

ORIGINAL RESEARCH

The following paper was adapted from one submitted by Beverly H. Moskowitz to Temple University in May 2009 as part of the requirements for the Doctorate in Occupational Therapy.

RESEARCH QUESTION

What is the effectiveness of a task-oriented approach compared to a process-oriented approach on handwriting legibility among elementary school children?

INTRODUCTION

Handwriting proficiency is one of the primary skills that children must demonstrate to participate satisfactorily in school. Studies have shown that between 30 and 60% of the school day is spent in writing tasks. (Volman, van Schendel, & Jongmans, 2006). Proficient handwriting, defined as that which is produced legibly and timely, has been associated with academic success, especially in higher grades (Graham, Harris, Mason, Fink-Chorzempa, Moran & Saddler, 2007).

Unfortunately, the prevalence of handwriting problems is staggering, and not just among children with learning problems. It is estimated that up to 25% of the typically developing population has difficulty with the task, while up to 90% of the learning disabled population has handwriting difficulties as well. Surveyed therapists report that the assessment and intervention of handwriting problems within the schools constitutes a majority of their referrals (Marr & Dimeo, 2006).

But more than simply insuring that children can handwrite the volume of work needed to be completed on paper, is the need to make sure that the written work is legible. One of the benefits of investing in handwriting education is the efficiency with which students accomplish writing assignments that teachers can read (Goldberg, & Simner, 1999). For the students who haven't mastered the automaticity of handwriting, there is an added cognitive drain as they attend to the mechanics of the task rather than its content and composition (Berninger, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks, & Fulton, 2006). Curricula that do not have formal handwriting instructional time or like whole language which doesn't emphasize drill and practice, may actually hinder fluidity in writing because its students lack necessary foundation skills. Some educators, however, question whether handwriting doesn't simply normalize over time and therefore most children will not need any formal intervention (Marr & Cermak, 2003). Unfortunately, research show that handwriting issues left unresolved lead to frustration as the years pass, less written output and ultimately lower grades (Graham & Perin 2007).

Handwriting has long been accepted as a complex task involving sensory, motor, perceptual and neuromuscular systems, (Berninger, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks & Fulton, 2006). The contribution of multiple sensory systems

including visual and kinesthetic, has led to research specifically designed to assess their degree of influence (Lockhart & Law (1994). The use of a multisensory approach to treatment has been theorized to be effective because of the difficulty children with learning disabilities have generalizing skills, (Lockhart & Law, 1994). Perceptual competence in the areas of visual memory, spatial relations, closure and sequencing have also been thought to be prerequisites for handwriting success (Daly, Kelley & Krauss, 2003; Denton, Cope & Moser, 2006 and Lockhart & Law, 1994). Yet, in spite of the popular perception that all of the above factors contribute to handwriting deficits, when studied as predictive measures of handwriting, only visual-motor integration was shown to significantly correlate with handwriting quality (Volman, van Schendel & Jongmans, 2006). Additional research on the effectiveness of a multisensory approach has been limited and inconsistent (Woodward & Swinth, 2002).

It is felt that the lack of a reliable sensory feedback loop interferes with the ability to visualize the motor patterns necessary for consistent letter production (Lockhart & Law 1994). Various authors have discussed the contribution of kinesthesia to movement memory. Kinesthesia, the conscious perception of movement and body position derived by feedback from the muscles, joints and skin, is purported to impact handwriting by providing error information and recall memory (Goyen & Duff, 2007).

The impact of motor planning and sequencing, motor control and execution along with neuromuscular development has been studied by others swayed by the therapeutic premise that distal mobility must be built on proximal stability and is reflected in a lack of rhythmicity of movement (Stott, Henderson & Moyes, 1987; Rosenblum, Goldstand & Parush, 2006 and Ben-Pazi, Kukke & Sanger, 2007). The emphasis on fine motor manipulative skill as a precursor to writing is based on the assumption that uncoordinated finger movements would translate into slow, awkward and ultimately illegible handwriting (Erhardt & Meade, 2005).

The Motor Learning Theory contends that for students to improve, the practice must be as similar as possible to the required assignment. The closed-loop theory of motor control proposes that error information leads to error correction and that such correction will generate its own kinesthetic input. Storage of this input leads to improved execution in subsequent handwriting attempts. (Sudsawad, Trombly, Henderson & Tickle-Degnan, 2002 and Asher, 2006).

Stott, Henderson & Moyes (1987) postulated that handwriting problems can be divided into a) faults of concept and style, which include failures of learning or teaching and b) faults of motor control, which include fine motor, perceptual or neurologic dysfunction. Berninger, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks & Fulton (2006) ascribe to the belief that some children having inadequate handwriting skills because they have had inadequate instruction. Along this line, only 12% of teachers surveyed reported that they'd received adequate preparation to teach handwriting (Graham, Harris, Mason, Fink-Chorzempa, Moran & Saddler, 2007). Researchers who attribute handwriting difficulties to orthographic deficits, that is an inability to remember the letterform in a rapid and sequential process, suggest that practice in coding letters has

a direct ability to impact handwriting skills in primary grades (Beringer, Vaughan, Abbott, Abbott, Rogan, Brooks, Reed, & Graham, 1997).

While therapists have traditionally focused on the underlying processes associated with handwriting, educators have typically concentrated on the tasks themselves. The task approach stresses direct teaching and skill generalization with the accompanying list of specially designed instruction like verbal prompts, fading and modeling (Jongmans, Linthorst-Bakker, & Westenberg, 2003).

Over the years, research into handwriting issues has expanded in scope to include developing measurement tools to assess handwriting, researching the effect of speed, stress and body positioning, identifying instructional or therapeutic techniques to address handwriting concerns, differentiating which letter forms are produced most legibly, identifying sequences for letter practice and increasingly popular, pencil grip (Dobbie & Askov, 1995).

Missing however, are studies that prove or disprove the prevalent theories that inform current practice. Instead, therapists randomly and without high-level evidence-based research, continue to employ a wide array of strategies and techniques in an effort to impact handwriting legibility.

The bottom line is that among the reasons that teachers refer to Occupational Therapy, improved legibility was requested by 64.4% with the next most common reason being decreasing student frustration with writing a distant second at 14% (Hammerschmidt & Sudsawad, 2004). To best do that, we need to clarify which teaching or therapeutic strategies are reliable and valid methods for effecting change. In short, this paper proposes to ask the following research question:

What is the effectiveness of a task-oriented approach compared to a process-oriented approach on handwriting legibility among elementary school children?

METHODOLOGY

Participants

While it was the original intent of this research to focus on handwriting interventions in the elementary grades, the availability of studies that specifically addressed legibility as an outcome measure necessitated broadening the scope of included populations. Consequently, 3 of the studies looked at preschoolers, 2 studied Kindergartners, 11 focused on first graders, 16 addressed second to fourth graders and 5 studied adolescents. Within these populations, 21 were enrolled in regular education, 3 were in special education and the remainders were unknown. Of the children in regular education, 11 were identified as at-risk. All but three of the studies specifically included children recognized as having handwriting problems. Most of the studies specified the sex of the participants. Twenty combined girls and boys, 4 studied boys, 1 did a case

study of a girl and 2 did not say. Of the diagnoses mentioned, 2 clearly mentioned that their participants had learning differences and 1 was delayed. The remainder did not specify any particular diagnosis. Previous involvement in therapy was specifically excluded by 17 of the participants and included in 3 of them. Reference to socioeconomic backgrounds or race was noted by 9 of the studies. Handedness was reported in 7 studies.

Interventions

Since it was the intention of this study to examine the effectiveness of various task-oriented (i.e. educational) and process-oriented (i.e. therapeutic) approaches in promoting legibility of handwriting, a variety of options presented themselves.

Eighteen articles examined direct handwriting instruction, including Beringer, Vaughan, Abbott, Abbott, Rogan, Brooks, Reed, & Graham (1997), Beringer, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks, & Fulton (2006), Cole (2005), Denton, Cope & Moser (2006), Erhardt & Meade (2005), Graham, Harris, Mason, Fink-Chorzempa, Moran & Saddler (2007), Goldberg & Simner (1999), Jongmans, Linthorst-Bakker & Westenberg (2003), Marr & Dimeo (2006), Massengill & Sundberg (2005), Park, Weber, & McLaughlin (2007), Peterson & Nelson (2003), Roberts & Samuels (1993), Robin, Armel & O'Leary (1975), Sims Jr. & Weisberg (1984), Sovik (1981), Sovik (1984) and Sudsawad, Trombly, Henderson & Tickle-Degnan (2002).

Depending on the years covered in the research, the part of the country or the world in which the research was done or the profession doing the research, the terms changed. However, any reference to a traditional instructional approach was included herein, namely drill and practice, precision teaching. Case-Smith (2002), Denton, Cope & Moser (2006) and Rosenblum, Goldstand & Parush (2006) also described handwriting practice, but not necessarily instruction.

Four articles examined the use of self-instruction to improve handwriting including Denton, Cope & Moser (2006), Erhardt & Meade (2005), Jongmans, Linthorst-Bakker, & Westenberg (2003) and Robin, Armel & O'Leary (1975). One article explored the impact of a phonics or language-only approach to handwriting (Goldberg & Simner, 1999).

Two articles did not attempt to alter the evolution of handwriting, but rather felt that immersion in an environment rich with printed material, the children will have sufficient exposure to letter forms such that they can essentially teach themselves how to make them (Goldberg & Simner, 1999). Another was a longitudinal study and sought to see whether time itself develops handwriting competency (Marr & Cermak, 2003).

Of the process-oriented approaches, ten looked at the influence of neurodevelopmental (i.e. gross motor and visual-fine motor,) exercises on their ability to improve handwriting, including Beringer, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks, & Fulton (2006), Beringer, Rutberg, Abbott, Garcia, Anderson-

Youngstrom, Brooks, & Fulton, (2006), Case-Smith (2002), Cole (2005), Denton, Cope & Moser (2006), Erhardt & Meade (2005), Peterson & Nelson (2003), Ratzon, Efraim & Bart (2007), Sovik (1981) and Sovik (1984).

Four examined a multisensory approach, including Denton, Cope & Moser (2006), Sudsawad, Trombly, Henderson, & Tickle-Degnan (2002), Lockhart & Law (1994) and Peterson & Nelson (2003). A number explored biomechanics and ergonomics like pencil grip, including Burton & Dancisak (2000), Dennis & Swinth (2001) and Koziatek & Powell (2003), Marr & Dimeo (2006) and posture Marr & Dimeo (2006), Peterson & Nelson (2003), and Rosenblum, Goldstand & Parush (2006). Three studied perceptual-motor training, Denton, Cope & Moser (2006), Erhardt & Meade (2005) and Peterson & Nelson (2003). Four used technology (e.g. biofeedback and computers) including Hughes, Jackson, du Bois, & Erwin (1979), Roberts & Samuels (1993), Rosenblum, Goldstand & Parush (2006) and Sovik (1984).

Jackson & Hughes (1978) and Hughes, Jackson, du Bois, & Erwin (1979) used relaxation methods prior to handwriting to measure change. One, Erhardt & Meade (2005) studied the benefit of consultation as an alternative treatment in teaching handwriting. Kinesthesia training was discussed by four including Berninger, Rutberg,

Many of the studies combined interventions, including a treatment approach with an educational one or using a number of different strategies altogether. In terms of specific handwriting programs, one study specified the use of the Handwriting Without Tears instructional program on which to base progress. Massengill & Sundberg (2005) and Denton, Cope & Moser (2006) used the D'Nealian program for both pretest and posttest data. Lockhart & Law (1994) used Benbow's Loops and Other Groups.

Outcome Measures

The primary outcome measure sought was legibility. This quality could be further detailed as consistency of letter size, correct directionality of letter formation, defined spacing within words distinguishable and smaller than spacing between words, appropriate use of the writing line, margin alignment, lack of crowding at the right margin and general readability.

Standardized outcome measurements were varied. Five studies used the ETCH including Case-Smith (2002), Dennis & Swinth (2001), Koziatek & Powell (2003), Marr & Dimeo (2006) and Sudsawad, Trombly, Henderson, & Tickle-Degnan (2002). Marr & Cermak (2006) used the SCRIPT. Two used the Minnesota Handwriting Test including Erhardt & Meade (2005) and Peterson & Nelson (2003). Handwriting Evaluation Scale was used by Roberts & Samuels (1993). The Test of Legible Handwriting was used by Goldberg & Simner (1999). Test of Written Language was used by Roberts & Samuels (1993). The Hebrew Handwriting Evaluation was used by Rosenblum, Goldstand & Parush (2006). Two researchers, Cole (2005) and Denton, Cope & Moser (2006), used the Test of Handwriting Skills. The Concise Assessment

Scare for Children's Handwriting, also known as the BHK, was used by one author, Jongmans, Linthorst-Bakker, & Westenberg (2003).

The remaining 12 studies developed their own criterion to measure progress based on comparisons to baseline samples. These included Beringer, Vaughan, Abbott, Abbott, Rogan, Brooks, Reed. & Graham (1997), Berninger, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks, & Fulton (2006), Burton & Dancisak (2000), Graham, Harris, Mason, Fink-Chorzempa, Moran & Saddler (2007), Jackson & Hughes (1978), Hughes, Jackson, du Bois, & Erwin (1979), Park, Weber, & McLaughlin (2007), Ratzon, Efraim & Bart (2007), Roberts & Samuels (1993), Robin, Armel & O'Leary (1975), Sims Jr. & Weisberg (1984), Sovik (1981) and Sovik (1984).

Results

Methods to teach handwriting could be divided into two categories. The first is the task-oriented approach typically used by teachers and focuses on the end product to increase cognitive understanding of letter shapes, including orthographic coding and memory. The second is the process-oriented approach typically used by therapists. This method focuses on the underlying perceptual, sensory, fine motor and neuromotor processes.

Most effective was the task-oriented approach as discussed by Beringer, Vaughan, Abbott, Abbott, Rogan, Brooks, Reed. & Graham (1997), Berninger, Rutberg, Abbott, Garcia, Anderson-Youngstrom, Brooks, & Fulton (2006), Case-Smith, J. (2002), Graham, Harris, Mason, Fink-Chorzempa, Moran, & Saddler (2007), Goldberg & Simner (1999), Marr & Dimeo (2006), Massengill & Sundberg (2005), Park, Weber, & McLaughlin (2007), Sovik (1981) and Sovik (1984). These investigators typically used a number of training strategies including visual models and verbal prompting to complete a series of worksheets or methods that involved, letter tracing, connecting letter dots, feedback, correction, repetition, self-appraisal and visual memory.

Many of the researchers mentioned the tests used to qualify the students as poor handwriters, reusing some of these tests to measure the outcome of intervention. These tests were mentioned in the discussion of Outcome Measures. The specific intervention programs used were only occasionally referenced and included both commercially available programs, like Zaner-Bloser, D'Nealian, ball and stick, Palmer or Handwriting Without Tears, and programs unique to the individual schools, teachers or therapists. As all of the above methods used principals of specific skill building along with most of the methods mentioned above, they were not analyzed individually. They are referred to in the matrix as Criterion Referenced outcome measures since each examiner used their own criterion to establish baselines and calculate change.

Inherent in the Direct Instruction approach was the need for visual cuing or models, sometimes referred to as page prompts or alphabet samples, with obvious starting points and directional arrows, verbal prompting and praise as noted by Sims Jr. & Weisberg (1984). Furthermore, self-instruction using existing visual prompts and

teaching children how to critique their work was also effective according to Jongmans, Linthorst-Bakker, & Westenberg (2003). Marr & Dimeo (2006) similarly found success in handwriting legibility using direct instruction, but combined their approach in a short-term summer program that also utilized a warm-up routine of gross and fine motor exercises.

Aside from the study by Marr & Dimeo (2006), which did not isolate the variables of direct instruction or direct instruction plus exercise, there is not much support to substantiate the benefits of the latter by itself. Studies examining neurodevelopmental and sensorimotor therapies, which encompassed all gross and fine motor exercise and perceptual programs, have been discouraging in their ability to impact handwriting. Cole (2005) found no increased legibility from students engaged in a prewriting exercise program as compared to a control group who did not engage in one. Lockhart & Law (1994) used a variety of sensory modalities to strengthen the learning process, but found nothing significant to report. While theories abound about the importance of postural stability and the need to develop the intrinsic musculature of the hand in order to properly sit still while mobilizing a pencil, the research was either only mildly supportive or noted that its impact in comparison to direct instruction was not *as* effective. The study by Berninger, V. W., Rutberg, J. E., Abbott, R. D., Garcia, N., Anderson-Youngstrom, M., Brooks, A. & Fulton, C. (2006) also came to that conclusion. Denton, Cope & Moser (2006) found significant improvements in handwriting as a result of practice in letter formation along with structured feedback and self-evaluation, but an actual decline in handwriting quality following sensorimotor intervention.

In spite of the disappointing results of motor, sensory and perceptual activities when implemented within the school, Erhardt & Meade (2005) achieved strong improvements in letter sizing and alignment and moderate improvement in legibility, form and spacing when these same concepts were integrated into a home program. Peterson & Nelson (2003) concluded that OT intervention, combining biomechanical, sensorimotor and teaching strategies was effective in improving handwriting among disadvantaged students, but these methods were not compared to each other nor studied exclusively as a means to impact handwriting without the additional influence of the other strategies. Ratzon, Efraim & Bart (2007) obtained significant improvements in copying skills of first graders following gross and fine motor activities, and even suggested that these findings could have implications for handwriting, but did not address handwriting specifically.

Research on grip patterns and diameters of writing instruments showed no correlation with legibility. Dennis & Swinth (2001), Burton & Dancisak (2000), Koziatek & Powell (2003). While discussions regarding pencil grasp have identified a developmental progression from palmar supinate grasp to the digital pronate grasp to the static and then dynamic tripod grasp, variations on these grasp patterns, including the quadrupod grasp, lateral tripod grasp, lateral quadrupod grasp, tripod grasp without web space and four finger with tips only grasp, though considered immature, inefficient and atypical, are not impacting legibility. (Dennis & Swinth, 1999).

Isolated variables and unique pre-writing set-ups offered unexpected results. Kinesthetic training as discussed by Sudsawad, Trombly, Henderson, & Tickle-Degnan (2002) was not found to be helpful in improving handwriting. But an alternative approach to improving handwriting quality by listening to relaxation tapes before engaging in a writing activity done by Jackson, & Hughes, (1978) and Hughes, Jackson, du Bois & Erwin (1979) showed significant correlations between efforts to increase self-control via relaxation and the subsequent task of writing itself.

Technology didn't seem to have an advantage in improving handwriting legibility (Roberts & Samuels, 1993). While it was assumed that the feedback from an electronic pen on the Apple Graphic Tablet would provide compelling and immediate information on issues of closure, letter size, directionality and regard for the writing line, in actuality the students did not utilize the information to correct their work any more than when they used simple plastic overlays or regular classroom practice.

DISCUSSION AND IMPLICATIONS

Despite the natural developmental progress of handwriting legibility from kindergarten to first grade as noted by Marr & Cermak (2003), both manuscript and cursive writing are skills resulting from a complex interplay of cognitive, perceptual and motor components. Just the same, the specific skills involved in producing legible handwriting appear to support Motor Learning Theory which notes that only through initial constant and blocked practice and later variable and random practice can acquisition of complex motor tasks, like handwriting, occur (Asher, 2006). Apparently, the nuances that distinguish accuracy from error are not self-evident. In fact, Marr & Cermak (2003) noted that while progress was consistent from kindergarten through first grade, the high performers continued to perform highly and the low performers continued to be low.

Yet, while precedence, expert opinion and popular therapeutic theories may have favored equally complicated and interwoven intervention strategies, in the case of handwriting, the most direct one appears to be the best.

Implications for Consumers

The purpose of school is to prepare children for the future. During the time in which children are within the classrooms, educators have a responsibility to teach them the foundation skills to be successful in school, their homes and eventually, their jobs. Nothing can be more important than making children feel competent about themselves and that the skills they've acquired will serve them well. On the same hand, few things will make them feel more incompetent than to start out their schooling career unable to master the very basics of written communication—an essential end product in every subject of every grade. Deficits in this area will have a pervasive effect on their work output, earned grades and ultimately their self-esteem.

Legible handwriting is an expectation for teachers, parents and students. The fact that the teaching of handwriting has been minimized if not eliminated in some schools over the years has led to an explosion of problem handwriters. The knowledge that handwriting ability is not an automatic or natural consequence of development should compel teachers and parents to demand its reinsertion into the curriculum, appropriate teaching methods in place to teach it and sufficient time allotted to master it.

In addition, though parents continue to worry about their children's unusual grip patterns, and teachers repeatedly question the occupational therapists about the importance of grip, evidence to support the impact of pencil grip on legibility is, at best, controversial, and most probably, unsubstantiated. Furthermore, any grip, whether efficient or inefficient, by virtue of its habituated use becomes "locked in". Attempts to change it by the beginning of second grade may be perceived by the child as too stressful. (Burton, & Dancisak, (2000).

Implications for Practitioners

Occupational Therapists working in the school systems have seen their case numbers increase over the years as more and more special education classes are created for students identified with learning differences. Beyond that, there are even more children languishing in regular education whose problems are either not severe enough to warrant an Individual Education Plan or a Service Contract, or whose diagnosis and placement is resisted by a parent. Just the same, recent legal rulings obligate schools to demonstrate due diligence for all children, regardless of whether they have IEPs, if a need has been recognized by the professional staff. Among these ever-growing populations are countless children struggling to keep pace with their classmates. And among the chief problems they're encountering is their inability to print.

In light of the growing numbers of referrals to Occupational Therapy and the clamor building in the regular education classrooms, it is critical that the time and manpower available be used most effectively. Toward that end, it is equally critical, according to the policy of best practices that strategies that are implemented actually work to remediate the problem. Yet, according to a survey conducted by Woodward and Swinth (2002) of therapists working within the schools, 92% reported using multisensory approaches to treat children with handwriting problems, including chalkboards, sky writing, sand trays, bead stringing and yes, shaving cream.

At present, the evidence is showing that direct instruction with self-reflection, visual and verbal cuing and opportunities for practice are most effective. This seems to strongly support the Theory of Motor Learning. If Occupational Therapy services are requested for handwriting problems, the first step may be to work collaboratively and integratively within the classroom to insure an optimal set-up for modeling and practice. This includes creating a framework for blocked and constant practice of handwriting skills, as well as the teacher's understanding of the importance of motor repetition before expecting generalization and skill implementation. If additional individual treatment is

needed and the IEP specifies one 30-minute session per week, it is essential that the time spent leave the child significantly and positively changed from how s/he started out. Under those tight constraints, it is even more important that the therapist employ strategies that will get the job done. In those cases, further use of random and variable practice as described by Motor Learning Theory, along with evidence-based research that addresses motivation and habituation issues, appears consistent with best practices. There may also be benefits in promoting core stability as suggested by the researchers who included physical therapy and gross motor interventions.

Implications for Researchers

Evidence-based practice has begun to dispel or support intervention strategies whose use and value were based on clinical experience or theory alone. Certainly, pencil grip abnormalities have been a case in point. Teachers and parents concerned with their children's pencil grip have made numerous contacts to the Occupational Therapy departments. In contrast to conventional wisdom that assumed that something should be done about it, the research shows that not only is there no greater likelihood of illegibility from an atypical grip, but that performance won't deteriorate any more during a longer writing assignment than it would by a student with a mature pencil grip.

Advances in technology have not accelerated or improved upon simple repetitive paper-pencil tasks. Multisensory approaches have not eliminated the need to practice handwriting. Neurodevelopmental approaches may make a student qualitatively harder and more stable within their classroom chair, but they do not appear to negate the need for repetitive structured writing time. And perceptual-motor activities alone do not translate into increased legibility and consistency without direct instruction, verbal prompting and visual modeling of letterforms in word or sentence contexts.

Instead, the above research seems to suggest the need to return to basics. Handwriting, as an acquired skill, complies with the Theory of Motor Learning. To be mastered, its intricate parts need to be taught in isolation, practiced repetitively, gradually modified and individually critiqued. No amount of Heavy Work, Connect-The-Dots or tactile play seems to be able to replace that step. In fact, the contribution of the gross motor development is itself unclear. This may indicate the need for further research to analyze the degree to which it contributes to the foundation of attention and learning, especially since none of the research involving physical therapy or gross motor activity isolated those variables, but rather combined them in a treatment approach with other modalities and methods.

While the benefits of direct instruction appear to have risen above many of the other strategies, there is still some question as to which methods or prompts are most effective therein. Visual models were often reported to be helpful. These include the samples on the worksheets, the desktop alphabet strips and the cue cards placed around the room. It may be helpful to learn which of these prompts children actually reference. It has been the experience of this therapist that despite the presence of cue cards on children's desks, aside from using them in association with phonics lessons, the children

do not use them as guides for handwriting. In fact, many children never seem to notice the directional arrows, the tiny numbering that indicates which lines are drawn first, second, etc or the starting points, let alone the similarities and differences between letter sizes when they are all lined up next to each other. From an edification standpoint, it would be interesting for researchers to study what children are actually relying on for guidance in handwriting within the classroom, if anything at all.

Along that line, researchers may also be motivated to study the optimal distance and/or angle for students to notice, access and use in-class instructional materials. This was not a feature of this study, but if visual cuing has been shown to be key, it would be helpful to further study this as well. From this author's experience, the slight angling of desks, accomplished currently by raising the back two desk legs up a notch, has been positively accepted. It would be interesting to research the benefit of this modification as it has the potential to place reading and copying material in a better angle for visual regard, and the writing surface at a comfortable slant.

It may also be of interest to researcher to further examine the differences between commercially and commonly used handwriting instructional programs, especially to see if one method is significantly more effective in its approach. Research in this area is limited, and often funded by the individual publishing houses themselves to show the merits of their own programs, thereby subjecting them to bias.

Lastly, it may also be helpful in advancing the theoretical basis for our profession to study the roles volition and habituation play in the process of handwriting remediation. While it is central to all best teaching and therapeutic practices to provide positive reinforcement, the impact of a child's self-concept on motivation, habit changing and response to challenge may augment constructs we tout as Occupational Therapists.

SUMMARY

In conclusion, the research above finds that:

- i* Four studies supported the need for visual cues.
- i* One study concluded that memory practice was needed.
- i* Nine studies determined that direct instruction was most helpful in comparison to other treatment approaches and two concluded that handwriting practice was still needed even after specific skill training had occurred.
- i* Studies on perceptual-motor training were inconsistent. Three studies concluded that perceptual-motor training was not helpful. One study found that perceptual-motor training was helpful.
- i* Treatment combinations were found to be effective. One study that combined sensorimotor, biomechanics, perceptual motor and direct instruction found that combination of approaches to improve handwriting.

Another study combining fine motor activities with direct instruction found positive results as well. A third study which combined fine and gross motor exercises with handwriting instruction over the summer also achieved success in improving handwriting.

- i* The three studies on pencil grip disputed popular perceptions, concluding that grip type did not correspond with legibility.
- i* One study isolated sensorimotor therapy versus direct instruction and found no benefit from sensorimotor therapy in remediating handwriting legibility.
- i* The four studies involving gross motor exercise all found that to be helpful, but the studies themselves included gross motor exercises in combination with other treatments, like perceptual-motor and direct instruction, or in a collaborative home program with OT and direct instruction.
- i* Technology usage had mixed results. Biofeedback to promote relaxation was found to positively impact skilled handwriting performance. Technology to provide feedback on handwriting errors was not helpful.
- i* Kinesthetic training was not found to help.
- i* Ocular exercises were considered to be helpful in one study.
- i* Self-instruction was found to be effective in promoting skill development.

In conclusion, it appears that the finer details, which distinguish acceptable from illegible handwriting, are not self-evident, automatic or a natural result of normal development. Handwriting needs to be taught in frequent, short-term sessions that emphasize the task itself. Optimum conditions would include visual models, verbal cuing and opportunities for repetitive practice. Self-evaluation also helps children recognize and correct their errors.

While a number of different treatment approaches, instructional methods and learning conditions were discussed, there were still a few potentially confounding variables not reviewed. Topics for future research may include the use of differently lined paper in its ability to impact legibility, organization and neatness as well as angled desks or slant surfaces and their impact on legibility from an ocular-motor perspective. It may also be helpful from a direct instruction standpoint, to review the various aspects of legible handwriting, from letter size to shape, spacing and slant to determine which factors or combinations thereof contribute most to the perception of legibility and therefore which factors should be addressed first and/or primarily in promoting it. The benefit of building postural stability from both a neuromotor perspective and an ergonomic one (i.e. desk and chair proportions) would also be interesting to explore as all the research involving gross motor activity and/or Physical Therapy intervention had positive results. Lastly, it would be helpful to further compare classic therapeutic approaches (i.e. visual perception, fine motor, neuromotor, ocular-motor) with each other as well as in contrast to specific skill building. This would be a direct examination of the differences between the process-oriented versus the task-oriented approach to handwriting remediation. The availability of more controlled, randomized and sizeable studies could help all school-based therapists determine what, if any, contribution these

methods play in facilitating handwriting proficiency or whether time would be better spent focusing on evidence supporting other methods instead.

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