Handwriting was Therapy: A Reflection

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***Abstract*—**Handwriting was a therapeutic intervention with an adolescent victim of a serious electrical accident that occurred in 1972. It was initiated two months after the accident as one aspect of educational therapy. The handwriting tasks involved copying numbers, printing letters, copying shapes, practicing cursive letters, writing sentences, and responding in writing to questions. Over time the quality of the writing ranged from illegible to considerable tremor and to legible with notable tremor. During practice sessions the writing was mostly legible with notable tremor. Writing therapy for this individual resulted in a return to totally legible handwriting. This result fostered this inquiry into what was occurring neurophysiologically during writing therapy. Refined technological approaches to study handwriting's neurophysiological influence on the brain at the time of this victim's handwriting therapy were unavailable. Contemporary neurophysiological research has documented that: 1) handwriting facilitates letter recognition and reading abilities; 2) within the brain there is an innate connection between motor regions for handwriting and the perceptual systems during perception of print or writing; 3) handwriting has a positive influence on memory development and the retention of memories. Handwriting therapy facilitated many of these unseen neurophysiological benefits for the electrical accident victim.

***Keywords*:** writing, therapy, neural benefits, memory

The accident

In 1972, a 17-year-old adolescent male was the victim of a serious electrical accident. It occurred at work when he touched the metal frame of a fire door and received an electric shock that caused him to collapse and fall into a nearby metal rack. The jarring of the rack caused an exposed wire that had been touching the metal frame of the fire door to fall on him on a wet floor he had been hosing. The wire had been disconnected from a ventilation fan and was mistakenly turned on. It was noted later that it was thought that the victim was in contact with the live wire for about a minute and a half. After the victim's contact with the wire was broken, there was about a 4-to-5- minute period before an ambulance, rescue squad and police arrived. The victim required artificial respiration during the short trip from the scene of the accident to the hospital. Forewarned hospital personnel began treating the victim immediately. Of concern was the condition of circulatory arrest resulting from ventricular fibrillation. He was successfully treated by means of electrical defibrillation of the ventricles. A physician reported that he was able to follow a light stimulus with his eyes. This was followed by another period of ventricular fibrillation that was followed by respiratory arrest. After these incidents, there was no longer any response to the light stimulus. By the end of a third week, the adolescent came out of the coma. Toward the end of the second month of hospitalization, he was released from the hospital and referred for therapy. At the time, the pretherapy workup was minimal. In this regard, it is noteworthy that a quite recent study stated that no standardized testing procedure is available for diagnosing persisting symptoms of electrical accidents (Rådman, Wold, Norman, Olausson, & Thordstein, 2023). As we proceed, I would like to share how handwriting was applied as one aspect of therapy with this victim of an electrical accident that occurred many years ago and view it in a contemporary context.

Handwriting was therapy

Educational therapy was initiated. The therapeutic notes indicated that the victim was performing academically in the average range prior to the accident. A basic educational therapeutic intervention with him consisted of handwriting tasks intended to monitor his abilities to follow and remember instructions. From the neurologist Wilson's (1999) perspective, writing involving the use of a hand is a most helpful and meaningful intervention. Also, Berninger (2009) reported that writing was one of the informal tasks that she observed among the children and adolescents referred to her at Boston Children's Hospital. The experience influenced her initiation of extensive research and sharing about writing's developmental, educational, and remedial issues (Berninger, 2009, 2019; Berninger & Chanoyu, 2012).

The therapeutic procedures began and continued with the victim being requested to copy and practice writing examples of numbers, printed letters, shapes, cursive letters, and sentences taught by the therapist. He was also assigned practice homework. As the therapy progressed, he was

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challenged to make written responses to questions. Applying a somewhat recent criteria to the results of these writing activities, they ranged from illegible, considerable tremor, and legible with notable tremor (Fahn, Tolosa, & Marin, 1988, p. 226). It is noteworthy that using ballpoints resulted in the most illegible and considerable tremor during writing. Significantly hard pressure of both pencil and pen were noted on practice pages. During several months of writing therapy, legible with notable tremor was the most observed criteria for the practice results. It is also worth noting that this individual set his own writing pace, was very persistent concerning practice sessions and positive about progress. The long-range outcome of writing therapy for this individual was a return to normal writing ability. It should be noted that the refined technological approaches to study writing such as functional magnetic resonance imaging was not available at the time of this writing therapy. From what is now known about writing and neural processes a great deal can be better understood about what likely occurred neurophysiologically during this individual's writing therapy program and why he benefitted from it.

Contemporary Knowledge of Handwriting's Impact

Cursive writing, printing, and tracing are visual-motor activities that have been and are being studied neurophysiologically with children, adolescents, and adults. These studies have involved observation of writing's influence on brain activity via functional magnetic resonance imaging (fMRI) (e.gs., James, 2010; James & Atwood, 2009; James & Engelhardt, 2012; James & Gauthier, 2006; Longcamp, Anton, Roth, & Velay, 2003, 2005; Longcamp et al, 2008, 2014; Richards et al., 2011) and also high-density electroencephalogram (HD EEG) with Geodesic Sensor Nets of 256 sensors on participants' heads (Ose Askvik , van der Weel, & van der Meer, 2020; Van der Meer & Van der Weel, 2017; Van der Weel & Van der Meer, 2024). The studies allowed for observation and recording of brain function while the individuals were writing that identified writing's neurodevelopmental, educational, and therapeutic benefits.

Among the noteworthy findings are that: 1) writing facilitates letter recognition and reading abilities (James & Engelhardt, 2012; James, Jao, & Berninger, 2016; Longcamp, Anton, Roth, & Velay, 2003; Longcamp, Zerbato-Poudou, & Velay, 2005); 2) there is an innate connection between motor regions for writing and the perceptual systems during perception of print or writing (James & Atwood, 2009; James & Gauthier, 2006); and 3) writing has a positive influence on memory development and the retention of memories (Bohay, Blakely, Tamplin, & Radvansky, 2011; Longcamp, Boucard, Gilhodes, & Velay, 2006; Van der Weel, & Van der Meer, 2024). What is learned from this cluster of studies is how beneficial writing is to development. We learn that so much more than letters or words on paper is happening in the brain of the one who is writing.

In this regard, it is meaningful to return to the topic of this reflection on handwriting as therapy. In retrospect, it can be assumed that the handwriting therapy facilitated many unseen neural benefits for the electrical accident victim. A quite positive influence on memory and remembering was noted. handwriting for this individual was a motor activity that especially facilitated the three memory systems—procedural, semantic, and episodic as proposed by Tulving (1985a, 1985b, 1985c, 1987, 1993). Being given directions and shown how to write and copying what he was shown established his procedural memory for writing and semantic memory for the meaning of the word 'write'. Responding to the therapist's instructions regarding the writing tasks activated his episodic remembering for having written and semantic remembering of the meaning of the various writing tasks—i.e., write numbers, print letters, copy shapes, practice cursive letters, sentences, and to make written responses to questions. Hereafter, when asked to write, writing is evidence of attainment of semantic memory of the writing lesson's instructions and episodic memory of the lesson events. It is meaningful to know that these memory systems are hierarchical. Tulving (1985a) shares that ". . . at the lowest level . . . procedural memory, contains semantic memory as its single specialized subsystem and semantic memory, in turn contains episodic memory as its specialized subsystem" (p. 387). In other words, semantic memory is dependent upon procedural memory and episodic memory is dependent upon both procedural and semantic memory. A final reflective

observation is that for the electrical accident victim handwriting became the origin of procedural memory, also regarded as ". . . motor memory, body learning, or habit memory" (Jensen, 1998, p. 107, 2005, p. 135) that resulted in the emergence of semantic and episodic memories of handwriting.

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