Teaching Cursive Handwriting First Leads to Fluency in Reading and Writing

Elizabeth Seton

Loyola University Maryland

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Dr. Sharon Dubble

Abstract

The human brain processes handwriting and reading in separate hemispheres: the left hemisphere reads manuscript print; and the right hemisphere writes cursive handwriting. Directed simultaneous multi-sensorial cursive handwriting instruction enables young children to write fluently. The continuous strokes and joined letters in cursive handwriting help young children join letter sounds to make words, especially when the child's handwriting is large. The legible letterforms stored in unconscious muscle memory free the mind to think quickly. Legibility develops as a result of fluency, and gradually improves as fine motor skills mature. The author discusses effective and ineffective methods of handwriting instruction, and recent handwriting research illustrated with examples of successful handwriting intervention.

Keywords: cursive handwriting, muscle memory, reading, writing fluency, dysgraphia

Teaching Cursive Handwriting First Leads to Fluency in Reading and Writing

The brain processes handwriting activity differently from keyboarding activity, and the manner in which the brain processes cursive handwriting differs from the manner in which the brain processes manuscript printing. The instructional manner in which a child learns to write, as well as the handwriting style, affects the way the child's brain forms the neural connections for writing and reading. The child's active participation in multi-sensorial directed handwriting instruction forms the child's brain in a manner that increases the rate of fluency and legibility in writing and reading, which remains with the child forever.

The penmen of the "Golden Age of Ornamental Penmanship from 1850 to 1925" (Sull, 2012) experienced an emotional connection when handwriting that is not possible in keyboarding. One of today's penmen, Michael Sull, explains his feeling of that emotion:

> There is a marvelous anticipation I feel as I ready myself to write, for I know that in a moment I shall be on a journey of language and emotion that will take me anywhere I wish to go. It is an exciting adventure that I cannot wait to begin - to think of the privilege I have in choosing the most special words without cost, that, through the movement of my pen, I can speak to someone else in my own voice, and in my own way. The sheer joy if it overwhelms me. In this hectic world, handwriting affords me a sense of calm, allowing moments of privacy, personal expression, and communication with another human soul. There is no machine between my thoughts and the paper upon which I write; the person whom I address will interpret thoughts formed by my own hand. They will see me and hear my own voice; my signature will be in every letter, every word, and on every line. They will know that no one else but me sent it; that only I

said exactly what I wrote for no one else but them. And except for distance, we can look into each other's eyes, touch each other's hand, and not be apart." (Sull, 2011, p. 3)

Michael Sull's feeling when writing reflects the emotion of previous penmen. This emotion is one that all children should experience. It is for this reason the author has written this paper.

Introduction

The acquisition of writing and reading begins in infancy, with every gross motor movement developing laterality and directionality in the brain in preparation for looking, moving, talking, writing, observing, touching, listening, and reading. Movement begins at birth in a clockwise direction (Montanaro, 1991). The infant observes the mouth of the speaker to absorb language (Montanaro, 1991). The infant participates in daily routines (Veness et all, 2012). He or she discovers hands, and reaches for objects (Lillard, 2003). The infant brings hands and feet to the mouth, and then rolls to the side to start exploring the environment (Wanrooy, 2002). Freedom of movement develops a habit of active participation (Educaring Resources for Infant Educarers, 2012). Crawling opens the hands and spreads out the thumb and fingers in preparation for writing. The infant's brain develops in response to the environment (Elliot, 1999). The infant responds to his or her name (Veness et all, 2012). The infant makes gestures to communicate (Veness et all, 2012). Infants who interact with sign language have five signs and one word by eight months of age (Signing Smart, 2012). The toddler starts to walk, and the hands are free to work (Montanaro, 1991). The toddler points to ask, "What's that?" (Veness et all, 2012). As the toddler picks up small objects, the pincer grasp develops in preparation for writing. The toddler shows objects, indicating a desire to communicate (Veness et all, 2012). The toddler responds to directions to give objects (Veness et all, 2012). The toddler smiles, nods, waves, and talks to initiate communication (Veness et all, 2012). First

scribbles reveal the power of the hand, and soon develop into a manner of expressing thoughts in drawings.

The ability to write fluently develops from the availability of the mind, freed from focusing on how to write letters, to generate thoughts directly onto the paper. The focus on fluency in handwriting instruction for young children enables critical thinking to develop. Reading develops as a result of handwriting. Legibility develops from the legible form imprinted in muscle memory, and gradually improves as the child gains control of the hands. Large writing on a vertical surface aids formation of good habits in body positioning, and imprints in the muscle memory the legible form of large letters. Finally, the child is ready to sit and take a crayon into his hand to write. Now the writing and reading process begins.

Summary of Research Studies

Handwriting: A Tool for Fluent Reading

An American research study compared the relationship between the ability to print manuscript letters and the reading fluency rate (Rose, 2004). Five Grade 1 classes participated, with 94 children, and five Grade K classes participated, with 106 children. Teachers recorded each child's manuscript print handwriting fluency rate as well as reading fluency rate over a nine-month period. Results indicated that as the child's rate of printing fluency increases, so does the child's rate of reading fluency (Rose, 2004). A control group tested the relationship between not learning to write and reading fluency. The results of that group showed that while some children learned to write before learning to read, children who were poor readers were also poor writers (Rose, 2004). When teachers increase time on handwriting instruction, reading fluency develops as a result. This relationship was apparent at the writing fluency rate of forty letters per minute (Rose, 2004).

Large Handwriting: A Tool for Legibility

An Australian research study compared the relationship between cursive handwriting size and legibility (Phillips, Ogeil, & Best, 2009). Participants wrote the cursive handwriting word "minimum" on a vertical Smartboard in the three different sizes recommended for Smartboard use in a classroom: 2 cm, 7 cm, and 12.5 cm (Phillips et al., 2009). Researchers scaled all written words to a uniform 10 cm height, and then compared legibility using handwriting analysis software (Phillips et al., 2009). Results indicated that as the size of the written word increased, so did the legibility (Phillips et al., 2009). The larger size required the writer to use more gross motor action, which expressed more muscle memory data into the handwriting form (Phillips et al., 2009). When young children write large letters, the form of the letter stored in muscle memory becomes more legible (Lidbetter, 1913).

Cursive Handwriting: A Tool for Fluent Expression

Thomassen and Teulings used digital tablets and digital pens with handwriting analysis software to study the motor systems involved in preference for writing clockwise or counterclockwise movements (Thomassen & Teulings, 1979). The study of 26 people between age four and adulthood identified two distinct motor systems for handwriting: First, an early unconscious, motor-driven movement used for habitually controlled simple tasks, starting with clockwise movement and developing into counterclockwise movement most rapidly between five and seven years, moving from bottom left upward, as in cursive handwriting (Thomassen & Teulings, 1979). Later, a conscious, cognitive-driven movement is apparent in distinct handwriting characteristics: careful strokes for complex tasks; variances in speed in response to environment; movement from counterclockwise to clockwise direction with increased speed (Thomassen & Teulings, 1979).

Fluency: A Tool for Legibility

A research study of 48 Grade K children in France used digital tablets with handwriting analysis software to compare different methods of cursive handwriting instruction on the fluency and legibility of their cursive handwriting to determine the relationship between their handwriting skill and the method of handwriting instruction (Vinter & Chartrel, 2010). It compared the following three types of cursive handwriting instruction: copying static images of letters; observing dynamic images of letters; observing dynamic images of letters and copying them afterwards (Vinter & Chartrel, 2010). Results indicated that while there was some advantage in legibility with the visual instruction, there were clearly more advantages in fluency with both the visual and the motor instruction (Vinter & Chartrel, 2010). Fluency developed into increased speed without affecting legibility; therefore, these researchers recommend focusing on fluency rather than legibility (Vinter & Chartrel, 2010).

Legibility: A Product of Ergonomic Body Position

A research study in the Netherlands compared the effects of body position to the performance of fine motor activities among children in three age groups: 6-year-olds, 8-year-olds, and 10-year-olds (Smits-Engelsman, Swinnen, & Duysens, 2004). The results revealed increasingly precise fine motor control as the child matures, and that the child's body position in relation to the fine motor activity affects the fine motor control in every age group (Smits-Engelsman et al., 2004). The study focused on the ergonomic position of the arm, wrist, and fingers, in relation to the body midline, comparing fine motor performance when crossing the midline versus performance when remaining in the hemispace of the dominant hand (Smits-Engelsman et al., 2004). Results identified significant negative differences in fine motor performance when crossing the body midline. The researchers recommend positioning the

dominant hand in the same hemispace as the activity, and positioning the activity parallel to the arm rather than to the table (Smits-Engelsman et al., 2004).

Muscle Memory: The Key to Legibility

Shadmehr (1997) used PET brain scans to study the relationship between active movement and brain activity showing motor memory stored in either short-term memory or long-term memory (Shadmehr, 1997). The results revealed that brain activity generated by active movement begins within one hour after the active movement, even when the active movement has ceased or remained unchanged (Shadmehr, 1997). The brain does not respond to passive activity in the same manner. The child must generate his or her own movements. The muscle memory stored after active movement either remains in the short-term memory for up to five hours before dissipating, or moves into the long-term memory (Shadmehr, 1997). The instructional method affects how the child's brain stores the memory.

Effective Handwriting Instruction: A Tool for Muscle Memory

A research study in the Netherlands evaluating the cursive handwriting of 36 eight-year-old children, half of them fluent legible writers and half of them illegible writers, compared methods of handwriting instruction to learning outcomes (Overvelde & Hulstijn, 2011). Researchers tested the following three instructional handwriting methods: tracing an unfamiliar static image (“tracing”); tracing an unfamiliar dynamic image (“pursuit”); writing in response to explicit descriptive instructions for an unfamiliar image (“explicit”) (Overvelde & Hulstijn, 2011). The results showed better learning outcomes for the group of children taught by explicit instructions than for the two groups of children taught by tracing images (Overvelde & Hulstijn, 2011). The researchers specifically recommend not allowing children to trace letters (pencil and paper) because doing so delays memorization of letterforms (Overvelde & Hulstijn, 2011).

Directed Handwriting Instruction: A Remedy for Dysgraphia and Dyslexia

A meta-analysis research study in the United Kingdom compared handwriting and spelling instruction to learning outcomes in over 1,000 children diagnosed with dyslexia and dysgraphia (Montgomery, 2012). The study emphasizes the need for earlier intervention through teacher education in recognizing early indicators of writing and reading difficulties (Montgomery, 2012). The author seeks to increase each child's access to effective methods of handwriting instruction in the primary grades (Montgomery, 2012). She proposes that today's instructional focus on reading to the exclusion of writing in the primary grades causes more children to have difficulties in reading and writing – that reading develops as a result of writing (Montgomery, 2012). Many children diagnosed with dyslexia also have dysgraphia, which can cause additional academic and social difficulties if not remediated early through effective handwriting instruction (Montgomery, 2012). Cursive handwriting is part of the treatment for dyslexia and dysgraphia because it eliminates letter reversals (Montgomery, 2012).

Discussion and Analysis

Handwriting: A Tool for Fluent Reading

Writing and reading are two separate brain processes (Hellige & Adamson, 2007; Potgieser & DeJong, 2011). The right hemisphere processes cursive handwriting, and the left hemisphere processes manuscript printing (Hellige & Adamson, 2007; Vinter & Chartrel, 2010). Manuscript printing aids development of reading (Harman James, 2012), and cursive handwriting aids development of writing (Montessori, 1912). The more time a child spends handwriting, the more the child's development of reading will progress (Rose, 2004). Some children do learn to read before they learn to write (Rose, 2004); however, young children who have poor handwriting are poor readers (Rose, 2004). Writing letters helps children remember

the letterform (Longcamp, Boucard, Gilhodes, & Velay, 2006). The wise teacher focuses on handwriting fluency, knowing that reading and legibility will develop as a result (Afonso & Alvarez, 2011; Case-Smith, 2012). The child's process of thinking of the sound of the letter and remembering the letterform helps the child identify which letters to write to read (Afonso & Alvarez, 2011). A very young child just starting to learn to write is able to read what he or she has just written, but not what another author person has written (Montessori, 1912).

Large Handwriting: A Tool for Language Expression

Large handwriting requires more gross motor muscle effort on the part of the writer (Phillips et al., 2009); therefore, it imprints a more legible form of the letter in muscle memory (Nelson & Trafford, 2003). Handwriting instruction for the primary age child must allow for the child's developmental need for large writing (Bloser, 1919). The child's large writing aids the imprinting of the letterform in muscle memory, thereby enabling fluency in writing and reading to develop (Bloser, 1929; Case-Smith, 2012). Young children benefit from writing large letters on a vertical surface as well as a horizontal surface (Nelson & Trafford, 2003). Later, the child's fine motor movements will refine the size and legibility of the letterform (Chartrel & Vinter, 2008; Conti, 2012). When a young child writes in small letters, muscle tightness and incorrect grip may develop (Nelson, 2012; Vinter & Chartrel, 2008).

Cursive Handwriting: A Tool for Fluent Expression

The type of handwriting form, cursive handwriting, or manuscript printing, taught in primary grades affects the young child's level of ease in learning to write, as well as the young child's development of fluency (Nelson, 2012). The young child goes through a developmental stage of intense development of and preference for counterclockwise movement (Thomassen & Teulings, 1979). This stage occurs after the young child has just completed a stage of preference

for clockwise movement, starting at birth and continuing into toddlerhood (Thomassen & Teulings, 1979). The young child can easily absorb the counterclockwise movement of cursive handwriting (Montessori, 1912). It is not developmentally appropriate to force a young child in this stage of intense interest in counterclockwise movement to write with the opposite orientation (clockwise, top to bottom) of manuscript printing (Thomassen & Teulings, 1979). Fluency develops easily in the continuous connected letters in cursive handwriting, but not in the discontinuous separate letters in manuscript printing (Teulings & Romero, 2003). Cursive handwriting, not manuscript printing, is ideal for developing fluency in primary age children (Longcamp, Boucard, Gilhodes, & Velay, 2006). The connected letters in cursive handwriting aid reading and spelling (Montgomery, 2012; Teulings & Romero, 2003). Preschool and primary age children learn cursive handwriting more easily than manuscript printing (Lidbetter, 1913; Montessori, 1912; Vinter & Chartrel, 2010). A multi-sensorial instructional method is more effective for teaching cursive handwriting (Bara & Gentaz, 2011; Montessori, 1912)).

Fluency: A Tool for Legibility

Fluency in writing is the ability to think and write freely without consciously thinking about letter formation (Nelson, 2012). Fluency in reading is the ability to read and comprehend freely without consciously thinking about sounding out the words or identifying sight words (Nelson, 2012). Focusing on fluency in handwriting instruction for the young child helps develop in the child habits of quick and critical thinking and fluent writing (Bara & Gentaz, 2011; Nelson, 2012). A focus on fluency is more important than a focus on legibility in handwriting instruction for the young child (Vinter & Chartrel, 2010). Fluency and legibility are both appropriate handwriting goals for learning; however, the focus in instruction for young

children should be on fluency (Vinter & Chartrel, 2010). As children develop fluency in writing, their reading fluency also develops (Rose, 2004).

Legibility: A Product of Fluent Handwriting

The child's body position in relation to the paper position, as well as the position of the arm, wrist, and hand, affects legibility (Smits-Engelsman et al., 2004). The young child's fine motor skills develop in response to neurological growth; therefore, the appropriate time to focus on legibility is after the child's neurological growth has completed (Vinter & Chartrel, 2010). Focusing on fluency in the primary grades aids development of legibility (Karhu & Tesche, 1999; Liang, Moraux, & Iannetti, 2011; Nelson, 2012). As the child matures and develops good fine motor control, handwriting gradually becomes more legible (Santangelo & Graham, 2012). It is not developmentally appropriate to focus on legibility during a stage of child development when the limited fine motor skills hamper the ability to write legibly (Conti, 2012). Legibility develops as a result of fluency (Berninger, 2012).

Muscle Memory: The Key to Legibility

The key factor in developing fluency is the integration of letterforms in long-term memory. Fluency cannot develop when the letterform remains in short-term memory because the focus on retrieving the letterform from short-term memory prevents attention to thought processes for language production (Nelson & Trafford, 2003). The goal in attaining fluency is to develop a long-term muscle memory of letterforms (Shadmehr, 1997) through the student's active participation in effective multi-sensorial handwriting instruction (Bara & Gentaz, 2011; Nelson & Trafford, 2003). Students who can write fluently are able to do so because they do not have to think about how to write at the same time they are thinking about what to write (Nelson, 2012). Students who cannot write fluently are not able to do so because their attention to short-

term memory of letterforms prevents them from focusing their attention on composition (Harman James, 2012). Recent fMRI images of the brain of children who have been writing letters show little brain activation in the conscious short-term memory of the legible writers, and much brain activation in the conscious short-term memory, of the illegible writers (Berninger, 2012). This difference in activation of the short-term memory of legible and illegible writers is significant because it indicates that legible writers do not have to focus their attention on the retrieval of letters from their short-term memory; therefore, their mind is free to focus on fluent composition (Nelson & Trafford, 2003). Likewise, illegible writers have to focus their attention on the retrieval of letters forms from their short-term memory; therefore, they cannot focus on composition at the same time (Nelson & Trafford, 2003). Simultaneous use of multiple senses in handwriting instruction aids formation of long-term muscle memory (Karhu & Tesche, 1999; Liang, Moraux, & Iannetti, 2011; Nelson & Trafford, 2003; Overvelde & Hulstijn, 2011).

Effective Handwriting Instruction: A Tool for Muscle Memory

Effective instructional methods imprint accurate forms of letters in unconscious muscle memory, which enables fluency in writing and reading to develop (Nelson & Trafford, 2003). The method of handwriting instruction affects the acquisition of muscle memory and fluency (Overvelde & Hulstijn, 2011). When a child actively participates, the child's brain develops in response to the activity (Elliot, 1999). When a child's participation is passive, for example, watching someone else do handwriting activity, the child's brain does not respond to the passivity (Elliot, 1999). Active motor movement simultaneously experienced with active verbalization of the motor behavior, as well as auditory impression of verbalization, imprints a muscle memory into long-term memory (Montessori, 1912; Nelson & Trafford, 2003). Integrating a rhythmical chant pattern helps children focus on the instruction (Chartrel & Vinter,

2008). Dictation, rather than copying, aids auditory memory recall, handwriting, spelling, and fluency in writing and reading (Montgomery, 2012). Consider this fact when preparing the child's environment for writing. Visual representations of letters placed within the child's view are stored in short-term visual memory (Harman James, 2012). The child's attention devoted to periodically looking at the visual image while writing keeps the image of the letterform in short term memory, thus preventing it from moving into long-term memory (Bara & Gentaz, 2011). The same effect applies to the child's attention to tracing lines in the shape of letters (Overvelde & Hulstijn, 2011). The child's memory of letters cannot move into long-term muscle memory because the child's attention focuses on the visual image of the letter, which prevents or delays the development of fluency in writing and reading. Likewise, when the child practices writing letters independently, without having access to a visual representation, the child's memory of letter recognition improves (Overvelde & Hulstijn, 2011). Active multi-sensorial methods of handwriting instruction are more effective than passive methods of handwriting instruction (Case-Smith, 2012; Nelson & Trafford, 2003). In order to impress the form of a letter in long-term memory, it is necessary for the child to process the form of the letter through multiple senses (Montessori, 1912; Nelson & Trafford, 2003). In contrast, when another person holds the child's hand and moves it while verbalizing, the child's interpretation of that movement is not necessarily related to the letter-form; thus, no muscle memory of the letter form is imprinted in the child (Elliot, 1999).

Directed Handwriting Instruction: A Remedy for Dysgraphia

Today's handwriting publishers and teachers can help children develop good handwriting skills. Directed multi-sensorial handwriting instruction is effective, even for children who have dysgraphia (Montgomery, 2012). The Peterson Directed Handwriting lessons begin with a

selection of either rhythmic music, rhythmic voices of the teacher and the students, or rhythmic counting corresponding to the strokes of the letter (Nelson & Trafford, 2003). The teacher's goal is to help every child learn to write while voicing rhythmic words or counting rhythmically (Nelson & Trafford, 2003). The teacher is keenly aware that it is only when the child can say the rhythmic words while writing, that the letter form can be imprinted in the child's muscle memory (Nelson & Trafford, 2003). At first, the child may not be able to talk while writing because the child's cognitive processes focus on retrieving the letterforms from short-term memory (Nelson & Trafford, 2003). The child practices with the teacher, first with large gross motor air writing, reaching as high and wide as manageable while following the teacher's rhythmic chants and air writing (Nelson & Trafford, 2003). Animated letter cards demonstrate the starting point, direction, and stopping point of each letter stroke (Nelson & Trafford, 2003). Each stroke is color coded to emphasize these points; these are teaching fonts designed to exaggerate the points in order to help the child form an accurate muscle memory (Nelson & Trafford, 2003). Each child participates by imitating the teacher's air writing while attempting to voice the rhythmic words simultaneously (Nelson & Trafford, 2003). After the child finishes doing the air writing activity, the lesson continues with finger tracing on alphabet models while chanting the rhythmic words (Nelson & Trafford, 2003). After the child finishes the finger tracing activity, he or she attempts to chant the rhythmic words while writing the letter (Nelson & Trafford, 2003). The teacher checks the child's writing (Nelson & Trafford, 2003). If it is not accurate, the teacher repeats the air writing and finger-tracing activities as many times as necessary for the child to write a legible form of the letter (Nelson & Trafford, 2003). The rhythmic chants continue simultaneously as the children write, listen, and talk (Nelson & Trafford, 2003). Some children will be able to say the words while writing (Nelson & Trafford, 2003). Others will need more

practice before reaching that point of automaticity, as indicated by the child's ability to say the rhythmic words while writing (Nelson & Trafford, 2003). The child's focused attention on saying and writing the rhythmic words frees the short-term memory of the letter from the child's short-term memory, and imprints it into the child's unconscious long-term muscle memory (Nelson & Trafford, 2003). After the children can write the letter correctly, the teacher asks them to close their eyes and write the letter on paper (Nelson & Trafford, 2003). The child's ability to write the letter correctly with eyes closed indicates the imprinting of the letter into muscle memory (Nelson & Trafford, 2003). This handwriting instruction method has been effective with all children, including children who have dysgraphia (Montgomery, 2012; Nelson & Trafford, 2003). Directed multi-sensorial cursive handwriting instruction is effective because it elicits the child's participation in a manner that focuses attention outside the body, which frees the image of the letter from the short-term conscious memory to imprint in unconscious muscle memory (Nelson & Trafford, 2003).

A recent meta-analysis of over 1,000 children who have dyslexia and dysgraphia illustrates and explains the effective role of directed multi-sensorial instruction in cursive handwriting and spelling (Montgomery, 2012). Since 1940, cursive handwriting has been an effective remedy and treatment for young children who have dyslexia and dysgraphia (Gillingham & Orton, 1940; Montgomery, 2012). Between 1920 and 1940 instructional handwriting methods in public schools changed from a cursive handwriting curriculum to a manuscript printing curriculum in the primary grades. It was during this transitional time period that doctors developed the first Orton-Gillingham remedial treatment cursive handwriting instruction method for young children (Gillingham & Orton, 1940). Prior to 1920, when cursive handwriting was the only form of handwriting instruction for all schoolchildren in all grades,

dyslexia and dysgraphia did not exist (Montgomery, 2012). Since then many researchers have recognized the significance of this fact; yet, recommendations to revert back to cursive handwriting instruction in the primary grades have been met with opposition (Montgomery, 2012). Reasons for opposition to reverting back to cursive handwriting instruction in the primary grades have not been based on scientifically validated research proving its developmentally appropriate effectiveness for young children. The Orton-Gillingham method of treatment for dyslexia and dysgraphia was based on research from doctors who had been working with war veterans with brain injuries (Gillingham & Orton, 1940). The doctors noticed that children who had dyslexia and dysgraphia responded well to similar instructional methods used in treating victims of brain damage (Gillingham & Orton, 1940). Highly effective specialty Orton-Gillingham treatment centers for the most severe cases of children who have dyslexia and dysgraphia are still in existence today, many of them located in children's hospitals (Camperdown Academy, 2012).

Cursive handwriting has several unique characteristics that differentiate it from manuscript printing. All single lower case letters begin on the baseline and move upwards from left to right. All lower case words move in a continuous left-to-right direction, starting on the baseline, continuing in a rhythmic pattern, and ending in a position that leads to the next word. The cursive writing sequence for words can be internalized in muscle memory (Montgomery, 2012). This continuous stroke single line per word characteristic of cursive handwriting helps children separate words and blend sounds within words. The stereognostic sensation of physically starting a sound of a word and not lifting the pen until the word is finished helps children understand how the sounds blend to make words.

The cursive handwriting instructional grouping of letters with similar strokes prevents the reversal problems children have with manuscript printing. For example, in manuscript printing children often confuse the orientation of the letters b, d, p, and q. These manuscript printing letters look the same, just turned in different directions. Manuscript printing instructional methods recommend grouping letters by similar strokes. Teachers emphasize the similarities in strokes in manuscript printing when they introduce the letters b and p with the manuscript clockwise letter group, b h n m r p, and they introduce the letters d and q with the manuscript counterclockwise letter group, d f c e a s o g q. (Note: manuscript handwriting instructional methods may vary slightly in letter groups.) In contrast, the grouping of letters with similar strokes in cursive handwriting instructional methods separates the four easily confused manuscript print letters, b p d q, into the following four separate cursive handwriting groups: p h k; a d q; w b v o; j y z q. It can be difficult to see the similarities in these cursive handwriting letters when viewing them in the Times New Roman font. See the following web site for animated illustrations of these cursive handwriting letter groups: http://www.peterson-handwriting.com/A_PDH_AP/StyleChooz.html. Children do not reverse or confuse the letters b d p q when writing in cursive handwriting (Nelson, 2012). Cursive handwriting aids memorization of spelling words because the entire word form imprints in muscle memory when taught through multi-sensorial directed instructional methods (Nelson, 2012). When taught through directed multi-sensorial cursive handwriting instruction, very young children have learned to write cursive handwriting, and then been able to read what they have written (Lidbetter, 1913; Montessori, 1912; Montgomery, 2012). After they learn to write and read fluently in cursive handwriting, they easily learn to write manuscript printing, without reversing letters. At that point, their two motor systems for writing are complete: the left hemisphere

processes manuscript printing, and the right hemisphere processes cursive handwriting (Hellige & Adamson, 2007). Teachers who have chosen to teach cursive handwriting rather than manuscript printing in the primary grades have made small personalized cursive handwriting booklets for each child to read using educational fontware, which prints cursive words in joined forms, as they appear in cursive handwriting (Nelson, 2012). In addition, these teachers encourage children to observe them handwriting cursive words in small booklets, on paper, and on the chalkboard.

Conclusion

In today's day of scientifically validated research, it is surprising to see a lack of focus on identifying the numerous factors that invalidate some research studies, the questions about what to research, and the questions about the significance of the findings. Extensive research studies have produced numerous fMRI brain scan images, detailed handwriting analyses, and numerous scientifically validated research reports. Yet in some respects, it seems that the researchers overlook the most important questions. It would be helpful if researchers, publishers, teachers, and parents of students experiencing writing and reading difficulties could access one database storing handwriting research categorized by topic; for example, one storage area for research regarding the creation of handwriting analysis software, and another one for tests of handwriting instructional methods. Much of the neuroscience research regarding brain function and development is highly relevant to handwriting instruction, assuming that the teacher researching handwriting understands the implications of the neuroscientist's research or that the neuroscientist or handwriting analysis developer understands the significance of his or her findings in relation to handwriting instruction (Gilet, Diard, & Bessiere, 2011; Thomassen & Teulings, 1983).

There have been recent attempts to create national handwriting standards (Zaner-Bloser, 2012), which sounds great in theory, but what happens if the adopted standards are not in alignment with how the young child's brain acquires the ability to write and read fluently? Who decides what the standards should be? Young children need an instructional method that aligns with their brain development. Highly effective methods cannot develop when legislation mandates ineffective standards.

Researchers, educators, publishers, scientists, software developers, legislators, handwriting specialists, and parents need to unite to cause effective handwriting instruction to be available to all students in all grades. Researchers need to consider several variables when conducting handwriting research. The child's body position in relation to the table and chair, as well as the paper, affects legibility. The child's arm, wrist, hand, and finger positions affect fluency and legibility. The method of handwriting instruction affects learning. Multi-sensorial methods, in which the child participates with multiple senses, including speech, are most effective. Passive methods of handwriting instruction are ineffective. The child needs to be moving his or her own body while simultaneously talking, and listening, to create a muscle memory of letterforms. Primary age children need researchers and other professional adults to work together to identify instructional handwriting methods that meet their needs. Researchers should continue to use scientifically validated research tools, such as digital handwriting tablets, and fMRI brain scan images. Professionals involved in making decisions about assessment tests should consider the benefits for children of assessing writing skills using handwritten tests on digital tablets rather than on a computer. Young children need to write cursive handwriting using their own hands in order to develop the brain for fluent thinking, reading, and writing.

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