Cognitive versus Multisensory Approaches for Handwriting: Current State of the Evidence

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Key Points:

There is little evidence to support the use of multisensory/sensorimotor approaches to handwriting intervention, and these interventions may be detrimental to students beyond first grade (Year 2).
Cumulating evidence supports the use of cognitive, task-specific interventions for handwriting.
Therapeutic intervention might be better served to students after first grade (Year 2); younger students tend to improve without intervention but older students with handwriting difficulties tend not to improve without intervention.
Current practice may not provide sufficient intervention to achieve gains in handwriting. Based on a recent summary of handwriting research, a minimum of 20 sessions twice weekly is recommended.

I had the good fortune of being invited to give the keynote address at the *Handwriting in the UK Conference* in July 2010. I presented results of a randomized clinical trial I conducted (Zwicker and Hadwin, 2009), as well as results from other studies (Sudsawad, Trombly, Henderson, and Tickle-Degnen, 2002; Denton, Cope, and Moser, 2006; Weintraub, Yinon, Bar-Effrat Hirsch, and Parush, 2009; Mackay, McCluskey, and Mayes, 2010), to summarize the evidence and suggest that cognitive approaches are more effective than multisensory approaches in improving the handwriting legibility of primary school students. As current practice tends to favour multisensory approaches (Feder, Majnemer, and Synnes, 2000; Taylor, 2001; Woodward and Swinth, 2002), my message was somewhat controversial.
I have since been asked to write an article for the *Dyspraxia Foundation Professional Journal* to highlight key messages from my keynote address, which is what follows. In the next article, my colleague Ivonne Montgomery and I present how we have translated this research knowledge into clinical practice by developing a printing program based on the current state of the evidence.

Why examine multisensory versus cognitive approaches to handwriting remediation?

These data are over 10 years old now but at the time I was planning my study the literature indicated that over 90% of occupational therapists in North America used a multisensory or sensorimotor approach to handwriting intervention (Feder, Majnemer, and Synnes, 2000; Woodward and Swinth, 2002). Multisensory

interventions also seemed to be favoured in the UK (Taylor, 2001). These findings were consistent with my clinical experience. Working as a school-based occupational therapist at the time, a colleague had recently developed guidelines for a multisensory printing program for use in our local school districts. Embarking on my Masters degree in Educational Psychology, I set out to examine the effectiveness of this multisensory printing program. Needless to say, this is not exactly what transpired in the ensuing years.

Delving into the literature, I was disheartened to discover that the evidence for multisensory interventions for handwriting was sparse and inconclusive (Oliver, 1990; Harris and Livesey, 1992; Lockhart and Law, 1994). More recent research suggested that handwriting intervention was effective, but it was unclear which part of the eclectic intervention was responsible for positive handwriting outcomes (Case-Smith, 2002; Petersen and Nelson, 2003). Around the same time, preliminary evidence supporting cognitive approaches to handwriting intervention began to emerge (Graham, Harris, and Fink, 2000; Miller, et al., 2001; Jongmans, Linthorst-Bakker, Westenberg, and Smits-Engelsman, 2003). Because cognitive and multisensory handwriting interventions had not been empirically compared, I decided to plan and implement a research study to meet this objective.

The Randomized Clinical Trial of Handwriting Interventions

Details of the study design and results have been reported elsewhere (Zwicker and Hadwin, 2009), so I will only highlight key points of the study in this manuscript. Seventy-two children in Grades 1 and 2 (equivalent to Years 2 and 3 in the UK) who had been referred to school-based occupational therapy for handwriting difficulties participated in the trial. Following assessments to determine developmental readiness to print and baseline handwriting ability, children were randomly assigned to one of three groups: (1) cognitive intervention; (2) multisensory intervention; and (3) no intervention (control) group. Children in the intervention groups were seen by an occupational therapist once weekly for 30 minutes over 10 weeks. Therapists adhered to intervention guidelines established for each group. Cognitive intervention followed a similar format as that outlined by Graham, Harris, and Fink (2000) and included modelling, imitation, discussion, practice, and self-evaluation. Multisensory intervention was designed from descriptions in the literature (Woodward and Swinth, 2000; Amundson, 2005) and from feedback of practising school-based occupational therapists. Activities included writing on the chalkboard, “sky-writing”, tracing bumpy glitter glue letters, tracing letters in cornmeal, and copying letters using coloured markers, pencil, and paper. Both intervention groups followed the same letter sequence in each session. The focus of the cognitive intervention was on metacognitive awareness of letter formation using verbal mediation and self-evaluation, whereas the emphasis of the multisensory intervention was on learning the feel of the letter. The primary outcome was total letter legibility as measured by the Evaluation Tool of Children’s Handwriting – Manuscript (ETCH-M) (Amundson, 1995). Change scores (pre-test-post-test) were calculated for each participant. The study design is summarized in Figure 1.

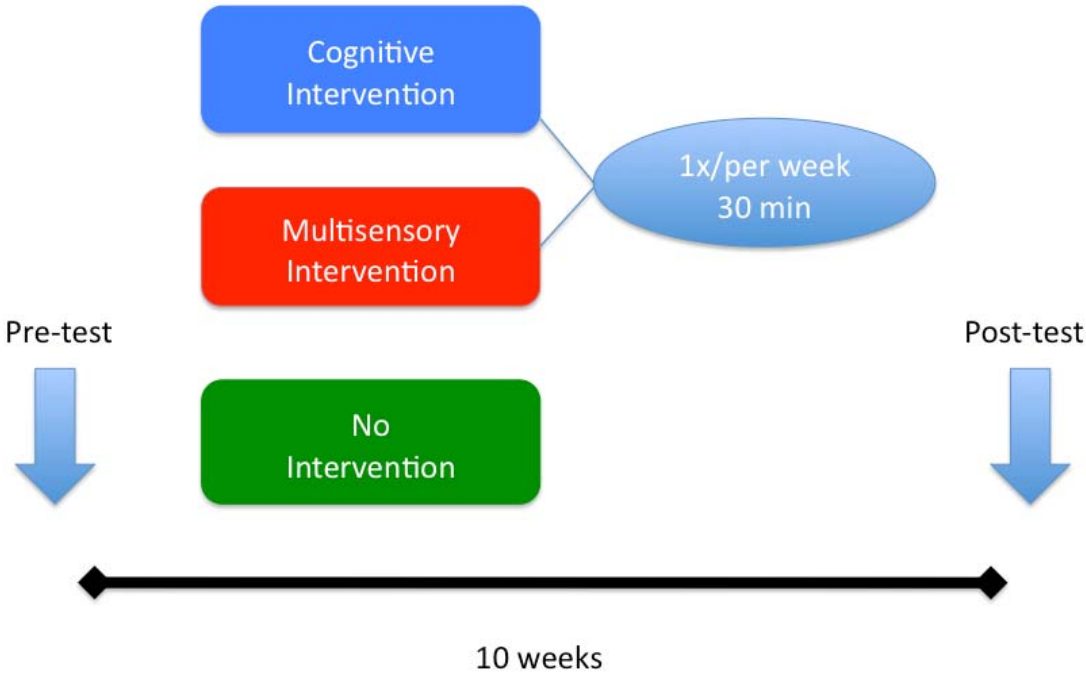

Figure 1. Study Design Comparing Handwriting Interventions

There were no significant differences between the three groups in terms of gender distribution, grade level, visual motor integration skills, or pretest ETCH scores. The sample was 71% boys and 29% girls, with the majority of the students (n=45) in Grade 1 (Year 2) and the remainder (n=27) in Grade 2 (Year 3). Taken as a whole, there were no significant differences in change scores across the three groups following intervention (*F* [2,69], 1.42, n.s.). However, when we examined differences between grade levels, an interesting pattern emerged. As can be seen in Figure 2, students in Grade 1 (Year 2) improved regardless of intervention (including no intervention), with a slight but non-significant advantage of the multisensory intervention. In contrast, students in Grade 2 (Year 3) showed little improvement with the multisensory intervention, achieving comparable gains to having no intervention at all. These students showed much greater improvement with the cognitive intervention (Figure 3). In fact, all students in Grade 2 (Year 3) obtained higher legibility scores at post-test, whereas 4 of 9 students in the multisensory group and 3 of 10 students in the control group had lower legibility scores at post test.

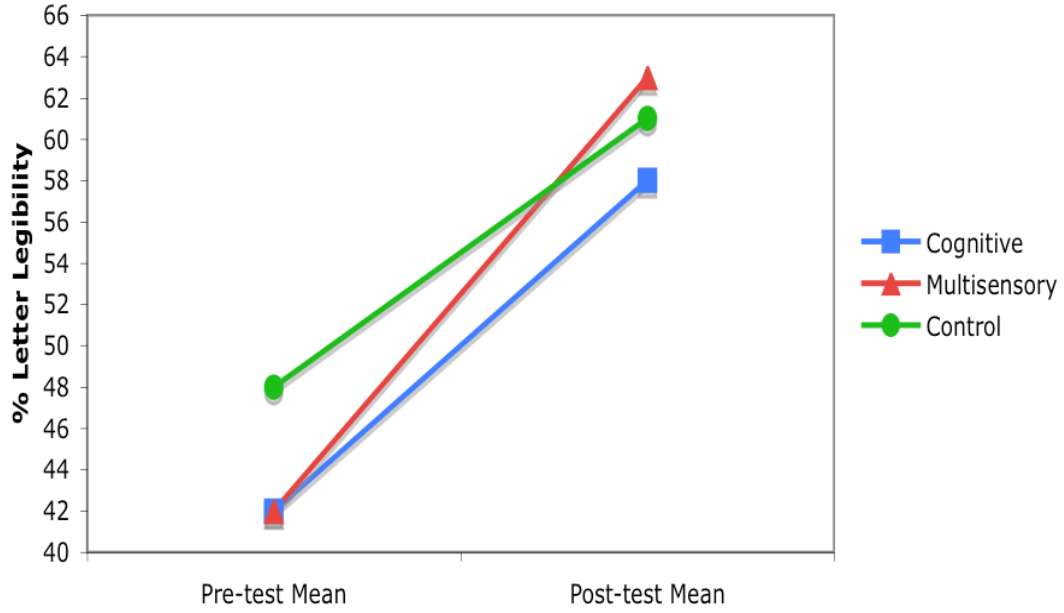

Figure 2. Change in Legibility Scores for Students in Grade 1 (6-7 years)

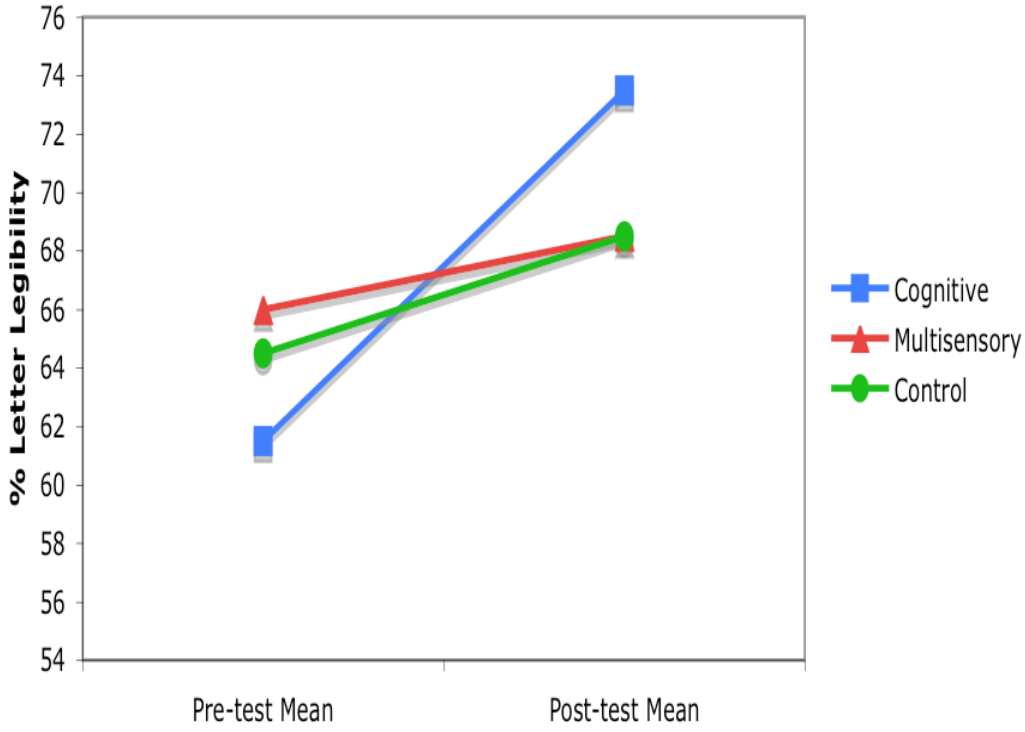

Figure 3. Change in Legibility Scores for Students in Grade 2 (7-8 years)

These findings suggest that there may be developmental differences in response to intervention, and that the type of intervention matters. Students in Grade 1 (Year 2) showed similar gains whether they received intervention or not. This is an important

finding for two reasons: (1) many students in Grade 1 (Year 2) are receiving occupational therapy intervention for handwriting difficulties, but it appears that time and regular classroom instruction are sufficient to produce gains in handwriting legibility; (2) much of the current research related to handwriting has been conducted with Grade 1 (Year 2) students. This research calls into question these research findings because students in this grade improve without direct intervention. In contrast, children in Grade 2 (Year 3) did not improve without intervention, which is consistent with the literature (Hamestra-Bletz and Blöte, 1993; Jongmans, Linthorst-Bakker, Westenberg, and Smits-Engelsman, 2003). More importantly, these students tended to have poorer handwriting legibility with multisensory intervention. Cognitive intervention was the only intervention to produce gains in handwriting legibility. This may be because students in Grade 2 (Year 3) have further developed cognitively and have greater meta-cognitive skills compared with their younger peers. As Grade 2 (Year 3) students typically no longer receive explicit instruction in class, struggling writers appear more likely to benefit from cognitive-based handwriting intervention.

This study is not without limitations. We might have found more robust findings with greater intensity or frequency of intervention. Whilest the amount of intervention (once weekly for 30 minutes) was generous in relation to current school-based practice, a recent review of the literature suggests that a minimum of twice weekly practice over 20 sessions is required to produce positive results in handwriting legibility (Hoy, Egan and Feder, 2010). Because the ETCH is a measure of global legibility, it may not have been sensitive enough to measure subtle changes in handwriting legibility. We did not record the amount and type of in-class handwriting instruction the students received. Whilst variability of these factors may have influenced the results, the random allocation of students across interventions groups probably mitigated these effects.

Integration of Findings with Other Studies

The study described above was completed in 2005. Since that time, several studies on handwriting interventions have been published. I will now highlight a few of these studies published in occupational therapy journals and compare the results with our study (Zwicker and Hadwin, 2009) and with each other.

Multisensory and Sensorimotor Interventions Can Result in Decline in Performance

Denton, Cope, and Moser (2006) also conducted a randomized clinical trial of handwriting interventions. They studied 38 children (6-11 years) with handwriting dysfunction and compared sensorimotor intervention (n = 14), therapeutic practice (n = 15), and no intervention (n = 9). The sensorimotor intervention addressed visual perception, visual motor integration, proprioception/kinesthesia, and in-hand manipulation skills, whereas the therapeutic practice group worked on handwriting skills through copying, dictation and writing from memory. Students were seen 4 times a week for 5 weeks, for a total of 10 hours of intervention. Results were not significant between the groups, but overall findings suggest that the therapeutic practice group showed positive gains in handwriting, the sensorimotor group showed a decline in performance and the control (no intervention) group showed no change in handwriting performance.

Consistent with Zwicker and Hadwin (2009), the dose of intervention was probably

insufficient to produce statistically significant results, but the pattern of findings was similar between the two studies. Older students receiving multisensory/sensorimotor interventions showed a decline in their handwriting, whereas cognitive/therapeutic practice produced positive results.

Working on Sensorimotor Skills Does Not Improve Handwriting

Sudsawad, Trombly, Henderson, and Tickle-Degnen (2002) compared the effects of kinaesthetic training, handwriting practice, and no intervention on the handwriting legibility of 45 first-grade students (6-7 years). Kinaesthetic training involved practice on two kinaesthetic tasks, with the assumption being that improved kinaesthesia would translate into improved handwriting. Handwriting practice included copying letters, words and sentences with visual and verbal feedback for letter size, alignment and spacing. Both groups had daily intervention for 30 minutes for 6 days. There was no significant improvement in handwriting for any group as measured by the ETCH, but improvement was noted by teachers of students in all groups (including those not receiving intervention). As with the other studies described, the amount of intervention may not have been enough to produce significant findings. Interestingly, all groups showed improvement in kinaesthesia (with or without training), but kinaesthetic training had no effect on handwriting legibility or speed. These results are similar to Denton and colleagues (2006) who found that improvements in sensorimotor skill did not lead to improvements in handwriting (and, in fact, resulted in a clinically meaningful decline in handwriting).

Grade 1 (Year 2) Students Improve and May Not Require Intervention
Mackay, McCluskey, and Mayes (2010) conducted a study involving 16 children (6-8 years) who received 8 weekly task-specific handwriting sessions of 45 minutes each. The intervention appeared to combine some multisensory elements (e.g., practising letters in a dish of rice) with cognitive elements (e.g., verbal instruction, modelling, and feedback). Significant improvements were noted and were comparable to gains shown in other studies (Case-Smith, 2002; Zwicker and Hadwin, 2009). However, a major limitation of this study is a lack of control group. The improvements noted may have resulted regardless of intervention, as was seen in the control group of Grade 1 (Year 2) students in Zwicker and Hadwin's (2009) study. Because students of this age are still learning how to print and are receiving in-class instruction, occupational therapy intervention at this age may be not necessary.

Cognitive/Task-Specific Intervention is Effective for Students in Grade 2 (Year 3) and Higher
Weintraub, Yinon, Bar-Effrat Hirsch, and Parush (2009) conducted a randomized clinical trial with students beyond Grade 1. In a sample of 55 students in Grades 2-4, these authors compared the effects of task-specific intervention, task-specific plus sensorimotor intervention and no intervention on handwriting legibility. Intervention was carried out for 8 weekly one-hour sessions in groups of 4-6 students. Although both intervention groups improved, only the task-specific intervention group showed statistically significant gains in legibility. This study confirms results of other studies (Denton, Cope, and Moser, 2006; Zwicker and Hadwin, 2009) that sensorimotor intervention had no additional benefit (and perhaps took away from) the cognitive

elements of intervention. Consistent with Zwicker and Hadwin (2009), Weintraub and colleagues show that cognitive/task-specific intervention is superior to multisensory/sensorimotor approaches for children beyond Grade 1 (Year2).

Integrating the Evidence

Just as when I embarked on my Master's degree in 2003, there continues to be little evidence for multisensory/sensorimotor interventions for handwriting. Multisensory approaches may have some benefit for younger students as a means of engaging reluctant writers, but the approach has questionable value in improving handwriting legibility. This is especially the case for students in Grade 2 (Year 3) and above, where converging evidence suggests that older students appear to be disadvantaged by a multisensory/sensorimotor approach (Denton, Cope, and Moser, 2006; Weintraub, Yinon, Bar-Effrat Hirsch, and Parush, 2009; Zwicker and Hadwin, 2009).

Accumulating evidence indicates that cognitive handwriting approaches appear to have the most favourable results (Weintraub, Yinon, Bar-Effrat Hirsch, and Parush, 2009; Zwicker and Hadwin, 2009; Mackay, McCluskey, and Mayes, 2010). Whilst intervention differed between the studies, several features in these and other studies have been shown to be effective in improving handwriting. These include:

Numbered arrow cues (Berninger, et al., 1997)
Recalling letter formation from memory (Graham, Harris, and Fink, 2000)
Self-instruction/verbal mediation (Graham, Harris, and Fink, 2000; Miller, et al., 2001)
Self-monitoring and evaluation (Graham, Harris, and Fink, 2000)
Task-specific (Jongmans, Linthorst-Bakker, Westenber and SmitsEngelsman, 2003; Miller et al., 2010)

The last element – *task-specificity* – is consistent with motor learning theory (Zwicker and Harris, 2009) and reinforces the idea that therapy should be focused on the actual task to be learned and not the underlying components of the skill. Converging evidence shows that working on sensorimotor skills such as kinaesthesia or visual perception, does not result in improved handwriting skills (Denton, Cope, and Moser, 2006; Sudsawad, Trombly, Henderson, and Tickle-Degnen, 2002; Weintraub, Yinon, Bar-Effrat Hirsch, and Parush, 2009). In a recent summary of the evidence, Hoy and colleagues (2010) confirmed that actual *handwriting practice* was essential to improving handwriting outcomes.

As mentioned throughout this paper, many research interventions were likely "under-dosed" to produce robust effects. From my experience, this also seems to be the case in clinical practice. Research suggests that a minimum of 20 sessions offered two times a week is required to achieve improvements in handwriting (Hoy, Egan, and Feder, 2010). Our direct therapy or recommendations to others needs to reflect this frequency and duration of intervention.

Conclusion

The current state of the evidence indicates that cognitive-based, task-specific interventions produce better handwriting outcomes compared to multisensory/ sensorimotor interventions. Research also suggests that older students [Grade 2 (Year 3) and higher] are likely to benefit more from intervention than younger

students. These two findings are in direct contrast to my clinical practice prior to examining the literature and conducting handwriting research. Many students on my caseload were in Grade 1 and I often provided multisensory recommendations for improving printing skills. I have since changed my practice, as have many of my colleagues. In the light of the evidence I presented, I hope that you will reflect on your practice and consider how to incorporate evidence-based interventions and recommendations for your clients with handwriting difficulties. The next article, *Applying Current Research Evidence into Practice: Development of a Handwriting Intervention* Program (Montgomery and Zwicker, 2011) may help you get started or continue with this process. In this paper, we describe how we translated current handwriting research knowledge into clinical practice and provided a link to a free, evidence-based resource we created. We hope you find it useful.

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