



AOTA Critically Appraised Papers Series

Evidence Exchange

**A product of the American Occupational Therapy Association's Evidence-Based Literature Review Project*

CRITICALLY APPRAISED PAPER (CAP)

Focused Question

Is a cognitive-based program more effective than a multisensory program to increase handwriting performance in first- through third-grade students identified as having handwriting difficulties?

Zwicker, J., & Hadwin, A. (2009). Cognitive versus multisensory approaches to handwriting intervention: A randomized controlled trial. *OTJR: Occupation, Participation & Health*, 29(1), 40–48. <http://dx.doi.org/10.3928/15394492-20090101-06>

CLINICAL BOTTOM LINE:

Handwriting difficulties in school-aged children are one of the most common types of referrals to occupational therapy and are often remediated using multisensory strategies even though evidence of benefit is limited or inconclusive. Previous studies incorporating a variety of techniques included in handwriting interventions make it difficult to isolate the intervention component that contributes to improvements when they are evidenced in the literature. Some strategies listed include multisensory approaches, behavioral and motor-learning techniques, and developmental and behavioral strategies. Studies using a cognitive approach with resultant positive results provide preliminary evidence to the efficacy of this type of intervention.

This study provides occupational therapy practitioners with further evidence regarding the use of cognitive intervention approaches for remediating handwriting difficulties in school-based therapy, particularly in second-graders. The process of this approach included a guideline for intervention allowing for the school-based practitioner to establish more robust intervention sessions. Examples of sessions included alphabet warm-up, and activities included the following:

1. Singing the alphabet song, naming letters pointed to from an alphabet strip, and the child naming letters that come before and after the target letter as named by the therapist;
2. Modeling, which is a demonstration of letter formations including cards with numbered arrows sequencing stroke order and direction;
3. Imitation, during which a child imitates the therapist in forming while verbalizing the formation;
4. Discussion of how specifically grouped letters were alike or different;

5. Practice, which is the naming of a letter and verbalizing formation followed by tracing from a copy containing numbered arrows, tracing without numbered arrows, and copying (final practice was writing letters from memory); and
6. Evaluation, during which children determined the best-formed letter by circling it on the paper.

This study demonstrated that first-graders improved in handwriting performance regardless of which intervention received or receiving no intervention, suggesting that while these students are receiving handwriting instruction within the curriculum, direct occupational therapy services may not be indicated at that time. Second-graders did not improve in legibility scores without intervention, nor did they improve from using multisensory strategies. Cognitive intervention strategies resulted in improved handwriting legibility.

It would appear that developmental readiness for use of a cognitive-based approach is key to selecting the intervention strategy for handwriting remediation and should be a consideration when remediating this skill in children starting in second grade. It should be noted that limitations of sample size and geographic location make it difficult to generalize results to the population. Additionally, individualized attention received versus intervention chosen may have accounted for improvements in the study participants versus the control group. The findings support the use of cognitive-based strategy with opportunities to further investigate effectiveness within occupational therapy practices.

RESEARCH OBJECTIVE(S)

List study objectives.

1. To examine whether first- and second-grade students receiving either intervention would significantly improve with handwriting legibility as compared to students receiving no intervention at all.
2. To examine whether the students receiving the cognitive intervention would demonstrate a greater improvement in handwriting legibility as compared to those students receiving the multisensory intervention.

DESIGN TYPE AND LEVEL OF EVIDENCE:

Level I
Randomized controlled trial
Experimental, using pre- and post-intervention design.

Limitations (appropriateness of study design):

Was the study design type appropriate for the knowledge level about this topic? *Circle yes or no, and if no, explain.*

YES/NO

The study used a rigorous design, which isolated specific variables from outcomes identified from past research on this topic. Additionally, no ethical issues surrounded the withholding of treatment with the control group, as parents were aware their child might have to wait for 12 weeks to eventually receive intervention. This waiting period was similar to average wait lists for occupational therapy intervention. Finally, the study purpose set out to define effectiveness of treatment.

SAMPLE SELECTION

How were subjects selected to participate? Please describe.

Participants included first- and second-grade students who were referred to occupational therapy for handwriting difficulties. Fifteen occupational therapists identified students from their caseload on the basis of inclusion criteria and exhibited developmental readiness for learning to print based on their ability to copy the first 8 forms on the Beery–Buktenika Test of Visual Motor Integration (VMI). The parents and participants in the study provided their informed consent. The Evaluation Tool of Children’s Handwriting (ETCH) was then administered as a pretest indicator of handwriting skill. Participants scoring below 85% legibility were included in the study. Participants were then randomly assigned to 1 of 3 groups. Parents were informed that their child might wait 12 weeks for intervention if they were assigned to the control group but could choose intervention following posttest data collection.

Inclusion Criteria

1. Normal hearing and normal vision with or without glasses.
2. Normal cognition, as indicated within school file.
3. Developmentally ready to learn printing, as indicated by accurate scores on first 8 forms of the VMI.
4. No prior direct handwriting intervention.

Exclusion Criteria

1. A diagnosis of autism, mental retardation, fetal alcohol spectrum disorder, or severe developmental delay.
2. A medical or educational diagnosis that would interfere with writing.

SAMPLE CHARACTERISTICS

$N = 72$

Dropouts 1 (1%) (Parental consent not received)

#/ (%) Male 51/ 71%

#/ (%) Female 21/ 29%

Ethnicity NR
45 first-grade participants
27 second-grade participants

Disease/disability diagnosis Typically developing students with handwriting difficulties.

Check appropriate group size:

<20/study group	20–50/study group	51–100/study group ✓	101–149/study group	150–200/study group
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INTERVENTION AND GROUP COMPARISONS

Group 1: Multisensory Intervention

Brief Description	<p>The occupational therapists delivering the multisensory intervention to 24 participants followed strictly designed treatment protocols. Each session included the following:</p> <ol style="list-style-type: none"> 1. The therapist named letter grouping and demonstrated formation of target letters on chalkboard using chalk. 2. The child copied each letter 3 times, 1 letter at a time, on the chalkboard. 3. The therapist demonstrated and the child imitated “sky writing” of each letter 3 times. 4. The therapist demonstrated and the child imitated formations of each letter in a tray of sand or cornmeal 3 times. 5. The child traced over bumpy glitter-glue letters with his or her index finger 3 times. 6. The child traced and then copied each letter 3 times with a marker on a worksheet. 7. The child copied each letter 3 times with a pencil on regular-lined paper. <p>The approach in this group focused on the feel of the letters through a variety of sensory modalities. Children were encouraged by feel versus by verbalization.</p> <p>The format followed above was based on information from Woodward and Swinth (2002), as well as from feedback from therapists participating in the study.</p>
Setting	Intervention was received in the participants’ school setting.
Who Delivered?	Occupational therapists delivered individual treatment.
Frequency?	One time per week for 30 minutes per session.
Duration?	10 weeks.

Group 2: Cognitive Intervention

Brief Description	<p>The occupational therapists delivering the cognitive intervention to 24 participants followed strictly designed treatment protocols. Each session included the following:</p> <ol style="list-style-type: none"> 1. Alphabet warm-up. The therapist and/or the child sang the alphabet song. The child then named each letter of the alphabet the therapist pointed to, the therapist named a target letter, and the child named the letters just before and after the target letter. 2. Modeling, which is a demonstration and descriptions of letter formations. 3. Imitation, during which The child imitated the therapist by tracing a
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	<p>letter while describing how to form it.</p> <ol style="list-style-type: none"> 4. Discussion, during which the therapist and child discussed how letters in the group were similar and different. 5. Practice, which involved paper-and-pencil tracing and copying tasks, followed by practicing from memory. 6. Evaluation, during which the child circled the best-formed letter for each target letter introduced. <p>The approach in this group differed from that in the multisensory group, whereby emphasis was placed on metacognitive awareness of letter formation and included verbal mediation to guide letter formation.</p> <p>The format followed above was taken from procedures outlined by Graham, Harris, and Fink (2000).</p>
Setting	Intervention was received in the participants' school setting.
Who Delivered?	Occupational therapists delivered individual treatment.
Frequency?	One time per week for 30 minutes per session.
Duration?	10 weeks.

Group 3: No Intervention--Control Group

Brief Description	No intervention received outside of standard handwriting curriculum.
Setting	Classroom setting.
Who Delivered?	Classroom teacher.
Frequency?	NR
Duration?	NR

Intervention Biases:

Contamination

YES NO

The control group did not receive intervention. It was expected that all 3 groups would continue to receive handwriting instruction as part of the regular curriculum.

Co-intervention

YES NO

While all groups received handwriting instruction by their teachers, there was no control placed on intensity or approach used in the classroom. Therefore, variability in amount and type of instruction may have influenced the results.

Timing

YES NO

Intervention duration was a short time frame, reducing maturation as a factor for improvement.

Site

YES NO

The site of interventions was consistent across groups.

Use of different therapists to provide intervention

YES NO

While all therapists were trained in a specific protocol for intervention, it would be difficult to control intervention styles. Therapeutic use of self may play a role in influencing participation or outcomes.

MEASURES AND OUTCOMES

Complete for each relevant measure when answering the evidence-based question:

Name of measure, what outcome was measured, whether the measure is reliable and valid (as reported in article--yes/no/NR [not reported]), and how frequently the measure was used.

The ETCH was used to measure legibility of handwriting. This standardized assessment is comprised of 6 writing activities: writing alphabet from memory, writing numerals from memory, near-point copying, far-point copying, dictation, and sentence composition.

- a. Reliability, yes (test-retest), but not specified in the article except for greater reliability with total letter legibility (as the dependent measure) versus individual task scores.
- b. Validity, NR.
- c. Frequency, administered to participants pre- and post-intervention. Short- and long-term effects were not reported as a consideration in this study.

Measurement Biases

Were the evaluators blind to treatment status? Circle yes or no, and if no, explain.

YES NO

The principal investigator and a second rater scored all assessments and were blind to the interventions to ensure consistency of scoring. Both were unaware of whose assessments were being scored, as identifying information included a number versus name assignment. It does not appear as though interrater reliability has been established.

* However, the principal investigator was blind to pretest and posttest status of the assessments 60% of the time, while the second rater was blind to pretest and posttest status 100% of the time. The second rater scored only 30% of assessments that were randomly selected.

Recall or memory bias. Circle yes or no, and if no, explain.

YES NO

Self-report tools, surveys, or interviews were not conducted.

Others (list and explain):

NR

RESULTS

List results of outcomes relevant to answering the focused question.

Include statistical significance where appropriate ($p < 0.05$).

Include effect size if reported.

- While there was no significant difference across the change scores for each group, there was a medium effect size, as reported by the authors, between the cognitive intervention and control group ($d = .51$) and between the multisensory intervention and the control group ($d = .48$), suggesting something beneficial (relative to clinical change) about receiving intervention. This effect size was determined by calculating change from pretest and posttest scores.
- There was a large effect size between the change scores of the cognitive versus the multisensory intervention group ($d = 1.09$) and the control group ($d = .92$) in second-grade students. The larger effect size detects a clinical change.
- All second-grade students in the cognitive intervention group obtained higher legibility posttest scores, while 4 of 9 students in the multisensory group showed a decline, and 3 of 10 students in the control group exhibited lower legibility scores posttest.

Was this study adequately powered (large enough to show a difference)? *Circle yes or no, explain.*

YES NO

Total sample size was calculated for an analysis of variance with an alpha level of 0.05 and power at 80% to be 66, or 22 participants per group. This study had a sample size of 72, or 24 participants per group.

Were appropriate analytic methods used? *Circle yes or no, and if no, explain.*

YES NO

The ETCH may not have been an adequate tool to detect subtle changes, as it is a global measure of legibility. It does not assess other aspects of legibility (consistency of letter size, alignment, or ability to write on the line). Also assessment of handwriting occurred in a “snapshot” of 2 occasions, leading to variability of performance.

Were statistics appropriately reported (in written or table format)? *Circle yes or no, and if no, explain.*

YES NO

Total letter legibility scores and change scores were represented in table format. Level of significance was reported in written format.

CONCLUSIONS

State the authors’ conclusions that are applicable to answering the evidence-based question.

This study indicates that handwriting legibility of first-graders improved regardless of whether they received multisensory, cognitive, or no intervention. This finding questions the efficacy of providing handwriting intervention with children in the first grade. Students in second-grade exhibited improved handwriting legibility after receiving cognitive versus multisensory intervention; possibly indicating greater metacognitive skill as accounting for responsiveness to a cognitive-based approach. The authors suggest further investigation into using a cognitive approach to handwriting intervention, such as the Cognitive Orientation to Daily Occupational Performance (Missiuna, Mandich, Polatajko, & Malloy-Miller, 2001).

While medium to large effect sizes were noted within the study and improved legibility was evident, changes in overall scores were not statistically significant. Two reasons for this may be that the approaches used were similar in style and delivery and the test measure used may not have been sensitive to changes pretest and posttest. The ETCH is a gross measure of legibility.

References

- 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. <http://dx.doi.org/10.1037/0022-0663.92.4.620>
- Miller, L. T., Polatajko, H. J., Missiuna, C., Mandich, A. D., & Macnab, J. J. (2001). A pilot trial of a cognitive treatment for children with developmental coordination disorder. *Human Movement Science*, *20*, 183–210. [http://dx.doi.org/10.1016/S0167-9457\(01\)00034-3](http://dx.doi.org/10.1016/S0167-9457(01)00034-3)
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AOTA has determined that this CAP has met AOTA-established criteria and guidelines for research design, format, and structure. The CAP has been peer reviewed by CAP reviewers who are selected and trained by AOTA. However, the vigorous peer review process is conducted independently of the AOTA review and editorial processes.

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