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# Development, Reliability, and Validity of the Handwriting Proficiency Screening Questionnaire (HPSQ)

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## KEY WORDS

- deficiency
- digitizer
- handwriting
- pediatrics
- screening

**OBJECTIVE.** This study was used to (1) develop an occupational therapy screening questionnaire (the Handwriting Proficiency Screening Questionnaire [HPSQ]) to identify handwriting difficulties among school-aged children and (2) examine its reliability and validity.

**METHOD.** The questionnaire's content validity was established. Internal consistency, interrater and test-retest reliability, and concurrent and construct validity were initiated. Participants included 7- to 14-year-old ( $N = 230$ ) typically developing school-aged children.

**RESULTS.** The tool demonstrated good internal consistency ( $\alpha = .90$ ). Test-retest reliability for the score revealed an intraclass correlation coefficient (ICC) of .84 and interrater reliability of ICC = .92 for the total questionnaire score. Construct and concurrent validity were also confirmed.

**CONCLUSION.** The HPSQ is suitable for use by occupational therapists for identification of handwriting deficiency among school-aged children and is appropriate for varied academic and clinical uses. More studies with larger samples of varied age groups are required to further support the questionnaire's reliability and validity.

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**H**andwriting is a major occupation of childhood that is vital for schoolchildren's ability to function, work, and participate in the mainstream classroom environment (Daniel & Froude, 1998; Feder et al., 2005; Feder, Majnemer, & Synnes, 2000; Tseng & Chow, 2000). Elementary school children typically spend up to 50% of the school day engaged in writing tasks, some of which are performed under time constraints (McHale & Cermak, 1992; Tseng & Chow, 2000). According to teacher estimates, approximately 11% to 12% of female and 21% to 32% of male school-aged children have handwriting difficulties (Karlsdottir & Stefansson, 2002; Smits-Engelsman, Van Galen, & Michels, 1995).

The consequences of handwriting difficulties go beyond the task performance itself. In a summary of the existing views on the negative consequences of handwriting dysfunction, Graham, Harris, and Fink (2000) suggested that teachers tend to give higher marks for neatly written papers than for those in which legibility is poor. Thus, it appears that poor penmanship may influence perceptions about children's competence as writers (Klein & Tub, 2005). These literature findings reinforce the importance of identifying handwriting difficulties as early as possible, both as a preventive and as a corrective aid (Berninger & Amtmann, 2003).

The current view stipulates that handwriting is an activity required for the child's school participation. The identification of handwriting deficits is particularly significant in light of the importance of activity and participation concepts in both occupational therapy practice and in accordance with the *International Classification of Functioning, Disability and Health* (World Health Organization,

2001) framework. Recently, Lollar and Simeonsson (2005) indicated that not enough standardized tools are available to evaluate these central concepts.

The teacher is an important source of information about a child's handwriting. In fact, primary school teachers teach handwriting, but when problems arise, students are referred to occupational therapists (Asher, 2006). Indeed, handwriting difficulties is one of the most common reason for referring school-aged children to occupational therapists (Case-Smith, 2002; Erhardt & Meade, 2005), hence it is a major focus of school-based occupational therapy (Hammerschmidt & Sudsawad, 2004).

However, as indicated by O'Hare (2004) and Stefansson and Karlsdottir (2003), tools appropriate for handwriting performance evaluation in the school environment are lacking. Most current handwriting evaluations require substantial amounts of time to administer and score (see Rosenblum, Weiss, & Parush, 2003, for more details). Moreover, even if teachers do observe a child they suspect of having handwriting deficiencies, no quick standardized screening tools exist to confirm these concerns (Daniel & Froude, 1998). Thus, the valuable information that teachers possess regarding children's handwriting abilities within the natural environment of the classroom is lost.

Moreover, occupational therapists need to have a structured format that can be used by teachers to formally rate and transmit such information to therapists, as well as parents, to ensure proper follow-up and intervention. Another concern relates to the question of the criteria teachers use to judge children's handwriting. It is difficult to know whether the criteria they use are consistent with those chosen by the experts who develop evaluation tools. For example, Sudsawad, Trombly, Henderson, and Tickle-Degnen (2001) revealed that teachers' judgment of handwriting legibility showed no significant correlation to scores on the Evaluation Tool of Children's Handwriting (Amundson, 1995; Sudsawad et al., 2001). In addition, Daniel and Froude (1998) found that the level of agreement between occupational therapists and teachers on handwriting evaluation results was relatively low (i.e., 21%–36%). These findings highlight the need to develop a practical tool suitable for completion by the teacher and for the class environment that could provide a common language for therapists, educators, and researchers with respect to handwriting deficiencies (Hammerschmidt & Sudsawad, 2004; Stefansson & Karlsdottir, 2003).

Such a tool is particularly needed considering the development of occupational therapy services in the school setting (Weintraub, 2004), and therapists desire to adapt their intervention methods to suit teachers' expectations of the child in his or her educational environment. It would also provide a method for establishing a working collaboration between

teachers and occupational therapists (Asher, 2006; Orr & Schkade, 1997). Hammerschmidt and Sudsawad (2004) concluded that the perceptions of school-aged education teachers on handwriting difficulties can provide valuable information for occupational therapy practitioners' consultation and direct service provision related to handwriting in schools.

Moreover, considering the degree to which occupational therapists are involved in evaluating and planning treatment for deficient handwriting worldwide (e.g., USA—Case-Smith, 2002; Canada—Feder et al., 2000; Australia—Rodger, Brown, & Brown, 2005; Taiwan—Tseng & Chow, 2000; and Israel—Rosenblum, Goldstand, & Parush, 2006), a valid and reliable screening tool can be instrumental in guiding clinicians' decisions as to whether an in-depth analysis of handwriting is necessary. Thus, the information provided by an appropriate screening tool may serve as the first step toward establishing an appropriate intervention plan and treatment objectives. Yet, a review of the literature shows that no such screening tool currently exists.

The design and content of such a tool would be most appropriately based on the major factors and characteristics that are typically found in nonproficient handwriting, as described in the literature. For example, clinicians and educators have characterized nonproficient handwriting as being slow and tedious and as being typically accompanied by difficulties in letter production and rapid muscle fatigue (Benbow, 1995; Feder et al., 2000; Mojet, 1991; Tseng & Chow, 2000). In addition, the written product of these children is often characterized by incorrect letter formation, poor alignment, reversals, uneven size of letters, and irregular spacing between letters and words (Graham, Berninger, & Weintraub, 1998). Thus, from the findings of this literature, three important factors relating to nonproficient handwriting should be considered in the design of a screening tool for handwriting deficiencies: (1) legibility, (2) time and speed of performance, and (3) physical and emotional well-being.

The purpose of this study was to develop a practical and standardized Handwriting Proficiency Screening Questionnaire (HPSQ) for school-aged children. The study consisted of two phases: (1) scale development and determination of content validity and (2) examination of the internal consistency, interrater and test-retest reliability, and concurrent and construct validity using full-length handwriting process and product tests.

## Method

### *Scale Development and Determination of Content Validity (Phase 1)*

The assessment of content validity is typically considered the first step in the appraisal of a measurement instrument

(Kline, 2005). It refers to the extent to which the instrument covers the scope of the concept of handwriting deficiencies for the target population. It includes evaluation of the items' relevance (content relevance), as well as their capacity to represent every facet of the measured concept (content coverage).

The tool construction began with a brainstorming phase, conducted by a team of researchers, regarding which items would be most appropriate for identifying handwriting deficiency. The research team consisted of three expert pediatric occupational therapists who were lecturers in the departments of occupational therapy at two universities. All three had at least 15 years of experience managing handwriting difficulties among school-aged children and were currently involved in other handwriting studies. Survey items were developed from a review of the extant literature on handwriting deficiencies among children (see Rosenblum et al., 2003), as well as the clinical and academic experience of the research team.

The team established 10 items it considered to be the most important indicators of handwriting deficiencies, considering the following three domains (see the Appendix): (1) legibility (Items 1, 2, 10), (2) performance time (Items 3, 4, 9), and (3) physical and emotional well-being (Items 5, 6, 7, 8; Alston, 1983; Cornhill & Case-Smith, 1996; Rubin & Henderson, 1982).

The items were worded such that they would be clear and understandable to teachers and would be directly answerable from their observations of the child as he or she was writing in the classroom. A 5-point Likert-scale scoring format was established, such that 0 refers to *never* and 4 refers to *always*; higher scores indicate poorer performance (see the Appendix). The questionnaire final score was computed by summing the scores of all 10 test items.

At the next phase, expert clinicians, teachers, and researchers were asked to evaluate whether the questionnaire's items adequately covered the concept being evaluated, as well as the item's relevance and clearness. The expert's panel was composed of three expert consultants, three experienced pediatric occupational therapists, and four experienced teachers. All occupational therapists and teachers had more than 10 years of experience working with school-aged children. All experts were given a table that included a list of the 10 items and were asked to rate each item regarding its relevance for the concept being evaluated (yes or no) and whether its wording was clear enough for teachers.

One hundred percent agreement was found for the 10 items regarding the questionnaire's clearness and for the relevance of Items 1 through 6 and 8 through 10. However, only 80% of the experts agreed regarding the relevance of Item 7 (hand pain while writing). After consulting with two

more expert teachers who agreed with respect to the item's relevance, the research team decided to retain that item in the questionnaire.

After the content validation process, a secondary qualitative evaluation process was performed. Specifically, three teachers with more than 10 years of experience each were asked to respond to the 10 questionnaire items for four children from their respective classes whom they had identified as nonproficient handwriters. Moreover, they were asked to rate the questionnaire as to whether it was *very practical*, *more or less practical*, or *not practical* for teachers' use.

The teachers reported that the items were clearly written and that the completion of the questionnaire required only 5 to 10 min per child. Moreover, they claimed that the questionnaire gave an accurate portrayal of the individual children's handwriting deficiencies, which they had previously observed but not been able to document using a standardized tool. All stated that the questionnaire was very practical.

### *Examination of the Questionnaire's Reliability and Validity (Phase 2)*

Once the final version of the questionnaire was determined, the examination of its internal consistency, interrater and test-retest reliability, and concurrent and construct validity were initiated, using full-length handwriting process and product tests.

*Participants.* Included in this study were 230 children recruited from four regular public schools located in four different types of municipalities in northern Israel (large town, small town, kibbutz, and community settlement) whose participation was approved by their parents in response to a letter that was sent home with all the children. As presented in Table 1, the participants were in second through eighth grades. Their ages ranged from 7 to 14 years ( $M = 10.11$ ,  $SD = 1.9$ ). Participants had no documented developmental delays or neurological or physical impairments. All participants were White Jews of either Ashkenazi

**Table 1. Distribution of the Total Participant Sample Across Different Grades and the Handwriting Proficiency Screening Questionnaire (HPSQ) Means and Standard Deviations for Each Grade**

Grade	No. Participants	Boys	Girls	HPSQ Score	
				<i>M</i>	<i>SD</i>
2	22	12	10	8.04	7.17
3	31	19	12	7.85	7.68
4	36	20	16	4.88	7.09
5	39	20	19	5.48	6.86
6	36	19	17	5.31	5.60
7	33	19	14	6.21	5.36
8	33	16	17	4.45	5.47
Total	230	125	105	5.87	6.51

or Sephardic origin who were born in Israel and who used the Hebrew language as their primary means of verbal and written communication. Fifty-four percent were boys, and 46% were girls. Most of the participants were right-hand dominant (91%).

### Instruments

*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 to collect objective measures of the handwriting process (see Rosenblum et al., 2003a, for more details; see Figure 1).

In the current study, a paragraph-copying task (Figure 2) was performed on A4-sized, lined paper affixed to the surface of a WACOM Intuos II x-y digitizing tablet (404 mm × 306 mm × 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 children to change the grip they would otherwise ordinarily use or affect their writing 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 time taken to write each segment, the total time taken to complete the entire paragraph, on-paper time, and in-air time (i.e., the time during the writing of the paragraph during which the pen was not in contact with the writing surface; Rosenblum, Parush, & Weiss, 2003b). The spatial measure referred to was the total path length on the paper of all the characters written in the paragraph. 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 writing 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 children with poor and proficient handwriting for the system's spatial and temporal measures (Rosenblum et al., 2003a, 2003b).

Test-retest reliability of this system was determined by the author on a sample of 30 typical adults ages 20 to 40, 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 with respect to 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 ( $t[28] = 0.41, p = .68$ ) and writing velocity ( $t[28] = 0.28, p = .77$ ).

*Hebrew Handwriting Evaluation.* The Hebrew Handwriting Evaluation (HHE; Erez & Parush, 1999) was used to examine the handwriting product and assess legibility through both global and analytic measures. It contains of a standardized paragraph for assessing copying and writing performance and was used in the current study for both product and process evaluation. The text contains all the letters in the Hebrew alphabet and includes 30 words/107 letters (Erez & Parush, 1999). The interrater reliability of the HHE is .75 to .79,  $p < .001$ . Construct validity of the HHE was previously established by demonstrating statistically significant differences ( $t[207] = -2.34, p = .027$ ) between the performance of children with proficient handwriting and those with poor handwriting (Dvash, Levi, Traub, & Shapiro, 1995).

All 230 handwriting product samples were analyzed by the same evaluator. The evaluator was certified in HHE administration, having completed a course that was conducted by the tool developers for this purpose. As part of the

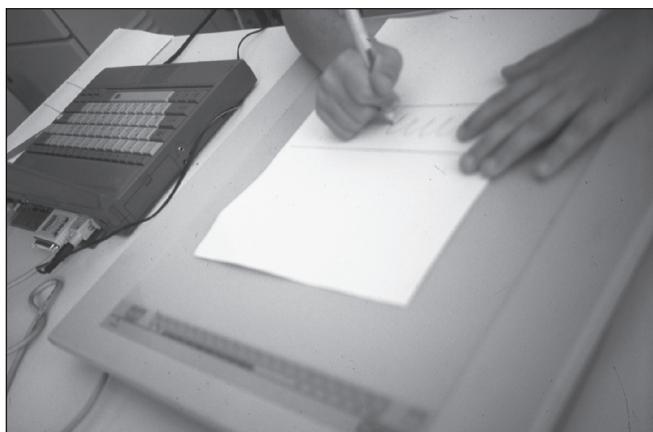


Figure 1. Computerized Penmanship Evaluation Tool, including a laptop computer, digitizer, and evaluation software.

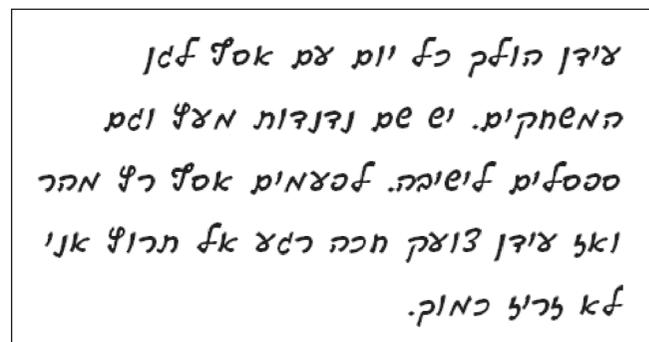


Figure 2. The paragraph-writing task.

certification process, good interrater reliability of the course participants was demonstrated ( $r = .75-.79, p < .01$ ).

The outcome measures of the HHE assessment of the written product included global legibility (scored on a 4-point Likert scale, ranging from *the most legible* [1] to *the least legible* [4]), which refers to the clarity of the handwriting. The number of letters written during the first minute was also recorded.

The analytic measurement of legibility used in the HHE examines the following 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

3. *Spatial arrangement of the written text*, as determined according to detailed and precise criteria, using a caliper calibrated to the millimeter

Specifically, these criteria include the vertical alignment of letters (including the extensions of letters above 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 of the four outcome measures of the HHE, a low score indicates good performance, and a high score indicates poor performance.

### Procedure

The study design conformed to the instructions stipulated by the University of Haifa Ethical Committee. Approval was given from the institutional review board of the Israeli Ministry of Education. After the children's parents signed an informed consent, their teachers were asked to complete the HPSQ for their students.

The questionnaires were completed by class tutors—educational professionals whose jobs involved teaching the child at least 2 hr a day, 4 days a week, and who had worked enough time with the child to be able to accurately observe the child's writing. The teacher was instructed to observe the child while copying written work with his or her ordinary pencil or pen for a full week. The children in the class were aware that the teacher was observing them as they wrote, but the teacher was able to choose the most appropriate time to do it. The teacher was asked to refer to three main components: (1) writing product legibility based on the teacher's as well as the child's perception (Items 1, 2, 10); (2) performance time, including whether the child performed too slowly, whether the child tended to frequently erase or cross out things that he or she had written, and whether the child needed to spend a lot of time looking back at the blackboard or the book while copying (Items 3, 4, 9); and (3) indications

of the child's physical and emotional well-being. This component included, for example, the child's willingness to write, willingness to do his or her homework as necessary, and behaviors indicating fatigue or pain while writing (Items 5, 6, 7, 8).

On the basis of the teacher's week-long observation and the general impression derived from the child's writing performance in class, the teacher was asked to rate the degree to which the behavior described in each item occurred (i.e., *never, rarely, sometimes, often, or always*).

To analyze test–retest and interrater reliability, two sixth-grade teachers were asked to complete the questionnaire twice on 30 students ages 11 to 12 (each teacher for his or her own students) with an interval of 3 weeks between the two evaluations. Those 30 students were part of the larger sample of the current study described.

The children for whom the questionnaires were completed were then tested using the CompPET (Rosenblum et al., 2003a) while performing a paragraph-copying task. This task was selected because it was considered to represent a handwriting task in which a child would typically engage. The paragraph was presented visually on the computer screen in the Gutman Yad-Brush 20-point Hebrew font type (shown in Figure 2). The same tester carried out all computerized data collection sessions.

All participants were tested individually under similar environmental conditions. Specifically, testing occurred in a quiet classroom in the participants' school during the morning hours. In addition, to achieve writing samples that would resemble those typically produced by the participants, all environmental factors were kept as similar as possible to writing conditions that the children would normally experience. Participants were seated on standard school chairs placed in front of classroom desks that were appropriate for their height.

In the third phase of the study, the participants' handwriting product was evaluated according to the HHE criteria (Erez & Parush, 1999).

### Data Analysis

The mean scores and standard deviations on the questionnaire were examined for each age group. Cronbach's alpha coefficient was used to examine the scale's internal consistency. Intraclass correlation (ICC) analysis was used to evaluate the test–retest reliability for the total questionnaire score and to evaluate the interrater reliability for each of the questionnaire's items as well as for the total scores.

Spearman correlation analysis was used to examine the questionnaire's concurrent validity because the HHE data represent an ordinal scale and because both the HHE scores and CompPET scores did not follow a normal distribution.

Similar reasoning was used in choosing the Mann-Whitney procedure to determine its construct validity.

Finally, a principal-components factor analysis was conducted to test the investigator hypothesis that the construct of handwriting deficiency may be multidimensional, that is, in terms of its significance with respect to the three factors delineated previously (i.e., legibility, time and speed of performance, and physical and emotional well-being).

## Results

### Questionnaire Results

The mean questionnaire score of the 230 children in the study sample was 5.87 ( $SD = 6.51$ ), and the median score was 4.00. The mean score and standard deviation for each grade is presented in Table 1.

### Internal Consistency

The Cronbach's alpha reliability of the 10-item scale was .90, indicating that the scale has good reliability. There was no need to delete any of the items because doing so did not improve the level of reliability. The reliability for each of the three factors relating to nonproficient handwriting—that is, (1) legibility, (2) time and speed of performance, and (3) physical and emotional well-being—was also computed. The Cronbach's alpha for the legibility items (1, 2, 10) was found to be .82; for the performance time items (3, 4, 9), it was found to be .85; and for the physical and emotional well-being items (5, 6, 7, 8), it was .81.

### Test-Retest and Interrater Reliability

The ICC for the test-retest scores was .84. With respect to interrater reliability (see Table 2), the ICC for the questionnaire's score was 0.92, whereas the ICC for the individual questionnaire items ranged from .64 to .91. The lowest cor-

relation was found for Item 4 (i.e., "Erasing a lot while writing";  $r = .64$ ), and the highest correlations were found for Item 1 (i.e., "Is the child's writing unreadable?";  $r = .91$ ) and for Item 2 (i.e., "Is the child unsuccessful in reading his/her own handwriting?";  $r = .90$ ).

### Concurrent Validity

The handwriting of all the participating children was evaluated using the two standardized tools previously described (i.e., the ComPET, Rosenblum et al., 2003a, and the HHE, Erez & Parush, 1999).

Significant moderate correlations were found between the total scores of the 230 participants on the HPSQ and those obtained with the HHE (Erez & Parush, 1999). Specifically, the correlation between the HPSQ and the global legibility score of the HHE was .65 ( $p < .001$ ); between the HPSQ and the number of erasures and corrections as determined by means of the HHE, .62 ( $p < .001$ ); between the HPSQ and the number of unidentifiable letters produced on the HHE, .65 ( $p < .001$ ); and between the HPSQ and the HHE score for spatial organization of the writing on the page, .52 ( $p < .001$ ).

Significant moderate correlations were also revealed between the total HPSQ scores and measures obtained by means of the computerized system. For example, a correlation of .65 ( $p < .001$ ) was found between the HPSQ and the total copying time, and a correlation of .61 ( $p < .001$ ) was found between the HPSQ and the length of the pen excursion on the page by means of the ComPET (Rosenblum et al., 2003a).

### Construct Validity

To examine construct validity, the participants of the study were divided into two groups (i.e., poor and proficient handwriters) on the basis of their total questionnaire scores. With respect to the 230 participants making up the entire study sample, the mean total score of the HPSQ was 5.87 ( $SD = 6.51$ ); scores ranged from 0 (indicating proficient handwriting) to 29 (indicating handwriting deficiency). With respect to the distribution of the participants' total scores, 21% scored 0, 50% scored between 0 and 4, and 25% scored more than 8. Of these children, 10% scored 16.50 and above.

The establishment of the cut-off score was based on the mean and standard deviation values, per the method used by Graham, Struck, Santoro, and Berninger (2006, p. 47). Thus, on the basis of these findings, the participants were divided into two groups: Group 1 consisted of children who achieved a total score of 0 to 13 ( $M + 1 SD$ ; proficient handwriters), and Group 2 included those who achieved a total score of 14 and up (poor handwriters).

On examination, it was found that 85% ( $n = 195$ ) of the participants were included in the proficient handwriters

**Table 2. Interrater–Intraclass Correlation Coefficient (ICC) Agreement Values Between Raters for Each of the Questionnaire Items and for the HPSQ Final Score**

ICC Value	Questionnaire Item
.91	Unreadable handwriting
.90	Unsuccessful in reading his/her own handwriting
.82	A lack of time to copy
.64	Often erases
.71	Does not want to write
.83	Does not do homework
.79	Complains about pain
.80	Tired while writing
.89	Needs to look often when copying
.73	Not satisfied with his/her handwriting
.92	HPSQ final score

Note. HPSQ = Handwriting Proficiency Screening Questionnaire.

group (Group 1), and 15% ( $n = 35$ ) were included in poor handwriters group (Group 2). Table 3 represents a comparison of the means and standard deviations of the ComPET and HHE measures in both groups. When examining the main ComPET scores of the participants in both groups, it was found that the proficient handwriters performed significantly better than the children in the poor handwriting group for several measures. For example, the children in Group 2 (poor handwriters) wrote using more letter segments ( $U = 1,859, n = 33, p = .0001$ ), required more time to form each segment ( $U = 1,449, n = 33, p = .0001$ ), wrote at a slower velocity ( $U = 2,316, n = 33, p = .031$ ), and stayed in air more often throughout the total time of paragraph writing ( $U = 1,998, n = 33, p = .001$ ) than did the participants in Group 1 (proficient handwriters). Moreover, the standard deviation of the pressure expended by poor handwriters on the paper was higher than that of the proficient handwriters ( $U = 1,721, n = 33, p = .0001$ ).

A similar trend was seen in comparing the results of the groups with respect to their performance on the HHE of the writing product. Specifically, results of the Mann-Whitney  $U$  test revealed that the participants in Group 2 (poor handwriters) performed significantly less well than those in Group 1 (proficient handwriters) for three of five of the HHE outcome measures (i.e., "Global legibility,"  $U = 1,584, n = 34, p = .0001$ ; "Number of letters written in the first minute,"  $U = 1,377, n = 34, p = .0001$ ; and "Spatial arrangement,"  $U = 1,584, n = 34, p = .0001$ ).

Finally, the principal-components factor analysis yielded surprising results. Two factors with eigenvalues  $\geq 1.00$  were initially extracted. Orthogonal rotation of the factors yielded the factor structure given in Table 4. The first factor includes Items 3 through 9 (performance time and well-being) and

accounts for 54% of the variance. The second factor includes Items 1, 2, and 10 (legibility) and accounts for 13% of the variance. Thus, the two factors together explain 67% of the variance.

## Discussion

Several challenges had to be met to develop a quick screening tool for handwriting proficiency. First, no such standardized handwriting screening tool currently exists, despite the potential contribution of such a tool to enhance communication and sharing of data between occupational therapists and educators regarding children's handwriting difficulties (Stefansson & Karlsdottir, 2003). Hence, no data exist with which to compare the current study results. Second, even for most of the full-length handwriting evaluation tools used worldwide, levels of reliability reach only moderate levels. This reliability level includes the HHE, which was used as a comparison measure in the current study (see Rosenblum, Weiss, et al., 2003, for more details).

Although the HPSQ is still undergoing research, the results of the current study have shown it to be highly reliable and valid and have indicated that the items of the tool successfully reflect the constellation of handwriting problems in children. Specifically, results of the research on the HPSQ have revealed that it has high internal consistency (.90) and test-retest reliability (.84,  $p < .01$ ). These findings are significant when comparing the HPSQ with to the reliability of most full-length, in-depth handwriting assessments (see Rosenblum et al., 2003, for more details). Moreover, compared with values found for full-length, in-depth handwriting evaluations, interrater reliability for the final score of the questionnaire was high (.92) and similar

**Table 3. Comparison of Means and Standard Deviations of the Computerized Penmanship Evaluation Tool (ComPET) and the Hebrew Handwriting Evaluation (HHE) Outcome Measures for Proficient and Poor Handwriter Groups**

Outcome Measure	Group 1: Proficient		Group 2: Poor		$p$
	$M$	$SD$	$M$	$SD$	
<b>ComPET</b>					
Number of segments	269.33	179.12	353.51	170.46	**
Time per segment	.82	.33	1.37	.70	**
On-paper time (whole paragraph)	73.74	27.63	71.36	30.87	
In-air time (whole paragraph)	181.94	73.70	209.80	94.07	**
Total path length on paper (whole paragraph)	1,788.37	857.51	1,587.51	1,043.64	
Mean pressure	701.85	117.84	731.10	122.99	
Mean velocity (whole paragraph)	33.24	7.83	30.79	7.80	*
<b>HHE</b>					
Global legibility	1.53	.72	2.23	1.01	**
Number of letters written in the first minute	65.01	19.08	43.24	19.84	**
Letters erased or overwritten	3.93	3.68	5.58	5.54	
Unrecognizable letters	3.41	7.88	3.82	4.07	
Spatial arrangement	7.00	1.59	8.32	2.45	**

\* $p < .05$ . \*\* $p < .001$ .

**Table 4. Orthogonal Factor Loading Matrix for the 10 Items**

Factor 2	Factor 1	Questionnaire Item	Item No.
.90		Unreadable handwriting	1
.88		Unsuccessful in reading his/her own handwriting	2
	.83	A lack of time to copy	3
	.61	Often erases	4
	.87	Does not want to write	5
	.70	Does not do homework	6
	.63	Complains about pain	7
	.83	Tired while writing	8
	.80	Needs to look often when copying	9
.67		Not satisfied with his/her handwriting	10

or higher for each of the component items (.64–.91; Rosenblum, Weiss, et al., 2003). The questionnaire items with the highest reliability values were items that focused on the teacher’s judgment of the child’s legibility (i.e., Items 1 and 2). This finding is compatible with the findings of Hammerschmidt and Sudsawad (2004), who concluded that among the teachers ( $n = 314$ ) they examined, the most important criteria for determining whether a student has handwriting difficulties was their ability to read the student’s writing. However, these researchers noted that the majority of the study’s participants (72.7%) reported that they graded students’ handwriting on the basis of their subjective judgment of their handwriting quality (e.g., legibility, neatness, writing between the lines) rather than by using a standardized handwriting test. Thus, the advantage of the HPSQ is that it provides occupational therapists with a format for enabling teachers to gather this important information using a standardized tool in the natural environment of the classroom. This feature appears to support the tool’s ecological validity.

However, more studies with larger samples and including teacher interviews are required to check whether the high reliability for the legibility items stems from the fact that legibility is a visible, easy-to-score characteristic that may reinforce teachers’ tendency to give those items more extreme scores (although this was not seen in the current study results).

Another important finding of the current study was that significant moderate correlations were found between the results of the questionnaire and both handwriting legibility and performance time, which are both considered significant measures with respect to handwriting evaluation (Graham et al., 1998; Karlsdottir & Stefansson, 2002). Specifically, the results obtained through the questionnaire were found to correlate well with HHE measures of handwriting legibility and with handwriting performance time, as determined through the CompPET computerized handwriting evaluation

system. These findings indicate that the tool has good concurrent validity.

Moreover, the results of the current study confirmed the construct validity of the HPSQ. Specifically, significant differences were found between the study groups in measures of speed and legibility, such as the number of letters produced in the first minute of writing, mean handwriting speed, in-air time, global legibility, and organization in space. With respect to differences between the groups regarding the pressure used during writing, the study findings indicated that such differences exist not with the mean pressure per se but rather in the standard deviation of pressure. It is suggested that this finding be examined in future research.

The results of the principal-components factor analysis were surprising. Although the internal consistency was found to be high (.90)—a fact that may indicate that the questionnaire contains several very consistent dimensions that are inflating the reliability estimate—results revealed two main factors. Specifically, performance time and physical and emotional well-being were found to reflect one factor, and legibility appeared as a second, separate factor. This finding is interesting and may indicate that children who do not succeed in fulfilling the time requirements in class experience a greater lack of physical and emotional well-being than children whose handwriting product is illegible. Further research is required to examine this issue in greater depth.

The HPSQ represents a first step that can be used by occupational therapists to identify and treat handwriting deficiency. The results of the current study revealed the high internal consistency and test–retest reliability, good ecological and concurrent validity, and construct validity of the HPSQ. Such findings may lead to additional research and clinical applications in the future.

For example, research can include the performance of large-scale surveys on the incidence of handwriting difficulties among schoolchildren, as well as an examination of the effectiveness of occupational therapy programs to remediate such difficulties (Graham, Harris, Fink-Chorzempa, & MacArthur, 2003). Early identification and appropriate intervention may prevent the child from entering into a cycle of feelings of inadequacy and discouragement that often result from and sometimes perpetuate difficulties in the technical aspects of producing written work. Thus, further studies could enable the translation and use of the questionnaire for different languages for early identification worldwide.

With respect to potential clinical applications, Hammerschmidt and Sudsawad (2004) wrote that it is often unclear to teachers when to refer a child with handwriting difficulties for occupational therapy and when it would be sufficient to provide educational interventions to remediate handwriting problems. Thus, through the HPSQ, the occupational

therapist can provide the teacher with a way of determining whether a child needs to be referred for occupational therapy treatment rather than simply relying on direct educational intervention alone.

Moreover, once the results of the questionnaire have been analyzed by the occupational therapist, the information provided can form the basis for discussions between the occupational therapist and the child. An interview with the child based on the questionnaire's results may enable therapists to hear the child's perspective regarding his or her handwriting status. In this way, children can be helped to understand what their difficulties are, why their handwriting needs to be improved, and why occupational therapy intervention may be necessary. Both the questionnaire results and the interview with the child may lead to a more focused, collaborative, and client-centered evaluation and treatment process.

Finally, the information that the HPSQ provides can assist the occupational therapist in targeting the criteria and elements of handwriting that teachers expect to be focused on in therapy, further assisting the therapist in determining both the type of evaluations to use and the goals of therapy. This process would ensure that the intervention focuses on the issues that the teacher thinks are most important for the child's classroom performance (Hammerschmidt & Sudsawad, 2004).

In sum, the HPSQ enables an identification of handwriting deficiency and is appropriate for varied academic and clinical uses. Further studies with larger samples of varied age groups are required to further support the questionnaire's reliability and validity. ▲

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## Appendix. Handwriting Proficiency Screening Questionnaire (HPSQ)

Child's name \_\_\_\_\_ School and class \_\_\_\_\_ Teacher's name \_\_\_\_\_

Date \_\_\_\_\_

Please complete the following questionnaire based on your impression of (child's name) \_\_\_\_\_ handwriting in your class.

Question	Never 0	Rarely 1	Sometimes 2	Often 3	Always 4
1. Is the child's writing unreadable?					
2. Is the child unsuccessful in reading his/her own handwriting?					
3. Does the child not have enough time to copy tasks from the blackboard?					
4. Does the child often erase while writing?					
5. Does the child often feel he/she does not want to write?					
6. Does the child not do his/her homework?					
7. Does the child complain about pain while writing?					
8. Does the child tire while writing?					
9. Does the child need to look at the page/blackboard often when copying?					
10. Is the child not satisfied with his/her handwriting?					