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EFFICACY OF AN EXPLICIT HANDWRITING PROGRAM[1]

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Summary.—The aim of this study was to investigate the effects of an explicit handwriting program introduced during the first grade of elementary school. Grade 1 children ($N = 23$) with an age range of 6.1 to 7.4 yr. (15 girls, 8 boys) were administered an additional handwriting program of two weekly sessions of 45 min. over six weeks. Another group of 19 Grade 1 children (11 girls, 8 boys) received only the regular handwriting program of one weekly session. The Concise Assessment Scale for Children's Handwriting was administered to measure the changes in quality and speed of handwriting. The children given the explicit program showed better quality and speed of handwriting than did the control group. Their handwriting was more regular, with fewer ambiguous letters and fewer incorrect relative heights.

The prevalence of nonproficient handwriters varies from 6 to 10% among children between 8 and 13 years (Berninger, Mizokawa, & Bragg, 1991; Smits-Engelsman, Niemeijer, & van Galen, 2001) and is also related to gender, with more boys found to be nonproficient handwriters (Berninger, Nielsen, Abbott, Wijsman, & Raskind, 2008). Children with nonproficient handwriting, in terms of quality or speed, show weaker results in spelling compared to that of their peers who are proficient handwriters (Berninger, *et al*., 1991); such children are in a double-task situation and must work harder as they have to think about how to form a letter and at the same time how to generate a written text (Berninger, Vaughan, Abbot, Abbot, Woodruff Rogan, *et al*., 1997). Moreover, teachers tend to give lower marks to papers with poor handwriting than those with good handwriting (Alston & Taylor, 1987).

Teaching a child to be competent in handwriting helps to optimize that child's results at school and to decrease poor composition results (Jones & Christensen, 1999). However, the time devoted to teaching handwriting in a classroom is often given low priority in school curricula. Graham, Harris, and Fink (2000) found that one-third of teachers interviewed combined the teaching of handwriting with other courses, one-third devoted a specific course to the teaching of handwriting once a week, and one-third gave only specific instruction to children who had difficulties.

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Graham, Harris, Mason, Fink-Chorzempa, Moran, and Saddler (2008) showed that 88% of teachers interviewed thought that they did not have sufficient training to teach handwriting.

When poor handwriting is identified, two types of remediation are usually proposed. The first one is based on sensorimotor programs carried out by individual therapists outside the school program (Laszlo & Bairstow, 1983; Harris & Livesey, 1992). The second type is an intensive handwriting program introduced during school time for a group of children who are at risk of developing nonproficient handwriting and which includes specific teaching activities such as alphabet singing or practising letters at different speeds (Berninger, *et al*., 1997; Graham, *et al*., 2000; Jongmans, Linthorst-Bakker, Westenberg, & Smits-Engelsman, 2003). Studies which compared the efficacy of these two types of remediation tend to show that the remedial handwriting program within school seems more efficient than sensorimotor therapies (Denton, Cope, & Moser, 2006; Weintraub, Yinon, Hirsch, & Parush, 2009).

Among handwriting programs, the programs that include explicit learning with verbal cues (names of letters that may serve as retrieval cues) also contribute to improving handwriting (Jones & Christensen, 1999). Furthermore, the variation of parameters such as force or speed of movement is useful in assisting the learner in paying more attention to these variable parameters (Jongmans, *et al*., 2003). When handwriting is taught within a meaningful context that allows children to use handwriting in a purposeful way, they are more motivated to master the skill (Denton, *et al*., 2006). Finally, the time devoted to teaching and to learning handwriting must be sufficient for each child to reach the required level of handwriting (Karlsdottir & Stefansson, 2002; Denton, *et al*., 2006).

The observed benefits of handwriting programs vary from one study to another. Several authors (Lockart & Law, 1994; Berninger, *et al*., 1997; Jongmans, *et al*., 2003; Denton, *et al*., 2006) observed that children with nonproficient handwriting showed significant improvement in the quality of their handwriting after an intensive program. However, Jongmans, *et al*. (2003) showed that a group with nonproficient handwriting improved in quality but not in speed of handwriting whereas a control group of proficient handwriters showed a more significant increase in speed but not in quality of handwriting (see also Lockart & Law, 1994). When children's handwriting improves, competences other than handwriting have been found to improve as well, such as recognition of letters (Denton, *et al*., 2006), grammar and orthography (Berninger, *et al*., 1997), and ability to write stories (Jones & Christensen, 1999). Few studies have compared the effects of an intensive program featuring explicit learning with those of a regular, nonintensive program based on implicit learning. Therefore, the

aims of the study were (1) to assess the effectiveness of an explicit handwriting program introduced at the beginning of Grade 1, and (2) to compare the quality of the handwriting of a group who received a program based exclusively on the learning and use of cursive letters from the beginning of the school year to the handwriting of a group who had a regular program in which children printed letters during the first trimester while having one weekly lesson with cursive letters.

It was assumed that the children who followed an explicit program would progress significantly more in quality and speed of handwriting than the children of the control group who would have the regular program of only one weekly lesson. The handwriting of children from the experimental group would have significantly fewer ambiguous letters, corrections of letter forms, and irregularities in joining strokes than the handwriting of the control group. The speed of handwriting from the experimental group would be significantly faster than the control group.

Method

Participants

The research took place in a regular school from a rural part of the French part of Switzerland. Grade 1 begins after two years of kindergarten; the children learn to read and to write during this first year of primary school. Three Grade 1 classes from a regular public school participated on a voluntary basis. Grade 1 children ($n = 23$; 6.1 to 7.3 years old) from two classes constituted the experimental group with 15 boys and 8 girls. The control group ($n = 19$) was composed of 8 girls and 11 boys from one class. No differences in the teaching of handwriting between the teachers were observed. In the school system where the research took place, it was not possible for the parents to choose the school or teacher of their child. The children were all fluent French speakers and they came from the same kindergarten which provides an identical pregraphism program. The objectives of this program were to become familiar with different graphical tools, to master movements for graphism, and to learn how to draw different shapes such as circles and vertical and horizontal lines as well as diagonals. All the children in these classes participated in the study with the written consent of their parents who were informed that they could withdraw their children at any time during the research.

Measure

As the children had not learnt during kindergarten how to write letters, no handwriting evaluation was possible at the beginning of Grade 1. The experimental and control groups were assessed for speed and for quality with the French version of the BHK-Concise Assessment Scale for Children's Handwriting (Charles, Soppelsa, & Albaret, 2003) two months

after the end of the explicit program. In this test, the child is only asked to copy a text, for 5 min., in cursive letters. The first five lines are analysed in the assessment process, using 13 criteria: (1) letter size, (2) left margin widening, (3) poor word alignment, (4) insufficient word spacing, (5) acute turns in connecting letters or overly long connections, (6) no joining strokes, (7) collision of letters, (8) inconsistent letter size, (9) incorrect relative height of letters, (10) letter distortion, (11) ambiguous letter forms, (12) correction of the letter, and (13) unsteady writing trace. Each criterion is given a rating from zero to five, therefore the quality of handwriting may range from between 0 (worst) and 65 (best). For children in Grade 1, a score under 20 means no difficulty, a score between 21 and 28 signifies poor handwriting, and a score at or above 29, very poor handwriting. Concerning the speed of handwriting, the number of letters written during the 5-min. period is counted; the mean is 170 letters and a score two standard deviations below the mean is 82.1 letters. The inter-rater reliability for the BHK is .90, and the concurrent validity with teachers' judgement is .68 ($p < .01$; Charles, *et al*., 2003).

Procedure

The first author of this paper, along with two students training in occupational therapy, administered the additional program of two 45-min. weekly sessions for a period of six weeks.

Handwriting Programs

The objectives of the program were to develop digital dexterity, to provide the child with explicit learning using the development of learning strategies such as auto-evaluation, anticipation or verbalization, and to practice endurance and speed. A review of the literature was carried out to identify the most effective methods for teaching and learning handwriting. Each session was composed of five parts. The first part started with digital dexterity exercises, as digital dexterity is a predictive factor in handwriting quality (Cornhill & Case-Smith, 1996) among a group of Grade 1 children composed of proficient and nonproficient handwriters in a group of 10-year-old children (Weintraub & Graham, 2000). Several in-hand manipulations were practiced, such as sequential opposition of digits or translation movements of five small objects, one after another, from the fingertips to the palm or from the palm to the fingertips.

During the second part of the program, the usefulness of handwriting was also discussed with the children. As proposed by Denton, *et al*. (2006), a meaningful context was provided for the children who were asked why it was important to learn handwriting. They were also given the task of writing short sentences for their classmates to read. The children were instructed to make links between written letters and phonological sounds

Author: Is this correct? 65 is best, but a score above 29 is poorer handwriting than 20. Please clarify.

(Denton, *et al*., 2006). They were then encouraged to find words that contained the letter being learnt or to enunciate all the possible sounds for one letter.

During the third part of the program, the teaching of letters was carried out. As the letters "a, c, d, g, q, o" had already been learnt by the children during the weeks preceding the experiment, the following letters were presented: "e, l, h, k, f, b, i, t, u, v, w, j, y, m, n, p, r, s, x, z." During each session, two or three letters were learnt only in cursive style. The researcher administering the additional program modeled the movements required for writing each target letter while providing explanations about the directional stroke of the letter. As mentioned by Jones and Christensen (1999), explanations provided with modeling are more effective than explanation or modeling alone. As in the experiment conducted by Berninger, *et al*. (1997), each child had the model of the letter in front of him, with arrows indicating the direction and instructions instructions to memorize how to write it.

During the fourth part, children practised the letter on white paper, varying speed and size, and then they wrote it on a page that contained a model of the letter. They were able to try out different kinds of pens and pencils.

Next, the children were given a metacognitive task: as described by Jongmans, *et al*. (2003), they analyzed their handwriting to identify the differences between their own production and the model. Each child explained to the researcher where he should pay attention the next time he wrote the letter. He then identified the best-written letter and put a sticker under it.

The regular school program includes 40 min. each week of handwriting which involves practising two or three letters in a notebook. The children are asked to copy the letter several times, then to copy words that contain those letters. However, during the first trimester of the school year, children must write with print letters, i.e., in the style of printed materials such as books or newspapers, for all their written work. It should be pointed out that certain print letters are not formed in the same way in cursive writing (b, f, h, k, l, p, r, s, v, w, x, z). This practice is typical of most teachers from the state where the research took place. It has no particular theoretical basis.

Analysis

A *t* test for independent groups was performed for comparisons of the two groups on quality and speed variables at posttest with SPSS Version 13. Significance was set at $p < .05$.

Results

For the quality of handwriting on the BHK, the children from the ex-

perimental group had a mean of 17.1 (SD = 7.2), and the children from the control group had a mean of 24.7 (SD = 7.0). For the speed of handwriting, the mean of the explicit handwriting program group was 55.7 (SD = 19.7) letters in 5 min., while the mean of the regular handwriting program group was 40.7 (18.6).

The experimental group performed significantly better on speed and quality than the control group. Differences between items of the BHK showed significantly fewer irregularities in joining strokes, better word alignment, fewer ambiguous letters, and fewer corrections of letters for the experimental group than for the control group (Table 1).

TABLE 1

Mean Difference and t Test For the Experimental (E; n = 23) and Control (C; n = 19) Groups on BHK Items Measuring Handwriting Skills

Items BHK	Group	M	SD	MD	df	t	d
Letter size	E	1.91	1.39				
	C	2.21	1.79	0.30	40	0.61	0.19
Left margin widening	E	0.78	0.90				
	C	0.84	1.67	0.06	40	0.14	0.04
Poor word alignment	E	3.53	1.54				
	C	4.46	0.95	0.93	37.39	2.38*	0.67
Insufficient word spacing	E	1.80	1.62				
	C	2.71	1.95	0.90	35.01	1.64	0.49
Acute turns or too long joining	E	1.46	1.54				
	C	1.32	1.63	0.14	40	0.28	0.09
Irregularities in joining strokes	E	3.41	1.40				
	C	4.57	0.78	1.15	35.54	3.36†	0.89
Collision of letters	E	0.11	0.36				
	C	0.26	1.14	0.15	40	0.61	0.18
Inconsistent letter size	E	1.79	1.45				
	C	2.64	1.72	0.85	40	1.71	0.52
Incorrect relative height of letters	E	0.92	1.26				
	C	2.42	2.26	1.50	26.97	2.56*	0.78
Ambiguous letter forms	E	1.45	1.52				
	C	2.68	1.14	1.23	40	2.70*	0.77
Correction of letter forms	E	0.65	0.99				
	C	0.50	0.85	0.15	40	0.52	0.16
Unsteady writing trace	E	0.00	0.00				
	C	0.08	0.34	0.08	18	1.00	0.34
Total score (quality)	E	17.07	7.21				
	C	24.70	6.97	7.61	41	3.48†	0.37
Speed	E	55.65	19.70				
	C	40.58	18.63	15.07	40	2.52†	2.03

Note.—d = Cohen's d. *p < .05. †p < .01.

Discussion

Two months after having received the explicit handwriting program, the children who had taken part showed a better quality in their handwrit-

ing than that of the control group. The main results of this study supported the results of several other studies (Lockart & Law, 1994; Berninger, *et al*., 1997; Denton, *et al*., 2006). As hypothesized, the handwriting of the experimental group contained significantly fewer ambiguous letters, fewer corrections of letter forms, and irregularities in joining strokes and a better alignment of letters than the control group's handwriting. The children from the experimental group probably had better control over the movements needed to perform handwriting, because what differentiated the two groups was the quality of the trace (joining strokes and alignment of letters). As the experimental group presented fewer ambiguous letters and corrections of form than the control group, it could be postulated that they had developed a better general motor program for forming letters (Smits-Engelsman & Van Galen, 1997), which confirms that when children are given the opportunity to analyze their written productions and to speak with someone about them, they can improve their motor programs. As in Jones and Christensen (1999), writing speed was faster for the experimental group than for the control group. However, this result differed from those of two studies which did not find any significant results in terms of speed (Lockart & Law, 1994; Jongmans, *et al*., 2003).

As mentioned in motor learning theory (Wulf, Shea, & Lewthwaite, 2010), explicit learning and self-controlled practice seem to influence the building of a motor program and to be optimal when combined with the performance of the movement. The results confirm this hypothesis and support the introduction of a handwriting program containing explicit learning as well as self-instruction and self-evaluation.

As children are required to write from the beginning of Grade 1, it would seem relevant to introduce an explicit handwriting program to improve skills that would lead to an improvement in all activities requiring handwriting. As mentioned by Graham, *et al*. (2000), introducing an additional handwriting program and allowing more time for children to learn these skills could prevent further difficulties in both handwriting and in tasks that involve writing.

Although the design of this study could not include a pretest evaluation, the significant difference can be explained by the influence of the additional program due to the significant difference between the two groups involving items that require better mastery of movements rather than the results of letters that could have been trained at home. This study should ideally be repeated in different contexts, especially with children at risk of developing handwriting difficulties. Longer-term follow-up should be conducted to assess whether the initial progress is maintained. The results of the present study indicate that an explicit handwriting program at the beginning of the first school year contributes to the mastering of

both quality and speed of handwriting. The automatization of handwriting could free attention and working memory, allowing higher achievement of other academic requirements.

REFERENCES

Alston, J., & Taylor, J. (1987) *Handwriting: theory, research and practice*. London: Croom Helm.

Berninger, V., Mizokawa, D., & Bragg, R. (1991) Theory-based diagnosis and remediation of writing. *Journal of School Psychology,* 29, 57-59.

Berninger, V., Vaughan, K. B., Abbot, R. D., Abbot, S. P., Woodruff Rogan, L., Brooks, A., & Reed, E. (1997) Treatment of handwriting problems in beginning writers: transfer from handwriting to composition. *Journal of Educational Psychology,* 89, 652-666.

Berninger, V. W., Nielsen, K. H., Abbott, R. D., Wijsman, E., & Raskind, W. (2008) Writing problems in developmental dyslexia: under-recognized and under-treated. *Journal of School Psychology*, 46, 1-21.

Charles, M., Soppelsa, R., & Albaret, J-M. (2003) *BHK–Echelle d'évaluation rapide de l'écriture chez l'enfant*. Paris: Editions et Applications Psychologiques.

Cornhill, H., & Case-Smith, J. (1996) Factors that relate good and poor handwriting. *The American Journal of Occupational Therapy,* 50, 732-739.

Denton, P. L., Cope, S., & Moser, C. (2006) The effects of sensorimotor-based intervention versus therapeutic practice on improving handwriting performance in 6- to 11-year-old children. *The American Journal of Occupational Therapy,* 60, 16-27.

Graham, G., Harris, L., Mason, L., Fink-Chorzempa, B., Moran, S., & Saddler, B. (2008) How do primary grade teachers teach handwriting? A national survey. *Reading and Writing*: *an Interdisciplinary Journal,* 21, 49-69.

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,* 92, 620-633.

Harris, S. J., & Livesey, D. J. (1992) Improving handwriting through kinaesthetic sensitivity practice. *The Australian Occupational Therapy Journal,* 39, 23-27.

Jones, D., & Christensen, C. A. (1999) Relation between automaticity in handwriting and students' ability to generate written text. *Journal of Educational Psychology,* 91, 44-49.

Jongmans, M., Linthorst-Bakker, E., Westenberg, Y., & Smits-Engelsman, B. C. M. (2003) Use of a task-oriented self-instruction method to support children in primary school with poor handwriting quality and speed. *Human Movement Science,* 22, 549-566.

Karlsdottir, R., & Stefansson, T. (2002) Problems in developing functional handwriting. *Perceptual and Motor Skills,* 94, 623-662.

Laszlo, J. I., & Bairstow, P. J. (1983) Kinaesthesis: its measurement, training, and relationship to motor control. *Quarterly Journal of Experimental Psychology,* 35A, 411-421.

Lockart, J., & Law, M. (1994) The effectiveness of a multisensory writing program for improving cursive writing ability in children with sensori-motor difficulties. *Canadian Journal of Occupational Therapy,* 61, 206-215.

Smits-Engelsman, B. C. M., Niemeijer, A. S., & van Galen, G. P. (2001) Fine motor deficiencies in children diagnosed as DCD based on poor grapho-motor ability. *Human Movement Science,* 20, 161-182.

Smits-Engelsman, B. C. M., & Van Galen, G. P. (1997) Dysgraphia in children: lasting psychomotor deficiency or transient developmental delay. *Journal of Experimental Child Psychology,* 67, 164-184.

Weintraub, N., & Graham, S. (2000) The contribution of gender, orthographic, finger function, and visual-motor processes to the prediction of handwriting status. *The Occupational Therapy Journal of Research,* 20, 121-140.

Weintraub, N., Yinon, M., Hirsch, I. B. E., & Parush, S. (2009) Effectiveness of sensorimotor and task-oriented handwriting intervention in elementary school-aged students with handwriting difficulties. *OTJR: Occupation, Participation, and Health,* 29, 125-134.

Wulf, G., Shea, C., & Lewthwaite, R. (2010) Motor skill learning and performance: a review of influential factors. *Medical Education,* 44, 75-84.

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METHOD

Participants

The research took place in a regular school from a rural part of the French part of Switzerland. Grade 1 begins after two years of kindergarten; the children learn to read and to

handwrite during this first year of primary school. Three Grade 1 classes from a regular public school participated on a voluntary basis. Grade 1 children (n = 23; 6.1 to 7.3 years old) from two classes constituted the experimental group with 15 boys and 8 girls. The control group (n = 19) was composed of 8 girls and 11 boys from one class. No differences in the teaching of handwriting between the teachers were observed. In the school system where the research took place, it was not possible for the parents to choose the school or teacher of their child. The children were all fluent French speakers and they came from the same kindergarten which provides an identical pre-graphism program. The objectives of this program were to become familiar with different graphical tools, to master movements for graphism and to learn how to draw different shapes such as circles, vertical and horizontal lines as well as diagonals. All the children in these classes participated in the study with the written consent of their parents who were informed that they could withdraw their children at any time during the research.

Measure

As the children had not learnt during kindergarten how to write letters, no handwriting evaluation was possible at the beginning of Grade 1. The experimental and control groups were assessed for speed and for quality with the French version of the BHK-Concise Assessment Scale for Children's Handwriting (Charles, Soppelsa, & Albaret, 2003) two months after the end of the explicit program. In this test, the child is only asked to copy a text, for 5 min., in cursive letters. The first five lines are analysed in the assessment process, using 13 criteria: (1) letter size, (2) left margin widening, (3) poor word alignment, (4) insufficient word spacing, (5) acute turns in connecting letters or overly long connections, (6) no joining strokes, (7) collision of letters, (8) inconsistent letter size, (9) incorrect relative height of letters, (10) letter distortion, (11) ambiguous letter forms, (12) correction of the letter, and (13) unsteady writing trace. Each criterion is given a rating from zero to five, therefore the quality of handwriting may range from between 0 (worst) and 65 (best). For children in Grade 1, a score under 20 means no difficulty, a score between 21 and 28 signifies poor handwriting and a score at or above 29, very poor handwriting. Concerning the speed of handwriting, the number of letters written during the 5-min. period is counted; the mean is 170 letters and a score two standard deviations below the mean is 82.1 letters. The inter-rater reliability for the BHK is .90 and the concurrent validity with teachers' judgement is .68 ($p <$ .01) (Charles, *et al*., 2003).

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The objectives of the program were to develop digital dexterity, to provide the child with explicit learning, using the development of learning strategies such as auto-evaluation, anticipation or verbalization, and to practice endurance and speed. A review of the literature was carried out to identify the most effective methods for teaching and learning handwriting. Each session was composed of five parts. The first part started with digital dexterity exercises, as digital dexterity is a predictive factor in handwriting quality (Cornhill & Case-Smith, 1996) among a group of Grade 1 children composed of proficient and non-proficient handwriters in a group of 10-year-old children (Weintraub & Graham, 2000). Several in-hand manipulations were practiced, such as sequential opposition of digits or translation movements of five small objects, one after another, from the fingertips to the palm or from the palm to the fingertips.

During the second part of the program, the usefulness of handwriting was also discussed with the children. As proposed by Denton, *et al*., a meaningful context was provided for the children who were asked why it was important to learn handwriting. They were also given the task of writing short sentences for their classmates to read. The children were instructed to make links between written letters and phonological sounds (Denton, *et al*., 2006). They were then encouraged to find words that contained the letter being learnt or to enunciate all the possible sounds for one letter.

During the third part of the program, the teaching of letters was carried out. As the letters “a, c, d, g, q, o” had already been learnt by the children during the weeks preceding the experiment, the following letters were presented: “e, l, h, k, f, b, i, t, u, v, w, j, y, m, n, p, r, s, x, z”. During each session, two or three letters were learnt only in cursive style. The researcher administering the additional program modeled the movements required for writing each target letter while providing explanations about the direction stroke of the letter. As mentioned by Jones and Christensen (1999), explanations provided with modeling are more effective than explanation or modeling alone. As in the experiment conducted by Berninger, *et al*. (1997), each child had the model of the letter in front of him, with arrows indicating the direction and to memorize how to write it.

During the fourth part, children practised the letter on white paper, varying speed and size, and then they wrote it on a page that contained a model of the letter. They were able to try out different kinds of pens or pencils.

Next, the children were given a metacognitive task: as described by Jongmans, *et al*. (2003), they analyzed their handwriting to identify the differences between their own production and the model. Each child explained to the researcher where he should pay attention the next time he wrote the letter. He then identified the best-written letter and put a sticker under it.

The regular school program includes 40 minutes each week of handwriting which involves practising two or three letters in a notebook. The children are asked to copy the letter several times then to copy words that contain those letters. However, during the first trimester of the school year, children must write with print letters, i.e., in the style of printed materials such as books or newspapers, for all their written work. It should be pointed out that certain print letters are not formed in the same way in cursive writing (b, f, h, k, l, p, r, s, v, w, x, z). This practice is typical of most teachers from the state where the research took place. It has no particular theoretical basis.

Analysis

A *t* test for independent groups was performed for comparisons of the two groups on quality and speed variables at post-test with SPSS Version 13. Significance was set at $p < .05$.

RESULTS

For the quality of handwriting on the BHK, the children from the experimental group had a mean of 17.1 (*SD* = 7.2) and the children from the control group had a mean of 24.7 (*SD* = 7.0). For the speed of handwriting, the mean of the explicit handwriting program group were 55.7 (*SD* = 19.7) letters in 5 min. while the mean of the regular handwriting program group was 40.7 (18.6).

The experimental group performed significantly better on speed and quality than the control group. Differences between items of the BHK showed significantly fewer irregularities in joining strokes, better word alignment, fewer ambiguous letters, and fewer corrections of letters for the experimental group than for the control group (Table 1).

DISCUSSION

Two months after having received the explicit handwriting program, the children who had taken part showed a better quality in their handwriting than that of the control group. The main results of this study supported the results of several other studies (Lockart & Law, 1994; Berninger, *et al*., 1997; Denton, *et al*., 2006). As hypothesized, the handwriting of the experimental group contained significantly fewer ambiguous letters, fewer corrections of letter forms, and irregularities in joining strokes and a better alignment of letters than the control group's handwriting. The children from the experimental group probably had better control over the movements needed to perform handwriting, because what differentiated the two groups was the quality of the trace (joining strokes and alignment of letters). As the experimental group presented fewer ambiguous letters and corrections of form than the control group, it could be postulated that they had developed a better general motor program for forming letters (Smits-Engelsman & Van Galen, 1997), which confirms that when children are given the opportunity to analyze their written productions and to speak with someone about them, they can improve their motor programs. As in Jones and Christensen (1999), writing speed was faster for the experimental group than for the control group. However, this result differed from those of two studies, which did not find any significant results in terms of speed (Lockart & Law, 1994; Jongmans, *et al*., 2003).

As mentioned in motor learning theory (Wulf, Shea, & Lewthwaite, 2010), explicit learning and self-controlled practice seems to influence the building of a motor program and to be optimal when combined with the performance of the movement. The results confirm this hypothesis and support the introduction of a handwriting program containing explicit learning as well as self-instruction and self-evaluation.

As children are required to write from the beginning of Grade 1, it would seem relevant to introduce an explicit handwriting program to improve skills that would lead to an improvement in all activities requiring handwriting. As mentioned by Graham, *et al*. (2000), introducing an additional handwriting program and allowing more time for children to learn these skills could prevent further difficulties in both handwriting and in tasks that involve writing.

Although the design of this study could not include a pre-test evaluation, the significant difference can be explained by the influence of the additional program due to the significant difference between the two groups involving items that require better mastery of movements rather than the results of letters that could have been trained at home. This study should ideally be repeated in different contexts, especially with children at risk of developing

handwriting difficulties. Longer-term follow-up should be conducted to assess whether the initial progress is maintained. The results of the present study indicate that an explicit handwriting program at the beginning of the first school year contributes to the mastering of both quality and speed of handwriting. The automatization of handwriting could free attention and working memory, allowing higher achievement of other academic requirements.

REFERENCES

Alston, J., & Taylor, J. (1987) *Handwriting: Theory, research and practice*. London: Croom Helm.

Berninger, V., Mizokawa, D., & Bragg, R. (1991) Theory-based diagnosis and remediation of writing. *Journal of School Psychology,* 29, 57-59.

Berninger, V., Vaughan, K. B., Abbot, R. D., Abbot, S. P., Woodruff Rogan, L., Brooks, A., & Reed, E. (1997) Treatment of handwriting problems in beginning writers: transfer from handwriting to composition. *Journal of Educational Psychology,* 89, 652-666.

Berninger, V. W., Nielsen, K. H., Abbott, R. D., Wijsman, E., & Raskind, W. (2008) Writing problems in developmental dyslexia: Under-recognized and under-treated. *Journal of School Psychology*, 46, 1-21.

Charles, M., Soppelsa, R., & Albaret, J-M. (2003) *BHK - Echelle d'évaluation rapide de l'écriture chez l'enfant*. Paris: Editions et Applications Psychologiques.

Cornhill, H., & Case-Smith, J. (1996) Factors that relate good and poor handwriting. *The American Journal of Occupational Therapy,* 50, 732-739.

Denton, P. L., Cope, S., & Moser, C. (2006) The effects of sensorimotor-based intervention versus therapeutic practice on improving handwriting performance in 6- to 11-year-old children. *The American Journal of Occupational Therapy,* 60, 16-27.

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,* 92, 620-633.

Graham, G., Harris, L., Mason, L., Fink-Chorzempa, B., Moran, S., & Saddler, B. (2008) How do primary grade teachers teach handwriting? A national survey Reading and Writing. *An Interdisciplinary Journal,* 21, 49-69.

Harris, S. J., & Livesey, D. J. (1992) Improving handwriting through Kinaesthetic sensitvity practice. *The Australian Occupational Therapy Journal,* 39, 23-27.

Jones, D., & Christensen, C. A. (1999) Relation between automaticity in handwriting and students' ability to generate written text. *Journal of Educational Psychology,* 91, 44-49.

Jongmans, M., Linthorst-Bakker, E., Westenberg, Y., & Smits-Engelsman, B. C. M. (2003) Use of a task-oriented self-instruction method to support in primary school with poor handwriting quality and speed. *Human Movement Science,* 22, 549-566.

Karlsdottir, R., & Stefansson, T. (2002) Problems in developing functional handwriting. *Perceptual and Motor Skills,* 94, 623-662.

Laszlo, J. I., & Bairstow, P. J. (1983) Kinaesthesis : its measurement, training and relationship to motor control. *Quarterly Journal of Experimental Psychology*, 35A, 411-421.

Lockart, J., & Law, M. (1994) The effectiveness of a multisensory writing program for improving cursive writing ability in children with sensori-motor difficulties. *Canadian Journal of Occupational Therapy*, 61, 206-215.

Smits-Engelsman, B. C. M., Niemeijer, A. S., & van Galen, G. P. (2001) Fine motor deficiencies in children diagnosed as DCD based on poor grapho-motor ability. *Human Movement Science*, 20, 161-182.

Smits-Engelsman, B. C. M., & Van Galen, G. P. (1997) Dysgraphia in children: lasting psychomotor deficiency or transient developmental delay. *Journal of Experimental Child Psychology*, 67, 164-184.

Weintraub, N., & Graham, S. (2000) The contribution of gender, orthographic, finger function, and visual-motor processes to the prediction of handwriting status. *The Occupational Therapy Journal of Research*, 20, 121-140.

Weintraub, N., Yinon, M., Hirsch, I. B. E., & Parush, S. (2009) Effectiveness of Sensorimotor and Task-Oriented Handwriting Intervention in Elementary School-Aged Students With Handwriting Difficulties. *Otjr-Occupation Participation and Health*, 29, 125-134.

Wulf, G., Shea, C., & Lewthwaite, R. (2010) Motor skill learning and performance: a review of influential factors. *Medical Education*, 44, 75-84.

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Table 1
Mean difference and *t* test for the experimental (E; *n* = 23) and control (C; *n* = 19) groups on BHK items measuring handwriting skills.

Items BHK	Group	*M*	*SD*	*M D*	*df*	*t*	*d*
Letter size	E	1.91	1.39				
	C	2.21	1.79	.30	40	0.61	0.19
Left margin widening	E	.78	.90				
	C	.84	1.67	.06	40	0.14	0.04
Poor word alignment	E	3.53	1.54				
	C	4.46	..95	.93	37.39	2.38*	0.67
Insufficient word spacing	E	1.80	1.62				
	C	2.71	1.95	.90	35.01	1.64	0.49
Acute turns or too long joining	E	1.46	1.54				
	C	1.32	1.63	.14	40	0.28	0.09
Irregularities in joining strokes	E	3.41	1.40				
	C	4.57	.78	1.15	35.54	3.36†	0.89
Collision of letters	E	.11	.36				
	C	.26	1.14	.15	40	0.61	0.18
Inconsistent letter size	E	1.79	1.45				
	C	2.64	1.72	.85	40	1.71	0.52
Incorrect relative height of letters	E	.92	1.26				
	C	2.42	2.26	1.50	26.97	2.56*	0.78
Ambiguous letter forms	E	1.45	1.52				

	C	2.68	1.14	1.23	40	2.70*	0.77
Correction of letter forms	E	.65	.99				
	C	.50	.85	.15	40	0.52	0.16
Unsteady writing trace	E	.00	.00				
	C	.08	.34	.08	18	1.00	0.34
Total score (quality)	E	17.07	7.21				
	C	24.70	6.97	7.61	41	3.48†	0.37
Speed	E	55.65	19.70				
	C	40.58	18.63	15.07	40	2.52†	2.03

Note.— *d*= Cohen's *d*. [a]*n* = 23. [b]*n* = 19. *$p < .05$. †$p < .01$.