation Tool (CompPET), including laptop computer, digitizer, and evaluation software.

paragraph, on-paper time, and in-air time (i.e., the time during the writing task in which the pen is not in contact with the writing surface; Rosenblum, Parush, & Weiss, 2003b). The spatial measure used was the total path length on the paper of all the characters written in the paragraph (Figure 3). In addition, the CompPET computes the mean pressure applied to the paper, as measured in nonscaled units from 0 to 1,024, as well as the mean handwriting velocity.

The CompPET demonstrates good validity and reliability. Four occupational therapy experts confirmed the face validity and suitability of the CompPET paragraph-copying task for handwriting performance evaluation. Moreover, the discriminant validity of the CompPET system was determined by the finding of significant differences between the performance of children with poor and with proficient handwriting for the system’s spatial and temporal measures (Rosenblum, Parush, et al., 2003a, 2003b; Rosenblum, Weiss, et al., 2004).

Rosenblum (2008) determined the test–retest reliability of this system on a sample of 30 typical adults ages 20 to 40

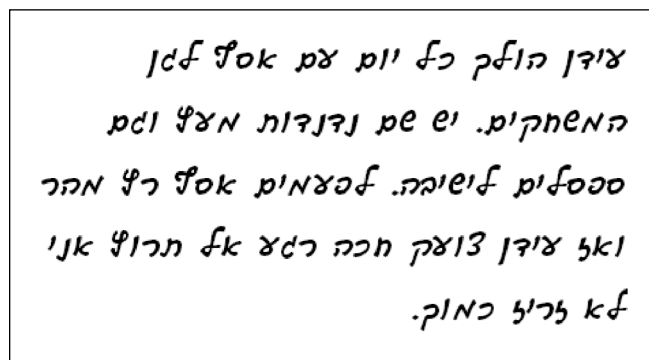


Figure 2. The paragraph writing task.

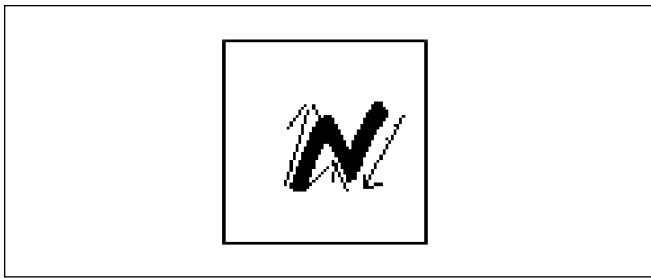


Figure 3. Written characters' total path length.

by demonstrating that no significant differences existed between their first and second handwriting performance by means of the objective measures of the CompPET. For example, no significant differences were found in total time of performance ($t[28] = 1.39, p = .18$), total length of pen excursion ($t[28] = 0.61, p = .54$), number of writing segments ($t[28] = 0.41, p = .68$), or writing velocity ($t[28] = 0.28, p = .77$; see Rosenblum [2008] for more details).

Hebrew Handwriting Evaluation. The Hebrew Handwriting Evaluation (HHE; Erez & Parush, 1999) consists of a standardized paragraph that is used to assess the legibility of the handwriting product through both global and analytic measures. The text contains all the letters in the Hebrew alphabet and includes 30 words and 107 letters (Erez & Parush, 1999). Global legibility, which is an outcome measure that refers to the clarity of the handwriting, is scored on a 4-point Likert scale, ranging from 1 (*most legible*) to 4 (*least legible*). The number of letters written during the 1st min is also recorded.

The analytic measurements of legibility used in the HHE consist of three variables: (1) letters erased or overwritten—the number of letters that were erased or written over; (2) unrecognizable letters—the total number of letters that could not be recognized because of the quality of letter closure, rounding of letters, or letter reversals; and (3) spatial arrangement of the written text, as determined in accordance with detailed and precise criteria, using a caliper calibrated to the millimeter. Specifically, these criteria refer to the vertical alignment of letters (including the extensions of letters previously mentioned and below the lines), the spacing of words and letters (whether too wide or overlapping), and letter size. The minimum score for spatial arrangement is 6, and the maximum score is 24. For all four outcome measures of the HHE, a low score indicates good performance and a high score indicates poor performance.

In a study conducted with 230 children, the interrater reliability of the HHE was found to be .75 to .79 ($p < .01$). All 230 handwriting product samples were analyzed by the same evaluator, who was certified in HHE administration after completing a course conducted by the tool developers for this purpose. The construct validity of the HHE was

established by demonstrating statistically significant differences ($t[228] = -2.34, p = .027$) between the performance of children with proficient and with poor handwriting (Dvash, Levi, Traub, & Shapiro, 1995).

PEGS. The PEGS (Missiuna et al., 2004) evaluates children's perceived ability to perform everyday occupations requiring motor performance in the home, school, and community environments. PEGS uses colorful picture cards that illustrate 24 tasks essential to daily living, which are divided into three subscales. The first includes 5 items that refer to self-care, the second includes 9 items that refer to school and productivity, and the third includes 10 items that refer to leisure. These cards are presented to the child in pairs, with one picture depicting a child performing a daily task competently and the other showing a child demonstrating less competence. The evaluator reads the statements under each picture and then asks the child to select which picture is most like him or her. The evaluator then asks the child whether the picture is "a lot" or "a little" like him or her and places the cards into four piles reflecting the child's stated competence ("a lot" or "a little" like the less competent child and "a lot" or "a little" like the more competent child). The score for each item ranges from 1 (*a lot like the less competent child*) to 4 (*a lot like the more competent child*). The manual reports good construct and content validity. Test-retest reliability ranges from .95 to .99, and internal consistency ranges from .92 to .98 (Missiuna et al., 2004).

Procedure

Ethical approval of the study was received from the Ministry of Education in Israel. Identification of the participants as having dysgraphia was done using the cut-off scores of the HPSQ. Children who met the inclusion criteria were invited to a quiet room in their school and completed the CHaP, the PEGS, and the copying task from the HHE through use of the CompPET. The handwriting products were subsequently evaluated according to the HHE criteria.

Data Analysis

The statistical analysis was performed using SPSS-13 (SPSS, Inc., Chicago). t tests were used to test differences between the HPSQ total scores of both groups. Because non-normal distributions were found in the additional measured items, Mann-Whitney tests were used to evaluate the significance of differences between the groups in regard to the scores of the CHaP, the scores of the PEGS, and the handwriting processes and products as measured by the CompPET and HHE. Spearman correlations were used to evaluate the significance of correlations between the different measures. Finally, a discriminant analysis was conducted to determine which variables (CompPET, HHE measures, and CHaP

subscales) were the best predictors of group membership (i.e., children with dysgraphia vs. control participants).

The level of significance for all performed analyses was set at .05.

Results

The study group consisted of 15 boys and 6 girls; mean age was 8 ± 0.62 years. The control group consisted of 15 boys and 6 girls; mean age was 8 ± 0.47 years. In both groups, 19 of the children were right handed and 2 were left handed.

Differences Between the Groups According to the Teachers' Reports in the HPSQ

Children with dysgraphia scored significantly worse than the children with typical handwriting on each subscale of the HPSQ (Table 2).

Differences Between the Groups in Handwriting Processes and Products

Children with dysgraphia showed significantly worse handwriting skills than the control participants in most handwriting processes, as measured by the ComPET, and in all handwriting products, as measured by the HHE (Tables 3 and 4).

Differences Between the Groups According to CHaP

First, the internal consistency of the CHaP was examined in each group. Medium-high reliability was found: Cronbach's alpha was .76 in the dysgraphic group and .69 in the control group. Children with dysgraphia had significantly higher CHaP total scores than the control participants ($U = 125$, $p = .016$; see Table 5), indicating that they expressed more negative feelings about their handwriting performance. Although their scores were higher than those of the control participants on all three CHaP subscales, the difference between the groups was significant only for the time performance subscale ($U = 114$, $p = .007$).

Relationship Between Children's Reports on the CHaP and Handwriting Processes and Products Among Children With Dysgraphia

With regard to handwriting processes, a significant positive correlation was found between the CHaP time performance subscale and the ComPET measure of total path length ($r = .464$, $p = .034$). The CHaP physical and emotional well-being subscale was also positively correlated with total path length ($r = .594$, $p = .005$) and with mean handwriting velocity ($r = .537$, $p = .012$). Thus, lower scores on these CHaP subscales were correlated with lower handwriting performance, as measured by the ComPET. When referring to handwriting product measures, the CHaP legibility subscale and the CHaP time performance subscale were significantly correlated with the number of letters that were erased or written over ($r = .456$, $p = .038$; $r = .513$, $p = .017$, respectively).

Relation Among Children's Reports on the CHaP, PEGS Total Scores, and Mean Scores of PEGS Subscales Among Children With Dysgraphia

Significant negative correlations were found between the PEGS total scores and all three CHaP subscales; that is, the legibility subscale ($r = -.531$, $p = .013$), the time performance subscale ($r = -.521$, $p = .015$), and the physical and emotional well-being subscale ($r = -.573$, $p = .007$). More specifically, the CHaP legibility and time performance subscales had significant negative correlations with the PEGS school/productivity subscale mean scores ($r = -.447$, $p = .047$ and $r = -.492$, $p = .024$, respectively). Thus, the less that children feel their handwriting is legible and the less capable they feel of keeping pace with time constraints in class, the lower their perceived self-efficacy.

Moreover, significant negative correlations were also found between the CHaP legibility and time performance subscales and the PEGS leisure subscale mean scores ($r = -.55$, $p = .01$ and $r = -.517$, $p = .016$, respectively). Thus, children who struggle with handwriting performance (legibility and time constraints) also have low perceived self-efficacy with respect to participation in leisure activities.

Table 2. Comparison of the Subscale Mean Scores of the Handwriting Proficiency Screening Questionnaire for Both Groups

Subscale	Children With Dysgraphia ($n = 21$)		Control Participants ($n = 21$)		Mann-Whitney U	$p <$
	Mean	SD	Mean	SD		
Legibility	1.97	0.35	0.76	0.56	9.0	.0001
Time performance	2.36	0.45	1.00	0.66	19.5	.0001
Physical and emotional well-being	1.92	0.58	2.58	0.45	11.5	.0001
Total mean score	20.76	3.47	7.62	4.25	0	.0001

Note. SD = standard deviation.

Table 3. Significant Differences in Writing Measures in the Writing Assignment Between the Groups According to the Computerized Penmanship Evaluation Tool

Writing Measure	Children With Dysgraphia (<i>n</i> = 21)		Control Participants (<i>n</i> = 21)		Mann–Whitney <i>U</i>	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>		
Total time	353.89	176.83	210.30	16.47	90	.001
On-paper time	90.41	69.50	63.50	16.47	140	.043
In-air time	263.47	123.19	149.49	61.40	42	.001
Total path length	5.59	1.97	3.54	1.15	85	.001
Mean pressure	765.05	78.01	782.90	92.85	180	ns
Mean writing velocity	24.81	8.58	23.37	3.82	213	ns

Note. *SD* = standard deviation; *ns* = not significant.

Table 4. Significant Differences in Writing Measures in the Writing Assignment Between the Groups According to the Hebrew Handwriting Evaluation

Writing Measure	Children With Dysgraphia (<i>n</i> = 21)		Control Participants (<i>n</i> = 21)		Mann–Whitney <i>U</i>	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>		
Global legibility	3.43	0.59	1.47	0.51	5	.0001
Number of letters written during the first minute	22.29	9.90	39.05	11.43	53.5	.0001
Letters erased or overwritten	7.38	5.49	2.24	2.07	69.5	.0001
Unrecognizable letters	14.67	13.21	3.67	2.08	38.0	.0001
Spatial arrangement	9.48	2.18	6.33	0.73	28.0	.0001

Note. *SD* = standard deviation; *ns* = not significant.

Table 5. Significant Differences in Writing Measures in the Children's Questionnaire for Handwriting Proficiency Subscales

Subscale	Children With Dysgraphia (<i>n</i> = 21)		Control Participants (<i>n</i> = 21)		Mann–Whitney <i>U</i>	<i>p</i>
	Mean	<i>SD</i>	Mean	<i>SD</i>		
Legibility	1.43	0.97	1.00	0.73	168	ns
Time performance	1.49	1.06	0.65	0.65	114	.007
Physical and emotional well-being	1.17	0.89	0.83	0.71	165.5	ns

Note. *SD* = standard deviation; *ns* = not significant.

According to these results, children who had worse feelings about their handwriting performance scored lower in self-efficacy on PEGS.

Discriminant Analysis

To assess the relative importance of the different variables in differentiating between children in both groups, a discriminant analysis was performed. The purpose of performing the discriminant analysis was to explore the possible contribution of children's self-reports on their handwriting performance to the identification of children with dysgraphia.

All of the independent variables that were shown to differ significantly between the groups in prior statistical testing were included in the analysis: handwriting process measures (total time and in-air time), handwriting product measures (global legibility, the number of letters written during the first minute, the number of letters erased or overwritten, the number of unrecognizable letters, and the total score for spatial arrangement of the written text), and the time performance subscale from the CHaP questionnaire.

One discriminant function was found for group classification of all participants (Wilks' $\lambda = .26, p < .001$). As shown in Table 6, the variables that made the greatest contribution to group membership were the spatial arrangement (HHE) final score (.59), the number of letters written in the first minute (HHE; $-.48$), and the number of letters erased or overwritten (HHE; $.38$). The values of the other measures

Table 6. Discriminant Analysis Structure Matrix Predictors' Loading Values

	Function
Spatial arrangement (HHE)	.594
Number of letters written in the first minute (HHE)	-.482
Number of letters erased or overwritten (HHE)	.381
In-air time (CompPET)	.360
Unrecognizable letters (HHE)	.358
Total time (CompPET)	.329
CHaP time subscale	.293
Global legibility (HHE)	.064

Note. HHE = Hebrew Handwriting Evaluation, COMPET = Computerized Penmanship Evaluation Tool, CHaP = Children's Questionnaire for Handwriting Proficiency.

are also presented in Table 6. Based on this one function, 95.2% of the dysgraphic group and 100% of the control group were correctly grouped. A kappa value of .95 ($p < .001$) was calculated, demonstrating that the group classification did not occur by chance.

Discussion

The current study emphasizes the role of handwriting as a central occupation of school-age children. Occupation-focused practice aims to move beyond impairment reduction to allow clients meaningful participation in life occupations (Christiansen, 1999; Kielhofner, 2002; Wilcock, 2001). Moreover, client-centered intervention stresses the need to consider the individual's assessment of his or her own abilities. This study evaluated whether children's self-reports on their handwriting performance do in fact correspond with their actual performance, as evaluated by handwriting process and product measures. Moreover, the study examined whether deficits in handwriting performance will be manifested in children's wider perceived self-efficacy regarding motor performance in class and in daily living.

The results of this study provide support for the relationship between the activity of handwriting and children's participation in school and in daily living. Children spend a large amount of time at school, and the feedback of teachers and peers may have a great impact on a child's development and participation as a student. Moreover, difficulties with handwriting in the early years may predict general learning difficulties later on (Harvey & Henderson, 1997; Simner, 1982, 1985, 1986, 1990), and problems that stem from difficulties in handwriting may become more complicated and difficult to resolve. Thus, it is of the utmost importance to screen handwriting deficiencies as early as possible, even in the first years of school.

Given that handwriting is a highly dynamic process and that handwriting deficiencies may have complex outcomes, clients' involvement in the goal-setting process should be a high priority (Law et al., 1994; Northen et al., 1995). Not only should handwriting evaluation be performed as early as possible and refer to both handwriting processes and products, it should also consider the extent to which these parameters correspond to children's self-reports regarding their handwriting performance. In addition, this early evaluation should take into account children's perceptions of the ways in which these abilities relate to other tasks and contexts and meaningful environments, such as school, home, and community.

The CHaP, which is a new self-report questionnaire, was shown to serve as an appropriate tool for this purpose. Children's self-reports on their handwriting performance

were obtained using the CHaP. When examining the relationship between the CHaP and handwriting process and product measures, it was found that children with dysgraphia who exhibited lower self-efficacy regarding handwriting abilities indeed had impaired handwriting processes and products, as manifested in impaired fluency and spatial arrangement and slower handwriting velocity.

The results provide us with insight into the experience of children with dysgraphia and their difficulties in organizing themselves in the writing space. Their practice of making more corrections and thus staying for a longer time with their pen on the paper results in longer performance time for accomplishing handwriting assignments. These dynamics are in line with previous reports that attribute "poor" handwriting to inappropriate spacing between letters or words, incorrect or inconsistent shaping of letters, letter inversions, and mixing of different letter forms (i.e., script and square; Hamstra-Bletz & Blote, 1993; Maeland & Karlsdottir, 1991; Rubin & Henderson, 1982; Sovik, Arntzen, & Thygesen, 1987a, 1987b). All of these factors lead to increased cognitive demands (Berninger & Graham, 1998; Jones & Christensen, 1999), make handwriting tasks longer, and contribute to the fact that handwriting among children with dysgraphia does not become automatic (Scardamalia, Bereiter, & Goleman, 1982).

These factors may explain the relationships found between the handwriting processes and products and each of the CHaP subscales, that is, the time performance, legibility, and physical and emotional well-being subscales. Moreover, these results are strengthened by the discriminant analysis, which showed that spatial arrangement, the number of letters erased or overwritten, and the number of letters written during the first minute contributed most to group membership in this study. These results support the relationships but must be viewed with caution in light of the small sample size.

Considering time constraints in class, teachers may pressure children to complete a given handwriting task while the other children who already completed the task must wait. When a child with dysgraphia compares his or her performance to that of typical peers in the class, it may negatively affect his or her sense of self-efficacy regarding handwriting performance. In addition, teachers tend to give higher marks for neatly written papers than for messy ones (Briggs, 1980; Chase, 1986; Hughes et al., 1983). These findings may enhance awareness among teachers about the negative consequences of handwriting deficiencies as well as the need for early screening of children with dysgraphia. After identifying a child who writes slowly, teachers should refer the child for a handwriting evaluation to minimize these negative outcomes.

As for occupational therapists, this preliminary report points to the need for further studies to strengthen the results and to elaborate the knowledge about spatial and temporal deficiencies of children with dysgraphia reported in previous studies (Smits-Engelsman, Van Galen, & Michels, 1995; Smits-Engelsman et al., 1998; Van Galen et al., 1993). Based on all measured handwriting products and processes examined in the current study, it is suggested that the intervention process be focused on the internalization of letter forms, spaces between letters, and spatial organization to improve handwriting performance (Berninger et al., 1997). In addition, this intervention should be accompanied by information from the child regarding his or her handwriting abilities so as to provide a better understanding about the way in which handwriting deficiencies affect the specific child and about the child's strategies of coping with those deficiencies. Such an approach may aid in setting intervention goals and, as Young, Yoshida, Williams, Bombardier, and Wright (1995) stated, may help the child to take responsibility for his or her own deficiency management.

From a broader perspective, the relationships found between the CHaP and PEGS total scores, as well as the PEGS subscale scores, point to the connection between handwriting deficits and motor performance in daily living, as expressed in leisure and self-care activities. Some authors have claimed that self-efficacy evaluation should be task focused (Gage & Polatajko, 1994), but the current study provides preliminary support for Bandura's (1990) theory that perceived self-efficacy mediates outcomes in a wide range of activities.

Limitations of This Study

The current study is based on a relatively small sample and refers to specific ages. In addition, only children whose parents agreed to their participation in the study were included in the sample. Moreover, the exclusion decision was based on parents' reports. Other children with dysgraphia whose parents did not allow their participation in the study might contribute to a greater diversity in the results and interpretations. These limitations should be considered in interpreting and generalizing the present results. Additional studies on larger samples of children with a wider age range should be performed to strengthen these results.

Despite the limitations, the current results highlight the need to enhance our understanding of the factors that affect the choices of children with dysgraphia and that facilitate their participation, as suggested by previous studies (Law, 2002; Law & Dunn, 1993). By using tools such as PEGS and CHaP, which provide useful data about a child's functioning and participation, we can better meet the child's

needs, maximize the child's involvement in treatment, and improve the treatment efficacy. In turn, the child's self-efficacy and self-confidence may be elevated, thereby encouraging the child's optimal participation in school and in activities of daily living. ▲

References

- Alston, J. (1983). A legibility index: Can handwriting be measured? *Educational Review, 35*, 237–242.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Bandura, A. (1977). Toward a unifying theory of behavioral change. *Psychological Review, 84*, 101–215.
- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 97–102.
- Bandura, A. (1986). *Social foundations of thought*. New York: Prentice Hall.
- Bandura, A. (1990). Some reflections on reflections. *Psychological Inquiry, 1*, 101–105.
- Benbow, M. (1995). Principles and practices of teaching handwriting. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child* (pp. 255–281). St. Louis, MO: Mosby.
- Berninger, V. W., & Graham, S. (1998). Language by hand: A synthesis of a decade of research on handwriting. *Handwriting Review, 12*, 11–25.
- Berninger, V. W., & Hooper, S. R. (2006). Introduction to special issue on writing. *Development Neuropsychology, 29*(1), 1–4.
- Berninger, V. W., Vaughan, K. B., Abbott, R. D., Abbott, S. P., Woodruff, R., Brooks, A., et al. (1997). Treatment of handwriting problems in beginning writers: Transfer from handwriting to composition. *Journal of Educational Psychology, 89*, 652–666.
- Berry, J. M., & West, R. L. (1993). Cognitive self-efficacy in relation to personal mastery and goal setting across the life span. *International Journal of Behavioral Development, 16*, 351–379.
- Bonny, A. M. (1992). Understanding and assessing handwriting difficulties: Perspective from the literature. *Australian Occupational Therapy Journal, 39*, 7–15.
- Briggs, D. (1980). A study of the influence of handwriting upon grades using examination scripts. *Educational Review, 32*, 185–193.
- Chase, C. I. (1986). Essay test scoring: Interaction of relevant variables. *Journal of Educational Measurement, 23*(1), 33–41.
- Christiansen, C. (1999). Defining Lives—Occupation as identity: An essay on competence, coherence, and the creation of meaning. *American Journal of Occupational Therapy, 53*, 547–558.
- Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy, 50*, 732–737.
- Dvash, L. E., Levi, M. R., Traub R., & Shapiro M. (1995). *Reliability and validity of the Hebrew Handwriting Evaluation*. Unpublished thesis, School of Occupational Therapy, Faculty of Medicine, Hebrew University, Jerusalem.
- Erez, N., & Parush, S. (1999). *The Hebrew Handwriting Evaluation* (2nd ed.). Jerusalem: Hebrew University, School of Occupational Therapy.

- Erhardt, R., & Meade, V. (2005). Improving handwriting without teaching handwriting: The consultative clinical reasoning process. *Australian Occupational Therapy Journal*, 52, 199–210.
- Feder, K. P., & Majnemer, A. (2007). Handwriting development, competency, and intervention. *Development Medicine and Child Neurology*, 49, 312–317.
- Feder, K. P., Majnemer, A., & Synnes, A. (2000). Handwriting: Current trends in occupational therapy practice. *Canadian Journal of Occupational Therapy*, 67, 197–204.
- Gage, M., & Polatajko, H. (1994). Enhancing occupational performance through an understanding of perceived self-efficacy. *American Journal of Occupational Therapy*, 48, 452–461.
- Graham, S. (1990). The role of production factors in learning disabled students' compositions. *Journal of Educational Psychology*, 82, 781–791.
- Graham, S., Harris, K. R., & Fink, B. (2000). Is handwriting causally related to learning to write? Treatment of handwriting problems in beginning writers. *Journal of Educational Psychology*, 4, 620–633.
- Graham, S., Struck, M., Santoro, J., & Berninger, V. W. (2006). Dimensions of good and poor handwriting legibility in first and second graders: Motor programs, visual-spatial arrangement, and letter formation parameter setting. *Developmental Neuropsychology*, 29, 43–60.
- Hamstra-Bletz, L., & Blote, A. (1993). A longitudinal study on dysgraphic handwriting in primary school. *Journal of Learning Disabilities*, 26, 689–699.
- Harvey, C., & Henderson, S. (1997). Children's handwriting in the first three years of school: Consistency over time and its relationship to academic achievement. *Handwriting Review*, 11, 8–25.
- Hughes, D. C., Keeling, B., & Tuck, B. F. (1983). Effects of achievement expectations and handwriting quality on scoring essays. *Journal of Educational Measurement*, 20, 65–70.
- Jones, D., & Christensen, C. A. (1999). Relationship between automaticity in handwriting and students' ability to generate written text. *Journal of Educational Psychology*, 91, 44–49.
- Karlsdottir, R., & Stefansson, T. (2002). Problems in developing functional handwriting. *Perceptual and Motor Skills*, 94, 623–662.
- Kielhofner, G. (2002). *A Model of Human Occupation: Theory and application* (3rd ed.). Baltimore: Williams & Wilkins.
- Laszlo, J. I., & Bairstow, P. J. (1984). Handwriting: Difficulties and possible solutions. *School Psychology International*, 5, 207–213.
- Law, M. (2002). Participation in the occupations of everyday life. *American Journal of Occupational Therapy*, 56, 640–649.
- Law, M., Baptiste, S., & Mills, J. (1995). Client-centered practice: What does it mean and does it make a difference? *Canadian Journal of Occupational Therapy*, 62, 250–257.
- Law, M., & Dunn, W. (1993). Perspectives on understanding and changing the environments of children with disabilities. *Physical and Occupational Therapy in Pediatrics*, 13(3), 1–17.
- Law, M., Polatajko, H., Pollock, N., McColl, M. A., Carswell, A., & Baptiste, S. (1994). Pilot testing of the Canadian Occupational Performance Measure: Clinical and measurement issues. *Canadian Journal of Occupational Therapy*, 61, 191–197.
- McHale, K., & Cermak, S. A. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy*, 46, 898–903.
- Maeland, A. F., & Karlsdottir, R. (1991). Development of reading, spelling, and writing skills from third to sixth grade in normal and dysgraphic school children. In J. Wann, A. M. Wing, & N. Sovik (Eds.), *Development of graphic skills* (pp. 179–184). London: Academic Press.
- Missiuna, C., Pollock, N., & Law, M. (2004). *Perceived Efficacy and Goal Setting System* (PEGS). San Antonio, TX: Psychological Corporation.
- Northen, J. G., Rust, D. M., Nelson, C. E., & Watts, J. H. (1995). Involvement of adult rehabilitation patients in setting occupational therapy goals. *American Journal of Occupational Therapy*, 49, 214–220.
- O'Hare, A. (2004). Hands up for handwriting. *Developmental Medicine and Child Neurology*, 46, 651–651.
- Pollock, N., McColl, M. A., & Carswell, A. (1999). The Canadian Occupational Performance Measure. In T. Sumsion (Ed.), *Client-centered practice in occupational therapy* (pp. 107–114). Edinburgh, Scotland: Harcourt Brace.
- Reisman, J. E. (1993). Development and reliability of the research version of the Minnesota Handwriting Test. *Physical and Occupational Therapy in Pediatrics*, 13, 41–55.
- Rosenblum, S. (2008). Development, reliability, and validity of the Handwriting Proficiency Screening Questionnaire (HPSQ). *American Journal of Occupational Therapy*, 62, 298–307.
- Rosenblum, S., Jessel, A., Adi-Japha, E., Parush, S., & Weiss, P. L. (1997, August). Quantitative characteristics of normal and dysgraphic children in Hebrew script. In *Proceedings of the 8th Biennial Conference of the International Graphonomics Society* (pp. 71–72). Genoa, Italy: ART.
- Rosenblum, S., Parush, S., & Weiss, P. L. (2003a). Computerized temporal handwriting characteristics of proficient and poor handwriters. *American Journal of Occupational Therapy*, 57, 129–138.
- Rosenblum, S., Parush, S., & Weiss, P. L. (2003b). The In Air phenomenon: Temporal and spatial correlates of the handwriting process. *Perceptual and Motor Skills*, 96, 933–954.
- Rosenblum, S., Weiss, P. L., & Parush, S. (2003). Product and process evaluation of handwriting difficulties. *Educational Psychology Review*, 15, 41–81.
- Rosenblum, S., Weiss, P. L., & Parush, S. (2004). Handwriting evaluation for developmental dysgraphia: Process versus product. *Reading and Writing*, 17, 433–458.
- Rubin, N., & Henderson, S. E. (1982). Two sides of the same coin: Variation in teaching methods and failure to learn to write. *Special Education: Forward Trends*, 9, 17–24.
- Sassoon, R. (1997). Dealing with adult handwriting problems. *Handwriting Review*, 11, 69–74.
- Scardamalia, M., Bereiter, C., & Goleman, H. (1982). The role of production factors in writing ability. In M. Nystrand (Ed.), *What writers know: The language process and structure of written discourse* (pp. 173–210). New York: Academic Press.
- Schunk, D. H., & Gunn, T. P. (1986). Self-efficacy and skill development: Influence of task strategies and attributions. *Journal of Educational Research*, 79, 238–244.
- Schunk, D. H., & Pajares, F. (2001). The development of academic self-efficacy. In A. Wigfield & J. Eccles (Eds.), *Development*

of achievement motivation (pp. 16–32). San Diego: Academic Press.

Simner, M. L. (1982). Printing errors in kindergarten and the prediction of academic performance. *Journal of Learning Disabilities, 15*, 155–159.

Simner, M. L. (1985). *Printing Performance School Readiness Test*. Toronto: Guidance Centre, Faculty of Education, University of Toronto, Ontario.

Simner, M. L. (1986). Further evidence on the relationship between form errors in preschool printing and early school achievement. In H. S. R. Kao, G. P. Van Galen, & R. Hoosian (Eds.), *Graphonomics: Contemporary research in handwriting* (pp. 107–120). Amsterdam: Elsevier.

Simner, M. L. (1990). Printing performance school readiness test. *Academic Therapy, 25*, 369–375.

Smits-Engelsman, B. C. M., Van Galen, G. P., & Michels, C. G. J. (1995). De leekrach beoordeeld: Inschatting van schrijfvaardigheidsproblemen en motorisch achterstand bij basisschool leerlingen [Prevalence of poor handwriting and the validity of estimation of motor proficiency and handwriting performance by teachers]. *Tijdschrift voor Onderwijsresearch, 20*, 1–15.

Smits-Engelsman, B. C. M., Van Galen, G. P., & Shoemaker, M. M. (1998). Theory-based diagnosis and sub-classification in the developmental coordination disorder. In J. Rispen, T. A. Van Yperen, & W. Yule (Eds.), *Perspective on the classifica-*

tion of specific developmental disorders (pp. 245–264). London: Academic Press.

Sovik, N., Arntzen, O., & Karlsdottir, R. (1993). Relationship between writing speed and some parameters in handwriting. *Journal of Human Movement Studies, 25*, 133–150.

Sovik, N., Arntzen, O., & Thygesen, R. (1987a). Relation of spelling and writing in learning disabilities. *Perceptual Motor Skills, 64*, 219–236.

Sovik, N., Arntzen, O., & Thygesen, R. (1987b). Writing characteristics of “normal,” dyslexic, and dysgraphic children. *Journal of Human Movement Studies, 31*, 171–187.

Tseng, M. H., & Chow, S. M. K. (2000). Perceptual–motor function of school-age children with slow handwriting speed. *American Journal of Occupational Therapy, 54*, 83–88.

Van Galen, G. P., Portier, S. J., Smits-Engelsman, B. C. M., & Shoemaker, L. R. B. (1993). Neuromotor noise and poor handwriting in children. *Acta Psychologica: European Journal of Psychology, 82*, 161–178.

Wilcock, A. A. (2001). Occupational science: The key to broadening horizons. *British Journal of Occupational Therapy, 4*(2), 56–61.

Young, N. L., Yoshida, K. K., Williams, J. I., Bombardier, C., & Wright, J. G. (1995). The role of children in reporting their physical disability. *Archives of Physical Medicine and Rehabilitation, 76*, 913–918.

AOTA Bestseller!

AOTA's Self-Paced Clinical Course

The Hand

An Interactive Study for Therapists

By Judy Colditz, OTR/L, CHT, FAOTA



This SPCC combines written coursework with interactive computer-based learning and examines the anatomical basis and clinical presentation of problems in the hand and forearm. Using the CD-ROM, *The Interactive Hand: Therapy Edition*, you will explore the multiple layers of complex anatomy while learning about palpation, examination, and the resource of common hand disorders.

This course also is an excellent preparation tool for the Hand Therapy Certification Exam.

Earn 1.6 AOTA CEUs (16 NBCOT PDUs / 16 contact hours).

Order #3017 (with CD-ROM)

AOTA members: \$260 Nonmembers: \$360

SP-116



Call **877-404-AOTA** ■ Shop online **store.aota.org**