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An Occupational Therapy Guide for Teaching Handwriting Skills to Adults

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AN OCCUPATIONAL THERAPY GUIDE FOR TEACHING HANDWRITING SKILLS TO ADULTS

by

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This Scholarly Project Paper, submitted by Kyla Miller and Nichole Schroeder in partial fulfillment of the requirement for the Degree of Master’s of Occupational Therapy from the University of North Dakota, has been read by the Faculty Advisor under whom the work has been done and is hereby approved.

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ABSTRACT

Handwriting is a skill utilized widely by adults; however, there is a lack of guidelines, information, or literature on the subject as it relates to adults. The purpose of this project was to develop guidelines for occupational therapists to use when providing handwriting interventions with adults. A literature review was conducted using PubMed, CINAHL, SCOPUS, DynaMed, and professional journals to further understand the topic of handwriting with adults and its relation to occupational therapy. Currently, there is limited research and information regarding handwriting with adults and no programs or guidelines were found to assist occupational therapists in developing treatment interventions to remediate adult patients’ handwriting. The guidelines developed for occupational therapists consist of a review of the anatomy and musculature involved with handwriting, grasp patterns, ergonomic factors relating to handwriting, visual control, proprioception and kinesthesia, spatial analysis, bilateral integration, and age-appropriate activities/intervention ideas for use with occupational therapists’ adult clients. The development of these guidelines was grounded in constructivist learning theory to enhance the meaning of the treatment for the client. These guidelines are intended to provide occupational therapists with a basic foundation of knowledge and treatment strategies to maximize their clients’ remediation of handwriting dysfunction. The authors of this scholarly project recommend more research be completed on handwriting practices with adults. It is also recommended that an assessment be developed that specifically addresses adult handwriting skills.
CHAPTER I

INTRODUCTION

Handwriting is a fundamental skill that has been utilized over the course of centuries by adults for multiple different purposes. Individuals need to possess many performance factors to be successful in handwriting tasks. These factors can be affected when an adult has incurred an illness or diagnosis that affects their upper extremity function. According to Feder and Majnemer (2007), adequate handwriting ability is a needed skill throughout adulthood. Although handwriting is a required skill for many adults to participate in their daily occupations, no research or literature was found that focuses on remediating adults' handwriting.

Occupational therapists work with people who have a variety of different diagnoses that affect hand function, specifically the skill of handwriting. There were no resources found to assist an occupational therapist with the remediation of handwriting practices with adults; therefore, a guide was developed to specifically address this issue. This guide encompasses foundational knowledge of the factors that can affect an adult's handwriting and ideas for interventions for remediation. As neurological disorders, specifically traumatic brain injury and cerebrovascular accident, have the power to affect a person’s hand function, cognition, affect, and other physical components, these diagnoses were the focus for this guide. As this guide is intended for use with adults, principles of adult learning theory were integrated to facilitate effectiveness for use with adults.
Adult learning theory encompasses many aspects of the adult learner. These aspects can include but are not limited to incorporating life experience of the adult, using the style in which the adult learns best, and giving the adult control of the content and pace of his or her learning (Collins, 2004). The client’s intrinsic motivation will be facilitated if each of these factors are addressed by the occupational therapist. Motivation is an integral aspect of the intervention process as individuals need to be invested in the content of their learning to receive the maximum amount of progress in their treatment and learning endeavors (Bastable & Dart, 2006).

A principal component of adult learning theory is ensuring adults are taught with learner-centered teaching methods. This approach integrates learner preferences and their style of learning they find most effective. Adults can learn visually, auditorily, haptically, or a combination of all three (Lemire, 2001). When each of these components have been considered, the occupational therapist assumes a more facilitative role and the client gains more control over the learning process.

The literature review located in Chapter II is composed of current research, literature, and background information on the subject of handwriting with adults. Also included is a more detailed summary of adult learning theory and how the principles were incorporated in the product. The following chapter, Chapter III, highlights the literature that was accessed and the methodology used to create the product. Chapter IV presents the product in its entirety and instructions for implementation. Lastly, Chapter V includes our conclusions and future recommendations for the product.
CHAPTER II
REVIEW OF THE LITERATURE

Imagine you have had a stroke and are suddenly unable to write your name, sign a check, or write a grocery list. How would you feel? What would you do to complete these tasks? What are your options to remediate this problem? Handwriting is often viewed as an insignificant skill that can easily be overlooked with the progression of technology toward computers. It is also a skill not typically addressed throughout the course of occupational therapy treatment. The aforementioned claims are supported by the scarcity of literature that exists on the topics of handwriting in adults. To fully understand the potential implications of this dearth of knowledge about handwriting, it is important to consider a patient case scenario.

Bill was a 54-year-old, married, father of three children. He made a living as an accountant and was travelling to work when he was involved in a motor vehicle accident in which he sustained a traumatic brain injury. Bill’s condition was deemed stable, but he was unable to speak secondary to tracheotomy placement. He was given a pen and paper to communicate. This would have been a great way for Bill to communicate, except that his lack of fine motor skills inhibited his ability to write. Communication between the occupational therapist and Bill was limited. Even though Bill was unable to write, the therapist did not focus interventions on this issue as she felt there were more important areas to address. Bill, however, began to feel increasingly frustrated in the treatment process as he was unable to indicate his needs and his involvement in planning
meaningful, individualized goals was extremely limited. The frustration that Bill experienced was often evidenced in treatment as Bill would refuse to attend treatment sessions, demonstrated a flat affect, and eventually, was diagnosed with major depression. While we are not suggesting that handwriting as a means to communicate would have significantly altered Bill’s treatment course, it may have allowed him to engage more readily in designing treatment strategies that were meaningful and also provided a method for Bill to communicate his needs to his family and healthcare team. It is consideration of patient function and the importance of handwriting as a fundamental performance area for many people which propelled us to examine the existing handwriting literature and research.

Chapter II is composed of current research, literature, and background information on the subject of handwriting with adults. The following pages will address the historical importance of handwriting, functional importance of handwriting, relevance of occupational therapy, and factors affecting handwriting. Additional areas that are reviewed include neurological disorders, pediatric handwriting assessments, frames of reference utilized to teach handwriting, and adult learning styles. This chapter also highlights the dearth of literature of handwriting practices with adults which persists in rehabilitation resources.

Handwriting is a fundamental skill that has been utilized over the course of centuries for multiple purposes. Handwriting origins have been traced back to its use in creating Italian Renaissance scripts in the 12th century while contemporary handwriting, which is practiced present day, began in the 16th century (Clayton, 1999). The first writing instruction manual was developed by Ludovico degli Arrighi in 1522 in Rome.
using Gothic cursive script. In 16th century England, writing was not taught universally to all people. Only those who were born into wealthy families and whose professions depended on written communication, such as doctors and clergymen, were taught the skills of handwriting. People of lower socioeconomic status were not given the opportunity to learn to write. Writing utensils have also progressed from quills and ink to ballpoint pens. Parchment paper was the initial writing medium used, while today, lined notebooks are utilized (Clayton, 1999). Although history addresses how the process of handwriting has evolved, there is limited information on its applicability with adults.

According to Feder and Majnemer (2007), adequate handwriting ability is not only important for children to be successful in school, but it is also a needed skill throughout adulthood. Much of the following literature review targets children because there is an expansive body of knowledge pertaining to children and handwriting. The dearth of literature that addressed adult handwriting is significant and noteworthy. This scarcity of information required that we use the available handwriting literature for children to structure treatment interventions for adults.

Today, children learn the skill of handwriting in school for use in composition, mathematics, and homework. Medical professionals use handwriting for tasks as complex as documentation purposes, but also for functions as simple as signing their name on a discharge summary. Also, despite the rise in technological substitutions for recording information and as a means of social contact with others (i.e. email), many persons still use handwriting for personal correspondence purposes. Some people use handwriting to capture their thoughts in occupations such as journaling, while others use it in scheduling tasks to structure their daily routine.
After passage of The Education of the Handicapped Act in 1975, (renamed The Individuals with Disabilities Education Act), occupational therapists began incorporating their services into the school systems as related services (The Individuals with Disabilities Education Act, 1997). Occupational therapists' roles in the school system have consisted of a variety of services; one of the most important services for consideration in this project is teaching and the facilitation of remediation of handwriting skills. The importance of occupational therapy skills and services gained exposure and prevalence after the passage of the Individuals with Disabilities Education Act in 1990 as it promoted equal opportunities for all children in the classroom; opportunities that include learning and developing handwriting skills (The Individuals with Disabilities Education Act, 1997). It was an area of client treatment in which occupational therapists became particularly valuable.

According to Jackson, Swinth, and Frolek Clark (2006), occupational therapists are involved in the development of handwriting curriculums in the school systems. Occupational therapists are often the first professionals to be contacted if a child is having difficulty with any of performance components that limit handwriting independence. These components may include ergonomic factors, upper extremity support, wrist and hand development, visual control, bilateral integration, spatial analysis, kinesthesia, and pencil grip as well as attention functions (Benbow, 1995). School-based pediatric occupational therapists have the knowledge and skills to assist with remediation of the aforementioned dysfunctions that can limit handwriting independence in children.

School-based occupational therapists are not the only specialty therapists who focus their attention on hand function. Occupational therapists who specialize in hand
therapy practice engage frequently with clients who have experienced orthopedic-related
dysfunction; a phenomenon which can be caused by neurological impairments.

According to the Hand Therapy Certification Commission (2002, para. 5), hand therapy
is the

art and science of rehabilitation of the upper quarter of the human body...using
specialized skills in assessment and treatment, hand therapists promote the goals
of the prevention of dysfunction, restoration of function and/or reversal the
progression of pathology in order to enhance participation in life situations for
individuals with upper quarter disease or injury. (para. 5).

In this arena, occupational therapists can be an integral part of the handwriting process as
they are the professionals working with a client with an injury affecting upper extremity
function. Together the occupational therapist and the client may engage in treatment to
remediate the factors that allow the person to hold a writing utensil and initiate and
sustain the required movements to produce writing. Hand therapists treat patients who
have injuries specific to hand dysfunction while other occupational therapists may treat
patients who demonstrate dysfunctional upper extremity use as a part of the overall
treatment of a disease or illness. Patients’ diagnoses can include cerebrovascular
accidents, traumatic brain injuries, fractures, nerve impairments, Parkinson’s disease,
multiple sclerosis, and a variety of other conditions. It is important to note that
occupational therapists working in all settings may target handwriting at some point in
their practice. Subsequently, occupational therapy is an important discipline in treating
persons with dysfunctions that affect the hand and, more specifically, the process of
handwriting itself.
Occupational Importance

Adults and children practice the skill of handwriting in multitudes of performance areas. The area of occupation titled “education” is defined as tasks required for a student to perform in a learning context (American Occupational Therapy Association [AOTA], 2002). As handwriting is a requirement in most educational environments, it is included in the scope of occupational therapy practice. Handwriting, as a part of education, is also considered an instrumental activity of daily living for students, more specifically, communication device use (writing equipment) (American Occupational Therapy Association [AOTA], 2002). Handwriting is a fundamental skill which children must master to be successful in nearly all aspects of their education.

While a great deal of resources have been dedicated to the remediation of children’s handwriting, little attention has been directed towards adults. Adults use this skill in many different areas of their life. Communication device use, specifically writing equipment, is utilized by adults in a variety of occupations. Adults may use these skills when preparing a written shopping list or completing written financial records. Each of these occupations is considered an instrumental activity of daily living (AOTA, 2002). Handwriting may also be an important aspect of an adult’s profession as job-related functions may include signing pay stubs, taking a message for a co-worker, or taking notes during an important meeting. More and more adults are engaging in informal educational opportunities to further their knowledge in specified interest areas (Creighton & Hudson, 2002). Also, many professions require persons to take continuing education courses to maintain their competency in their given profession. In each of these situations handwriting may be an important aspect to take notes, complete tests, and other written
tasks throughout the course. The authors propose a person’s independence in the aforementioned tasks requires mastery of handwriting skills; an occupation which is comprised of multiple performance-related factors.

Factors Affecting Handwriting

Prior to remediating handwriting, it is necessary for the occupational therapist to be aware of which hand, right or left, the client will be using to complete handwriting tasks. Handedness can be defined in different ways, although Courey, Hurley, and Foundas (2001) suggested handedness be defined by not only which hand is used to write, but also other factors of hand preference and hand performance. In one study, ninety percent of the sample proclaimed right hand dominance while 10% of the participants professed that they were left hand dominant (Mamolo, Roy, Rohr, & Bryden, 2006). A substantial literary foundation exists on the topic of handedness. Steenhuis and Bryden (1999) performed a study comparing hand performance in each hand in people who acknowledge that they were either right or left hand dominant. When comparing grip strength, the researchers found the population who had self-proclaimed they were left handed had no significant difference in strength between their right and left hands. However, the sample who stated that they were right handed demonstrated a difference as their right hand demonstrated greater strength than their left. Furthermore, 48% of the left handed population had a stronger right hand, compared to the 18% of the right handed population having a stronger left hand. In the same study, Steenhuis and Bryden concluded that people who reported left handedness used their right hand more frequently when picking up and manipulating objects than people who stated that they were right handed used their left. Conversely, Mamolo et al. (2006) found that there was no
significant difference between right and left handed individuals in comfortability using their preferred hand on the contralateral side of their body comparing using their non-preferred hand contralaterally. Both groups reported feeling more comfortable using their preferred hand on the contralateral side. To effectively assess and teach handwriting, it is important to understand handedness of the individual and the possible implications it may have on the learning process. Implications may include altering grasp patterns, paper positioning, and other biomechanics as ergonomic factors can differ for a right hand dominant person to a left hand dominant person.

Medland, Perelle, De Monte, and Ehrman (2004) conducted a study to compare the prevalence of right and left handedness across cultures, sex, and age. The researchers split the population into two main cultural categories: formal and informal. The formal populations included the countries where people learned to write versus the informal population where people did not learn to write. Medland et al. found that the informal population had a higher prevalence of being left handed compared to the formal population. When men and women were compared, the researchers found that there was a higher occurrence of left handed males. The authors reported a lower percentage of self-proclaimed right handed individuals who scored higher with their left hand in the younger sample than the left. The researchers proposed that the older population transferred to their left hand either by choice or coercion to use tools and other materials made for right handed individuals. In the event that a person sustains an injury that results in a non-functional upper extremity, it may be possible for someone to transfer learning to the contralateral limb through the use of coercion and presentation of tools that will assist in this process.
Neurological Disorders

Several disorders or injuries could result in the impairment of hand function. For the purposes of this scholarly project, we have narrowed our focus to neurologic conditions that may result in loss of hand function. The two diagnoses addressed in this literature review include cerebrovascular accident (CVA) and traumatic brain injury (TBI). The rationale for the focus on these diagnoses is that they both can impact an individual’s cognition, affect, and physical function.

Cerebrovascular Accident

According to the Centers for Disease Control and Prevention (CDC) (2006), 700,000 people experience a cerebrovascular accident each year. A cerebrovascular accident is defined as “a sudden or gradual onset of neurologic symptoms caused by a diminished supply of blood to the brain” (Reed, 2001, p. 270). Statistically, more males experience a CVA than females; however, females have a higher mortality rate. Approximately 75% of strokes occur in those over the age of 65 years. After the age of 55 years, a person’s risk of stroke doubles each decade. While stroke is the third-leading cause of death in the United States, it is one of the most common reasons for long-term disability (CDC, 2006).

According to the American Stroke Association (2007) many different types of CVAs can occur and can subsequently cause a wide array of physical and cognitive disabilities. There are two different types of stroke – ischemic and hemorrhagic. Ischemic strokes are caused by blockage or narrowing of blood vessels in the brain. This leads to lack of oxygen-rich blood to the brain causing cells to die. Ischemic strokes can further be broken down into thrombotic and embolic. Thrombotic strokes are caused by a blood
clot in an artery in the brain blocking blood flow to a specific area of the brain. Embolic strokes are caused by a clot that travels to the brain originating in a larger artery that leads to the brain. Hemorrhagic strokes are caused by blood leaking into the brain from a burst blood vessel. There are two types of hemorrhagic strokes - subarachnoid and intracerebral. Subarachnoid hemorrhages result from blood leaking into the subarachnoid space causing pressure on the brain and injuring brain cells. Often, this is caused by a ruptured aneurysm. Intracerebral hemorrhages result from blood leaking in the brain itself and are often the result of hypertension (American Stroke Association, 2007).

The location of the CVA in the brain results in specific functions of the body being affected. The frontal lobe is the area that controls planning and thinking processes whereas the parietal lobe is the area that controls sensory and visual perception (University of Michigan, 2000). Language, memory, and emotional functions are located in the temporal lobe while visual information is processed in the occipital lobe. For example, if a CVA occurs in the left hemisphere of the brain, the motor and sensory functions are affected on the right side of the body. (American Stroke Association, 2007). When a right hand dominant person experiences a CVA in the left hemisphere of the brain, impairments may be seen in his or her handwriting abilities for the previously stated reasons.

*Traumatic Brain Injury*

According to the Centers for Disease Control and Prevention (2006), 1.4 million people experience a traumatic brain injury each year. According to the Center for Disease Control and Prevention (2006) a traumatic brain injury (TBI) is defined as “a blow or jolt to the head or a penetrating head injury that disrupts the function of the brain” (p. 1). The
leading causes of a TBI are falls (28%), motor vehicle accidents (20%), being struck by
an object (19%), and assaults (11%). Statistically, males are 1.5 times more likely than
females to suffer a TBI. Newborns to four year olds and 15 to 19 year olds are at the
highest risk for TBI (Langlois, Rutland-Brown, & Thomas, 2006). It is estimated that at
least 5.3 million people in the U.S. currently have a long-term need for assistance to
perform activities of daily living as a result of a TBI (Thurman, Alverson, Dunn, &
Sniezek, 1999).

TBIs can be caused by a variety of different events. These can include, but are not
limited to: car accidents, motorcycle accidents, a bullet entering the skull, or objects
falling on the head (Reed, 2001). TBIs can be caused by an injury that infiltrates through
the skull (open) or by an injury in which there is no skull fracture (closed) (Reed, 2001).
Damage to the brain can be either localized in one specific area or diffused across a larger
area. The initial injury to the brain can cause a variety of other issues such as intracranial
hematomas, cerebral edema, hydrocephalus, and intracranial infection. (Reed, 2001).

Traumatic brain injuries can affect a wide variety of functions including those
specific to this project – hand function and learning. Functional limitations for a person
who has incurred a TBI can include limited strength and range of motion in upper
extremities, decreased problem-solving skills, decreased attention span, impaired
memory, aphasia, and difficulties with motor planning (Radomski, 2002). These are all
dependent upon the area of the brain that was affected by the traumatic brain injury.
These areas are the same that were previously mentioned in the section on CVA and
include the frontal, parietal, temporal, and occipital lobes. The frontal lobe is the area that
controls planning and thinking processes whereas the parietal lobe is the area that
controls sensory and visual perception (University of Michigan, 2000). Language, memory, and emotional functions are located in the temporal lobe while visual information is processed in the occipital lobe.

**Pediatric Handwriting Assessments**

The review of following assessments describe children's handwriting as there are infinite resources available; as previously noted there is a dearth of literature that addresses handwriting evaluation and treatment with adults. The following sections will discuss the purpose, reliability, and the validity for each assessment. Though the generalization and application of children's assessment research to adult assessment is limited, it nonetheless provides a foundation of considerations for addressing adult handwriting evaluation. The proceeding information also provides the reader with an introduction to important performance areas that should be considered when evaluating the handwriting skills of persons of any age.

*Evaluation Tool of Children's Handwriting*

The Evaluation Tool of Children's Handwriting (ETCH), developed by Amundson (1995), is a criterion-referenced tool designed to evaluate manuscript and cursive handwriting skills of children in grades one through six. The ages of children that can be evaluated using this tool range from six years, 0 months to 12 years, 5 months old. The ETCH was designed for children with "mild developmental delays, learning disabilities, and mild neuromuscular impairments" (Amundson, 1995, p. 2). It is used to assess a student's legibility and the speed of his or her handwriting; the test tasks are similar to those that students perform in the classroom. The ETCH is used to assess six different areas of children's handwriting including: alphabet production from memory,
numeral writing from memory, near-point copying, far-point copying, dictation, and sentence composition (Diekema, Dietz, & Amundson, 1998).

There have been multiple studies completed to assess the reliability and validity of the ETCH. As stated in the ETCH examiner’s manual (1995) interrater reliability and tester reliability were shown to be of acceptable levels. Diekema et al. (1998) found moderate test-retest reliability coefficients for total legibility scores. Schuette (2001) reported high test-retest reliability coefficients for total legibility scores. Both of these studies indicated the reliability of individual task scores were lower than total legibility scores. Koziatek and Powell (2002) published findings which supported a moderate relationship between predictor variables of legibility scores and the criterion variable.

Test of Handwriting Skills-Revised

The Test of Handwriting Skills-Revised (THS-R) was developed by Milone (2007), and was designed to evaluate neurosensory integration processes in children engaging in cursive or manuscript writing. The manuscript version of the test is appropriate for use with children ages 6 years, 0 months to 18 years, 11 months while the cursive version is appropriate for use with children ages 8 years, 0 months to 18 years, 11 months.

Internal consistency, test-retest, and interrater reliability for the THS-R were shown to be of high levels; however, this revision was completed in 2007 and no evidence was located that has contradicted or confirmed the original results. Content and construct validity for this evaluation were also shown to be promising, though Milone, (2007) encouraged continual re-evaluation to determine the accuracy of the test in evaluating the constructs of reliability.
Developmental Test of Visual Perception, Second Edition

The Developmental Test of Visual Perception, Second Edition (DTVP-2), developed by Hammill, Pearson, and Voress (1993), was designed to assess visual perception and visual-motor integration skills in children ages 4 to 10 years. The original DTVP-2 was developed in 1961 to “characteristics of visual perception, determine the effects of visual perception training, and identify children with perceptual disorders” (Hammill et al., 1993, p. vii). Strong internal consistency and test-retest reliability of the DTVP-2 were reported as .97 and .93, respectively. Strong reports of content, criterion-related, and construct validity were shown for the DTVP-2; however, Hamill et al. (1993) encouraged further studies to test these results.

Bruininks-Oseresky Test of Motor Proficiency

Developed by Bruininks and Bruininks (2005), the Bruininks-Oseresky Test of Motor Proficiency, Second Edition (BOT-2) was designed to assess the gross and fine motor skills of children ages 4 years to 21 years, (Bruininks & Bruininks, 2005; Deitz, Kartin, & Kopp, 2007). The BOT-2 is divided into eight subtests: fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength (Bruininks & Bruininks, 2005).

According to Bruininks and Bruininks (2005), internal consistency reliability was shown to range from the high .80s and the low .90s. Test-retest reliability ranged from the low .70s to the low .80s. Additionally, interrater reliability was shown to be high as noted by scores in the .90s. In a study conducted by Deitz et al. (2007), inter-rater reliability was tested using two examiners and 47 children with ages ranging from 4 years to 21 years. All subtests were shown to be greater than .90 except for the fine motor precision.
subtest which was .86. Test-retest reliability was tested with three different age groupings (4 to 7 year olds, 8 to 12 year olds, and 13 to 21 year olds) and was found to be ≥ .80 for the Total Motor Composite and the Short Form. Authors found strong validity when the BOT-2 was compared with other evaluations of this nature and was found to be highly correlated.

**Developmental Test of Visual Motor Integration**

Developed by Beery and Buktenica (1997), the Developmental Test of Visual Motor Integration, Fourth Edition (VMI) was designed to assess visual-motor integration including finger and hand movements in children ages three through seven if using the Short Form and ages three through 18 years if using the Full Format version (Beery & Buktenica, 1997). The internal consistency reliability was .96 while test-retest reliability was .87. Additionally, interrater reliability was .94. The overall reliability for the VMI was .92 (Beery & Buktenica, 1997). An additional study was conducted by Goyen and Duff (2005) to determine the ability of the Developmental Test of Visual Motor Integration to distinguish between children who have handwriting difficulties and those who do not have any difficulty. Researchers found that this test determined only a small number of children who had handwriting dysfunction.

**Test of Visual-Motor Skills-Revised**

Developed by Gardner (1995), the Test of Visual-Motor Skills-Revised (TVMS-R), was designed to assess a child’s ability to use his or her hand to produce motorically what he or she has visually perceived. This assessment is appropriate for use with children ages 3 years, 0 months to 13 years, 11 months. Overall reliability for the TVMS-R was reported at .92 across all ages (Gardner, 1995).
It is important to discuss the pediatric assessments as well as their reliability and validity as several of the characteristics may be applicable for evaluating the adult population. Discussing these aspects of the assessments also attest to their credibility and legitimacy. Concepts in the pediatric assessments could possibly be utilized for the future development of assessments for adults.

We have discussed numerous handwriting assessments that are indicated for use with pediatrics, but limited information is available regarding adults. There are tests that assess hand function in adults, but not specifically handwriting skills. The tests available that assess hand function in adults include the Jebsen Test of Hand Function, the Nine-Hole Peg Test, the Box and Block Test, the Purdue Pegboard, and the Minnesota Rate of Manipulation Test. These tests assess hand function in the areas of dexterity, grip, manipulation, speed, and strength, but fail to address the specific task of handwriting (Cooper, 2002).

Following a thorough search of PubMed, CINAHL, SCOPUS, DynaMed, and a plethora of professional journals, a small number of articles were found addressing adults and handwriting practices. Minimal resources were found for adult handwriting assessments and related practices. A great deal of the research regarding adults and handwriting practices are out-dated or originated from sources with questionable credibility.

If the occupational therapist has determined that a deficit in an adult's handwriting exists, it would be beneficial to confirm these results with a handwriting assessment that is appropriate for adults. However, no such assessment is known to be in
existence. Therefore, it is recommended that an assessment be developed for adults that focuses on the specific skills and tasks involved in handwriting.

Frames of Reference

After an occupational therapist has performed an assessment and has identified a need for remediation, the next step is determining which intervention style would be most beneficial for the adult. Interventions are guided by frames of reference; handwriting practice treatments are consistent with this premise. The following section describes commonly used frames of reference for guiding handwriting practices with children. Frames of reference used with children are addressed as there is expansive knowledge related to this topic and no information related to this topic with adults.

There are multiple different handwriting approaches that have been tested with children who are experiencing difficulty with this task, but none were found that addressed handwriting with adults. Amundson (2005) reported that there are five frames of reference that are most frequently used to teach written communication: neurodevelopmental, acquisitional, sensorimotor, biomechanical, and psychosocial. Often, occupational therapists use a combination of these approaches which is known as a multisensory approach. Woodward and Swinth (2002) found that 92% of occupational therapists in the United States use a multisensory approach to handwriting intervention while Feder, Majnemer, and Synnes (2000) found that 90% of Canadian occupational therapists use a sensorimotor approach to handwriting intervention.

Neurodevelopmental Frame of Reference

The neurodevelopmental frame of reference is based on principles of neurology and characteristic child development (Amundson, 2005). This frame of reference
addresses on improving motor function in children to facilitate their engagement in meaningful and purposeful activity. Successful performance in handwriting activities could be influenced by a variety of different mechanisms including, but not limited to: poor postural control, variable muscle tone, and inability to stabilize proximal muscle groups (Amundson, 2005). The neurodevelopmental frame of reference illustrates the importance of incorporating activities that prepare the child's posture and limbs for handwriting.

**Acquisitional Frame of Reference**

The acquisitional frame of reference refers to handwriting as a motor skill that can be acquired through three coinciding phases: the cognitive phase, the associative phase, and the autonomous phase (Amundson, 2005). During the cognitive phase the child is beginning to understand the process of handwriting and is also starting to develop cognitive strategies for implementing the required motor skills. The associative phase finds the child continuing to make adjustments with their handwriting skills. During this phase, proprioceptive feedback becomes more important than the visual skills that were the focus of the cognitive phase. During the final, autonomous phase, handwriting is performed automatically by the child with minimal effort and error with expectations that the child will begin to focus on more complex functions of handwriting. (Amundson, 2005).

**Sensorimotor Frame of Reference**

Contradicting evidence has been found with the sensorimotor approach for handwriting remediation for use with children. Sensorimotor approaches were found to be beneficial in a study performed by Peterson and Nelson (2003). The researchers found
that space, line, and size of letters improved significantly with occupational therapy intervention while legibility and form were shown to improve moderately. Interventions included having the children engage in heavy work at the beginning of each session and also using many different sensory modalities to help the children practice their letters. Varied writing surfaces were utilized as well as imagery to assist the child in remembering the shapes of different letters. A study conducted by Denton, Cope, and Moser (2006) found contradicting results when researching sensorimotor-based interventions for improving handwriting with children. The researchers examined four sensorimotor areas: in-hand manipulation, visual perception, proprioception, and visual-motor integration. Some of the interventions that were provided following a sensorimotor approach were word find activities, making shapes in bag of sand, weight bearing on upper extremities, and playing with marbles. Denton et al. (2006) found that the children’s handwriting performance declined overall using sensorimotor techniques. In-hand manipulation and visual perception did not improve when compared to children who did not receive any intervention. Proprioception and visual-motor integration were not improved while using this approach.

**Biomechanical Frame of Reference**

The biomechanical frame of reference focuses on modifying contextual factors that can affect a child’s performance in handwriting tasks rather than focusing on the actual performance skills (Amundson, 2005). Variables studied by Rosenblum, Goldstand, and Parush (2006) included ergonomic factors such as body positioning, pencil grip, pencil positioning, and consistency of pencil grip. Additional contextual factors affecting a child’s performance can include: sitting posture, paper position,
writing tools, and type of paper. Continual observation of ergonomic factors may provide etiological insight about why a child may not be performing at optimal levels with handwriting tasks (Rosenblum et al., 2006). The biomechanical frame of reference also incorporates performance components and their remediation. Performance components include performance skills which are motor skills, process skills, and communication and interaction skills (AOTA, 2002). The occupational therapist would assess these skills throughout the course of the treatment process and adjust interventions accordingly. For example, if a child is seated in a chair that is too large for him or her, the occupational therapist would find a more appropriately sized chair to facilitate better engagement in the handwriting task.

*Psychosocial Frame of Reference*

When applied to children's handwriting performance, the psychosocial frame of reference focuses on improving emotion regulation skills (Amundson, 2005). This frame of reference includes factors such as attention span, behavioral problems, hyperactivity, self-control, and coping skills. When a child has difficulty regulating these skills, his or her legibility and speed of writing has been found to decrease (Feder, Majnemer, Bourbonnais et al., 2005).

The profession of occupational therapy has indicated many intervention ideas that are acceptable for handwriting remediation in children, but none for adults. Even in child populations, there is a dearth of scholarly research that has trialed these intervention strategies. Further research is needed to support the benefits of handwriting interventions. Many of the concepts of frames of reference used with children will be similar when incorporating them for use with adults. The challenge is integrating age-appropriate
interventions for handwriting with adults within the confines of these frames of reference. Understanding the constructs of adult learning theory is important for the occupational therapist when interacting with adults and when attempting to facilitate client learning and participation during interventions.

Adult Learning Styles

To effectively assess and provide appropriate interventions for an adult, the therapist needs to understand adult learning. It is important for the adult to learn during the intervention process to increase his or her understanding of the reasoning behind the techniques used during therapy. As adults may learn in a variety of ways, different learning styles are explored and discussed in the proceeding paragraphs.

Malcolm Knowles was the first person to use the word andragogy to describe the study of adult learning (Bastable, 2006). He used this term to distinguish adult learning from the study of how children learn which is known as pedagogy. Andragogy and pedagogy are thought to represent opposite ends of a learning continuum. The primary difference between the theoretical perspectives is the amount and type of life experiences that the learner has before he or she enters the learning experience. Another difference is the amount of power or command that the learner has over the learning process and the context in which the learning is conducted (Collins, 2004). Adults are often taught with learner-centered methods as children are taught with teacher-centered methods. Learner-centered methods consider the learner’s preferences on the subject and method of learning while teacher-centered methods focus on what the instructor decides to teach his or her students. These concepts and differences are important to consider when structuring an educational course for adults. (Collins, 2004).
The constructivist learning theory focuses on how a person’s motivation can impact his or her learning (Braungart & Braungart, 2006). The teacher assumes a facilitative role and provides encouragement and support to the learner and his or her learning preferences and needs; subsequently, the learner has more responsibility and control over the direction of his or her education.

Adults need motivation throughout the entire learning process (Bastable & Dart, 2006). They need to know that what they are learning will be beneficial to them in some way and that the experience will have been worthwhile. Adults learn best when the information to be learned is of importance to them and if they can be convinced of its need. Therefore, when teaching an adult, it is important to find what is meaningful to that person to promote intrinsic motivation. Most often, adults are motivated to learn by a life experience that has provoked interest or made them want to learn more about a certain subject. In this project, the client’s motivation for learning will likely be the loss of function that a person has endured and his or her desire to remediate that dysfunction and resume his or her usual performance tasks. An adult will also be more motivated to learn new information if he or she is working toward a specific goal that is meaningful to him or her. (Bastable & Dart, 2006).

Autonomy and self-directedness also need to be considered when teaching adults (Bastable & Dart, 2006). The more life experience that is relative to the subject of learning that a person has, the more likely he or she will be motivated to engage in the learning process. If an adult is motivated to learn, he or she may also take more responsibility and perform more of their learning independently and with less encouragement from the instructor. An adult’s responsibility of learning needs to be
taken into consideration when teaching adults as the occupational therapist may need to alter the pace of his or her teaching depending on how self-directed the learner is. (Bastable & Dart, 2006).

Adult learning is more likely to be facilitated when an adult has some input into the style of learning (visual, auditory, kinesthetic) and the pace at which he or she is taught. This correlates with many adults being self-directed with their learning. Past life experiences can also affect the level of an adult’s engagement in learning (Russell, 2006). An adult may have preconceived ideas about what he or she will be learning which could possibly hinder his or her performance if the teacher is not aware of those ideas. If a teacher can successfully connect past life experiences to new information, it may facilitate an adult’s learning and thus make the learning more meaningful.

As an adult progresses through the learning process, it is important to apply/practice what he or she is learning; this can serve multiple purposes. The adult will have a chance to gain more practice with a certain skill, the teacher can observe/gauge how the student is progressing, and the adult may be able to see tangible gains in his or her progress (Collins, 2004; Russell, 2006). An adult’s confidence and motivation may increase if he or she is able to see an improvement in the skills he or she is trying to learn and master.

Lemire (2001) studied three different learning styles which he refers to as visual, auditory, and haptic. Visual learning is learning by what is seen. Some of examples of visual learning strategies would be graphic representation, modeling, posters, and worksheets. Learning by the act of listening would be auditory learning. Lectures, audio recorders, group work, and singing would be examples of some strategies that would be
beneficial to a person who learns auditorily. Lastly, learning haptically is learning by actively doing something. Strategies that are used to facilitate learning with these individuals would be plays, projects, demonstrations, and group work. (Lemire, 2001).

Lemire (2001) reported the percentage of each learning styles used in high school and college students, visual learning had the highest percentage for both the high school and college students with 41% and 62%, respectively. Auditory learning was the least percentage of preference for learning in both groups. College students preferred auditory learning less than high school students (Lemire, 2001).

Other concepts that affect learning, along with visual, auditory, and haptic, have been studied and examined by researchers. Honigsfeld and Dunn (2003) examined such affects such as lighting, sound, temperature, interactions, authority, food/drink intake, motivation, and time of day male and females in five different countries. Researchers found, overall, males preferred learning in groups and preferred more kinesthetic groups compared to females. When compared to females, males tended to be less self-, parent-, and teacher- motivated, and preferred lower room temperatures. Females were found to be more persistent and more responsible when compared to the males in the sample. (Honingsfeld & Dunn, 2003).

To promote learning for the adult client, occupational therapists need to be aware of the learning styles of the individual to facilitate greater learning. With a diverse group of persons, it is important to change the learning environment often to meet the needs of all group members. Changes such as lighting, room temperature, motivation, group learning, and single learning can assist individuals to meet learning needs. Once a desired learning strategy is determined, it is beneficial to apply this strategy when learning. It is
important for each individual to be aware of his or her learning style, as well. When a person is conscience of his or her own learning style, he or she will be able to implement this style independently to enhance his or her learning ability (Honigsfeld & Dunn, 2003).

Summary

The authors of this scholarly project have discussed the historical importance of handwriting, its significance in daily occupations, and the role of occupational therapists in remediation of handwriting dysfunction. Biological factors affecting handwriting, in addition to two of the neurological disorders that can impact hand function were also discussed. Also explained in this review were pediatric handwriting assessments and the lack of adult handwriting assessments. Lastly, adult learning styles and common frames of reference used to guide handwriting remediation were reviewed.

The review of literature culminated in a foundation of knowledge that has implications for the treatment of adult handwriting. Chapter III is comprised of the methodology which describes the process used in designing the product.
CHAPTER III

METHODOLOGY

The product described in the following chapter includes guidelines for occupational therapists who wish to engage their adult patients in handwriting remediation intervention. These guidelines are intended to provide occupational therapists with the basic knowledge of anatomy of the upper extremity, mature grasp patterns, body positioning, and ergonomics. Also included are preparatory skills needed to facilitate handwriting, principles of adult learning, and age-appropriate intervention ideas. In addition, a needs assessment is included to guide the interview process and ensure that the interventions implemented by the occupational therapist are client-centered.

The process of developing the guidelines began with a review of the literature. Several databases were utilized in the search including Pub Med, CINAHL, SCOPUS, DynaMed, and PsycINFO. Initially, a search for scholarly journal articles that specifically addressed handwriting practices was implemented. However, minimal literature was found and further communication with occupational therapy faculty and professionals in the United States and in Australia confirmed this lack of information. The search was expanded to include research that addressed handwriting practices with pediatrics, neurological disorders, and frames of reference utilized for instruction. Neurological disorders were chosen as a focus for this product due to the fact that an individual's
affect, physical function, and cognition can be impaired. Key words searched included: handwriting, history of handwriting, adult learning, pediatric handwriting assessments, cerebrovascular accident, traumatic brain injury, handedness, constructivism, and occupational therapy. The American Occupational Therapy Association (AOTA), American Stroke Association (ASA), Center for Disease Control (CDC), and the National Institute for Neurological Disorders and Stroke (NINDS) websites were utilized to access information to support the development of these guidelines.

After determining their relevance to the scholarly project, the articles and information collected were analyzed to identify similar concepts and contradicting evidence. This information was then used to develop guidelines for occupational therapists to utilize when teaching the skills of handwriting to adults. To successfully participate in the task of handwriting, many factors must be considered. Preparatory skills were determined to be an imperative aspect of the handwriting process; therefore a thorough review of anatomy, mature grasp patterns, proper body position, and ergonomic factors were included in the product. Visual control, proprioception/kinesthesia, spatial analysis/relations, bilateral integration, and cognition were also incorporated as well as possible intervention ideas for each of these areas. Interventions used with adults should be age-appropriate and client-centered, for that reason a guide was included within the product to help facilitate this process.

An Interview Guide/Handwriting Needs Assessment was developed to use in conjunction with the guidelines to ensure client-centeredness. Questions were created to elicit information from the client that would assist the occupational therapist in designing interventions that are meaningful to the individual. Throughout the development of the
interview guide/handwriting needs assessment, consideration was given to the readability of the questions, the context where handwriting is implemented, and the importance of handwriting to the client. Each of these characteristics corresponds with the theory of adult learning.

In order to effectively teach adults, the occupational therapist needs to be aware of the principles that guide adult learning. The theory guiding the development of this product is adult learning theory, more specifically, constructivism. According to Bastable (2006), constructivist methods are guided by what the learner chooses to learn. The learner is given more control over the learning content and how it is taught. When an individual is learning information that is meaningful to him or her, intrinsic motivation is enhanced. For this reason, it is imperative that the occupational therapist develop interventions that are age-appropriate and client-centered.

The product for this scholarly project incorporated the previously mentioned information into guidelines for an occupational therapist to assist an adult with handwriting remediation. Also included is a review of the anatomy and musculature of the upper extremity, common grasp patterns, ergonomic factors, and sensory components needed for successful handwriting performance. Chapter IV is composed of An Occupational Therapy Guide for Teaching Handwriting Skills to Adults. This guide provides occupational therapists with the foundational knowledge of preparatory skills required for handwriting and possible interventions that can be utilized to facilitate the handwriting process.
CHAPTER IV

PRODUCT

This chapter presents the product in its entirety. An Occupational Therapy Guide for Teaching Handwriting Skills for Adults was developed for occupational therapists to use with their clients who have incurred a neurological disorder. The guide begins by discussing the anatomy of the upper extremities followed by a review of mature grasp patterns that are commonly utilized during handwriting. Descriptions and pictures of each grasp pattern are provided for clarity. Also covered in this guide are ergonomic factors and sensory components that can affect the process of handwriting. The guide culminates in the provision of possible intervention ideas that can be used with adults to remediate any of the above mentioned factors. Prior to providing interventions, it is necessary for the occupational therapist to find what is meaningful to the client. An Interview Guide/Handwriting Needs Assessment was developed and included to facilitate this process. The guidelines will be bound for ease of usability by the occupational therapist.

This product was created largely from handwriting resources for children as no literature was found relating specifically to adults. Concepts derived from pediatric handwriting materials were adapted to meet the needs of adults. With the intention of making interventions more applicable to adults, this guide is age-appropriate and promotes client-centeredness.
As the guidelines are intended for use with adults, principles of adult learning theory are incorporated in this product. These principles take into consideration what motivates the client and how they learn most effectively (Bastable & Dart, 2006). An adult is more likely to learn when he or she has input into the medium (visual, auditory, kinesthetic) used to facilitate learning (Russell, 2006). Thus, it is imperative that the Interview Guide/Handwriting Needs Assessment be implemented to incorporate interventions that are age-appropriate and client-centered.

Before implementing the concepts contained in this guide, a referred client must present with a neurological disorder and a need for handwriting remediation. Once this need has been established, the occupational therapist should review the preparatory skills required for successful handwriting which are included in this guide. Utilization of the Interview Guide/Handwriting Needs Assessment should be performed early in the initial assessment process to determine the direction of the interventions. After determining which areas are deficits for the client, the occupational therapist should review the ideas for interventions, ensuring age-appropriateness and client-centeredness.
An Occupational Therapy Guide for Teaching Handwriting Skills to Adults

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Introduction

Handwriting is a fundamental skill that is utilized by adults for multiple different purposes. Many factors are involved in how successfully this skill is performed. When an adult has incurred an illness or diagnosis that affects their handwriting ability, remediation is necessary. Although handwriting is a needed skill for many adults, no literature or resources were found to assist the occupational therapist in the intervention process.

Several diagnoses can result in the impairment of hand function. This guide was developed for occupational therapists to use with clients who have incurred a neurological disorder, specifically cerebrovascular accident (CVA) and traumatic brain injury (TBI). Neurological disorders were chosen as they can involve multiple different areas including a client’s physicality, affect, and cognition.

The guide begins by discussing the anatomy of the upper extremities followed by a review of mature grasp patterns that are commonly utilized during handwriting. Descriptions and pictures of each grasp pattern are provided for clarity. Also covered in this guide are ergonomic factors and sensory components that can affect the process of handwriting. The guide culminates in the provision of possible intervention ideas that can be used with adults to remediate any of the above mentioned factors. Prior to providing interventions, it is necessary for the occupational therapist to find what is meaningful to the client. An Interview Guide/Handwriting Needs Assessment was developed and included to facilitate this process. The Interview Guide/Handwriting Needs Assessment is located in the appendices.

The theory directing the development of this guide is adult learning theory. Adult learning theory focuses on learner-centered principles. These principles incorporate what is meaningful to the learner and teaches him or her in the learning style that he or she prefers (Collins, 2004). A client’s intrinsic motivation is enhanced when he or she is learning a task or skill that is of importance to him or her (Bastable & Dart, 2006). For this reason, the Interview Guide/Handwriting Needs Assessment was developed. By using this Interview Guide/Handwriting Needs Assessment, occupational therapists can ensure that they are implementing age-appropriate and client-centered interventions which will increase a client’s motivation.

The occupational therapist utilizing this guide should begin by reviewing the foundational knowledge provided in the following pages. Once he or she has become familiar with anatomy, mature grasp patterns, ergonomic factors, visual control skills, proprioception/kinesthesia, spatial analysis/relations, bilateral integration, and cognitive impairments, the Interview Guide/Handwriting Needs Assessment should be implemented to guide the intervention process and ensure client-centeredness. After
the occupational therapist determines the need for handwriting remediation, he or she should refer to the interventions section for ideas to facilitate this process. It should be noted that the interventions included in this guide are merely suggestions and it is imperative that the occupational therapist considers what is meaningful to the client when developing interventions. Also, if functional mobility is not a possibility for the dominant hand, it may be more beneficial to have the client participate in handwriting tasks using their non-dominant hand.
Interview Guide/Handwriting Needs Assessment

This interview guide/needs assessment acts as a way to learn more about how often the client engages in handwriting practices and for what purpose. After obtaining the answers to this questionnaire, the occupational therapist can then adjust or modify their teaching strategies to ensure that the client is benefitting from what is being taught. The answers provided by the client will also help the occupational therapist to know what motivates the learner and thus enable him/her to incorporate interventions that will also be motivating.

Are you right or left hand dominant?

Are you satisfied with your current handwriting ability? Yes or no

If no, what would you change about it? Legibility, speed, dexterity, grip, etc.

How often do you currently engage in handwriting tasks? In the past?

What activities do you engage in that require handwriting skills?

How have you had to alter these activities? (if applicable)

Have you ever felt embarrassed by your inability to write?

How do you usually hold a pencil? (pictures, etc.)

What type of surface do you primarily use to write on? (flat, slanted, vertical, paper, chalkboard, etc.)

What posture do you use when engaging in writing tasks? (sit, stand, etc.)

How do you pay for items that you would like to purchase? (checks, cash, check card that needs to be signed)

Have you had to alter how you purchase items secondary to an inadequate writing ability?

What type of writing utensil do you primarily use? (pen, pencil, chalk, marker, etc.)

What is the size of the paper that you primarily use?

Is handwriting a primary goal for treatment?
Anatomy

Proper assessment and treatment of clients with handwriting dysfunction requires the therapist has a proficient understanding of the anatomy that is involved in handwriting performance. Not only is distal musculature critical to intact functioning, proximal musculature serves an important role in providing a stable foundation for the upper extremity. The first area reviewed is the shoulder complex, with the guide continuing distally to the elbow, wrist, and culminating with the hand. This is a brief overview of anatomy; it is recommended that if an occupational therapist should require more information on the anatomy, he or she should refer to educational textbooks on this subject. Recommended sources include the following:


The shoulder complex consists of three bones and the muscles, ligaments, and tendons that hold them together. The three bones are the humerus, scapula, and clavicle (Bogumill, 2002). To assist with understanding the shoulder complex, the muscles will be discussed as they pertain to the different movements associated at this anatomical area. The first motion to be discussed will be that of scapular motion. Movement allowed by the scapula includes depression, elevation, protraction, retraction, downward rotation, and upward rotation. Other motions allowed by the shoulder complex include flexion, extension, abduction, adduction, internal rotation, and external rotation.

The elbow joint consists of three bones and the muscles, ligaments, and tendons that hold them together. The three bones are the humerus, radius, and ulna (Patterson, 2002). Similar to the shoulder complex, the muscles will be discussed as they pertain to the different movements associated at this anatomical area. Movements associated with the elbow joint are flexion, extension, supination, and pronation.

The wrist joint consists of 15 bones and the muscles, ligaments, and tendons that hold them together. The
15 bones are the radius, ulna, scaphoid, lunate, triquetrum, pisiform, trapezoid, trapezium, capitate, hamate, and the five metacarpal bones (Berger, 2002). The muscles will be discussed as they pertain to the different movements associated at this anatomical area. Movements associated with the wrist joint are palmar flexion, extension, radial deviation, and ulnar deviation. There are five muscles involved with the previously stated movements at the wrist joint. The extensor carpi radialis longus and extensor carpi radialis brevis muscles enable the wrist to extend and radially deviate while the flexor carpi radialis muscle enables the wrist to flex and radially deviate. The extensor carpi ulnaris muscle enables the wrist to extend and ulnarly deviate while the flexor carpi ulnaris muscle enables the wrist to flex and ulnarly deviate. The palmaris longus muscle enables the wrist to flex (Clarkson, 2000).

The hand consists of 19 bones and the muscles, ligaments, and tendons that hold them together. The 19 bones consist of the five metacarpal bones, five proximal phalanges, five distal phalanges, and four middle phalanges (taking into account that the thumb does not have a middle phalange) (Chase, 2002). The muscles will be discussed as they pertain to the different movements associated at this anatomical area. Movements associated with the hand are flexion, extension, abduction, adduction, and opposition. Muscles that are involved in finger flexion include the flexor digitorum profundus muscle, flexor digitorum superficialis muscle, flexor digiti minimi muscle, and the lumbricals. The muscles involved in thumb flexion are the flexor pollicis longus muscle and flexor pollicis brevis muscle. Muscles that are involved in finger extension include the extensor digitorum communis muscle, extensor indices proprius muscle, extensor digiti minimi muscle, and the lumbricals. The muscles involved in thumb extension are the extensor pollicis longus muscle and the extensor pollicis brevis muscle. The muscles involved in finger abduction are the dorsal interossei and the abductor digiti minimi muscle. The palmar interossei muscles are responsible for finger adduction. The muscles involved in thumb abduction are the abductor pollicis longus muscle and the abductor pollicis brevis muscle. The lone muscle involved in thumb adduction is the adductor pollicis muscle. The lone muscle involved in thumb opposition is the opponens pollicis muscle (Clarkson, 2000).
Grasp Patterns

Grasp patterns are a focal point in handwriting. This section presents the most common mature grasp patterns used by adults. Mature grasp patterns are characterized by stabilization of the pencil with either three or four fingers, dynamic wrist position, and support provided by the wrist resting on the table (Benbow, 1995). Possessing a mature grasp pattern is a central component for the individual to use his or her handwriting skills effectively. It is important to note that if an individual does not possess one of the following grasp patterns, the occupational therapist should only remediate the grasp pattern if it is causing fatigue or pain, slower speed, and legibility problems. Specifically, this section will highlight five mature grasp patterns and the characteristics of each. Pictures are provided for further clarification.

It is important to note that if an individual does not possess one of the following grasp patterns, the occupational therapist should only remediate the grasp pattern if it is causing fatigue or pain, slower speed, and legibility problems.

Efficient hand skill development depends on the ability of each of the joints in the upper extremity to interact simultaneously. The joints of the upper extremity include the scapulothoracic, glenohumeral, elbow, and wrist. In order for mature grasp patterns to be utilized, each of the previously mentioned joints must function together effectively and have sufficient range of motion (ROM). As well as adequate range of motion, each joint of the upper extremity must provide stability for control of the distal joints (Benbow, 1995).

Successful performance in handwriting tasks indicate the need for interventions to address development of specific performance components related to the upper extremity with specific attention given to the hand. According to Benbow (1995) in order to develop sufficient grasp patterns, the following are indicated as goals for intervention:

“(1) to stabilize the wrist with fine manipulation of small tools, objects, and writing implements, (2) to open and stabilize the thumb-index web space, (3) to increase and stabilize the arches of the hands, (4) to separate the motor functions of the two sides of the hand, and (5) to develop two aspects of precision handling – precision translation and precision rotation. These hand functions are fundamental for all higher-level tool skills” (p. 257).

Resources indicate multiple different patterns of grasp. For the purposes of this scholarly project we will be discussing five grasp patterns: lateral tripod grasp, dynamic tripod grasp, lateral quadrupod grasp, dynamic quadrupod, and the adapted tripod
(D’Nealian) grasp (Refer to figures 1-10). Each of the following figures depicts a mature grasp pattern.
Lateral Tripod Grasp

(Figs. 1 and 2)
Characterized by a closed web space in which the pencil is held against the index and middle fingers with the pads of these fingers positioned on the shaft of the pencil. The thumb holds the pencil against the index finger and the thumb fingertip pad rests on the side of the index finger. The third and fourth fingers are flexed and provide stability when using this type of grasp pattern.
Lateral Quadrupod Grasp
(Figs. 3 and 4)
Possesses the same characteristics as the lateral tripod grasp. The only difference is that the pencil rests on the fourth finger as opposed to the third finger.
Dynamic Tripod Grasp
(Figs. 5 and 6)
Characterized by an open web space in which the pencil rests against the tip end of the middle finger with the pad of the index finger positioned on the shaft of the pencil. The thumb holds the pencil against the index and middle fingers and the thumb fingertip pad rests on the shaft of the pencil. The third and fourth fingers are flexed and provide stability when using this type of grasp pattern.
Dynamic Quadrupod Grasp
(Figs. 7 and 8)
Possesses the same characteristics as the dynamic tripod grasp. The difference is that the pencil rests on the fourth finger as opposed to the third finger.

Fig. 7

Fig. 8
Adapted Tripod (D'Nealian) Grasp
(Figs. 9 and 10)
Pencil is stabilized in the web space between the index and middle fingers as opposed to the thumb web space. The shaft of the pencil rests on the thumb fingertip pad with the sides of index and middle fingers resting along side of the pencil shaft. The third and fourth fingers are flexed and provide stability when using this type of grasp pattern. “This is an effective anatomic adaptation when joint stability is insufficient for controlled mobility...this posture is the most readily accepted alternate grip when a child or an adult is having motor or orthopedic writing problems” (Benbow, 1995, p. 267).
Ergonomic Factors

Ergonomic factors that are necessary to facilitate effective handwriting skills are reviewed in this section. As many individuals with neurological disorders lack postural control, ergonomic factors are important aspects to consider when engaging in the initial process of handwriting. These ergonomic factors include upper extremity stability and mobility, sitting posture, paper position, paper, pencil grip, and writing tools (Amundson, 2005).

**Upper extremity stability and mobility:** As previously stated, efficient hand skill development depends on the ability of each of the joints in the upper extremity to interact simultaneously. For the hand to possess efficient dexterity, the shoulder, elbow, and wrist need to provide strength and stabilization.

**Sitting posture:** Sitting posture is important because a stable trunk will enable the client to produce better arm control. Clients should place their feet firmly on the floor to provide ease of weight shifting and making adjustments to posture. The writing surface that is being utilized should be approximately two inches higher than the seated client’s elbows when they are flexed (Amundson, 2005). The client’s ankles, knees, and hips should be flexed at 90°. Clients should also be seated in an appropriately sized chair; there should be two inches from the back of the knee to the edge of the chair. If the client has been correctly fitted for a wheelchair, these measurements should be equivalent and the wheelchair will be an acceptable chair for handwriting. A properly fitted seat should facilitate the client to bend slightly forward and not back (Bridgeman, 2002).

**Paper position:** The paper should be positioned in close proximity to the client and should be parallel to the forearm of the writing hand; this is approximately 20-35° for right hand dominant individuals and approximately 30-35° for left hand dominant individuals.

**Paper:** Similar to writing tools, there are multiple different types of paper that can be utilized.

**Pencil grip:** Please refer to the previous section of grasp patterns.

**Writing tools:** There are a wide variety of writing tools that can be utilized for handwriting tasks. The chosen writing instrument should be comfortable and efficient for the client to use (Amundson, 2005). There are multiple adaptations that can be made to writing instruments and needs should be specifically tailored to each client.
Visual Control

Visual skills are needed for successful handwriting. In this section, visual control and related components are further described. As neurological disorders can affect an individual’s visual skills, it is important to be aware of and understand the associated concepts. The section on visual control will begin by defining the terms that are associated with both visual-motor skills and visual-perceptual skills. Visual-perceptual skills are controlled in the parietal lobe whereas visual information is processed in the occipital lobe (University of Michigan, 2000).

**Visual-motor**: Visual-motor skills develop sequentially in children and after incurring a cerebrovascular accident or traumatic brain injury, the same may hold true for adults depending on their level of function. According to Swearingen & Calder (2007), the stages of development include imitation, copying, and drawing from memory.

**Visual-perceptual skills**: (Schneck, 2005).

- **Visual memory**: Relates to the client’s ability to recall the shape and form of an object, letter, or word. Also refers to the client’s ability to immediately recall or store visual information until further needed.
- **Visual discrimination**: The ability to recognize the similarities and differences between shape, size, and form of an object, letter, or word.
- **Spatial organization**: Relationship between letters, words, and sentences on a page and the spacing between them.
- **Position in space**: The ability of the client to recognize letters and words, in any position, when they are written on paper.
- **Depth perception**: The ability to perceive distance between objects from the vantage point of the observer and the ability to determine how far away something is.
- **Figure-ground**: Refers to the client’s ability to focus on the important pieces of visual information as they are situated in a distracting visual field.
- **Figure-closure**: The client’s ability to recognize objects, shapes, or letters when only given partially completed presentations of the object, shape, or letter.
- **Form constancy**: The client’s ability to recognize objects, shapes, or letters when they are seen in different circumstances or environments.
- **Visual sequencing**: The client’s ability to determine where to initiate writing individual letters to subsequently form words.
- **Visuoconstruction**: Refers to the client’s ability to visualize in their head what they are currently writing or what they are planning to write. (Schneck, 2005).
Proprioception/Kinesthesia

Proprioceptive and kinesthetic abilities are required for effective handwriting. An individual’s ability to integrate proprioception and kinesthesia can be altered if they have sustained a cerebrovascular accident or traumatic brain injury (Hayes, 2004). Proprioception and kinesthesia are important concepts for occupational therapists to be aware of as they can affect how well an individual is able to use their upper extremity.

Proprioception and kinesthesia, in relation to hand function, deal with the perception of the hand, body movement, and body position. According to the American Occupational Therapy Association (AOTA), proprioception is defined as “interpreting stimuli originating in muscles, joints, and other internal tissues that give information about the position of one body part in relation to another” (AOTA, 1994, p. 1052). According to the same source, kinesthesia is defined as “the ability to identify the excursion and direction of joint movement” (AOTA, 1994, p. 1053).

Spatial Analysis/Relations

Spatial analysis and spatial relations are important aspects to consider when addressing handwriting. According to Sanspree (2000), spatial relations is defined as the client’s ability to distinguish themselves from other objects that they encounter in their environment. This is integral for occupational therapists to be aware of as the individual who has a neurological disorder will need to be able to distinguish themselves from their writing utensils and other objects in their environment in order to facilitate successful handwriting practices.

Bilateral Integration

As the process of handwriting involves using both upper extremities simultaneously, bilateral integration is a necessary skill to address during occupational therapy intervention. Bilateral integration is the process in which both sides of the body coordinate with each other to perform a function or movement. Effective bilateral integration involves both gross and fine motor movements as well as the ability to cross the body’s midline. In regards to handwriting tasks, bilateral integration is important because the client needs to incorporate the gross motor movement of the shoulder, elbow, and wrist joints with the fine motor movement of the hand while manipulating the writing utensil across the body’s midline to write on a piece of paper. Ineffective bilateral integration can result from inadequate postural-ocular development (May-Benson, 2005).
Cognitive Impairments

Secondary effects of a cerebrovascular accident or traumatic brain injury can include multiple cognitive impairments. These impairments could possibly affect how well an individual is able to attend to and participate in the task of handwriting. The following cognitive impairments will be discussed: attention, sequencing, and memory. Attention is defined as a client’s “ability to attend to a task” (Rubio & Gillen, 2004, p.441). Sequencing is defined as the client’s ability to complete a task by following the appropriate steps in the correct order. Memory is defined as the client’s ability to recall previously learned information. (Rubio & Gillen, 2004). Planning and thinking processes are controlled in the frontal lobe whereas language, memory, and emotions are controlled in the temporal lobe (University of Michigan, 2000).
Interventions

The authors will be discussing intervention ideas that can be implemented for each of the previously mentioned sections. It should be noted that these are merely guidelines and occupational therapy interventions should not be limited to these suggestions. If cognition is limited secondary to TBI or stroke, interventions can be modified to fit their abilities.

Anatomy

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weakness of shoulder</td>
<td>Interventions derived from the Interview Guide/Handwriting Needs Assessment</td>
</tr>
<tr>
<td></td>
<td>Weight-bearing techniques: Client can weight-bear while brushing teeth or watching TV.</td>
</tr>
<tr>
<td></td>
<td>Activities that involve carrying, reaching, or lifting.</td>
</tr>
<tr>
<td></td>
<td>A table top game, similar to Hi-Q, that sits vertical and requires the client to reach above shoulder level to place game piece. Client would have weights on wrists to increase their strength.</td>
</tr>
<tr>
<td></td>
<td>Vacuuming, sweeping.</td>
</tr>
<tr>
<td></td>
<td>Complete activities in a vertical plane.</td>
</tr>
<tr>
<td></td>
<td>Therapeutic exercise: free weights, theraband, resistance bars (focus on scapular stabilizers, shoulder flexion, shoulder extension, shoulder abduction, shoulder adduction, shoulder internal rotation, and shoulder external rotation)</td>
</tr>
</tbody>
</table>

19
<table>
<thead>
<tr>
<th>Weakness of forearm/arm</th>
<th>Balloon volleyball with weights on arms.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tossing a weighted ball.</td>
</tr>
<tr>
<td></td>
<td>Tricep push-ups.</td>
</tr>
<tr>
<td></td>
<td>Therapeutic exercise: weights, theraband, resistance bars (focus on elbow flexors, elbow extensors, forearm supinators, and forearm pronators)</td>
</tr>
<tr>
<td>Weakness of wrist/hand</td>
<td>Opening jars or bottles.</td>
</tr>
<tr>
<td></td>
<td>Unscrewing/screwing nuts and bolts.</td>
</tr>
<tr>
<td></td>
<td>Theraputty</td>
</tr>
<tr>
<td></td>
<td>Stamping (cards)</td>
</tr>
<tr>
<td></td>
<td>Beading</td>
</tr>
<tr>
<td>Lack of stability</td>
<td>Therapy/exercise ball activities (e.g. have client sit on therapy ball and balance self while performing tabletop or reaching activities).</td>
</tr>
<tr>
<td></td>
<td>Standing while folding laundry.</td>
</tr>
<tr>
<td></td>
<td>Sitting with limited support/contact and participating in reaching activities.</td>
</tr>
</tbody>
</table>
# Grasp Patterns

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immature/non-functional grasp pattern</td>
<td>Teach adapted tri-pod grasp (D/Nealian) by providing a picture and demonstrating the grasp.</td>
</tr>
<tr>
<td>Joint hyperextension</td>
<td>Taping practices to increase joint awareness.</td>
</tr>
<tr>
<td>Joint stability of the carpometacarpal and metacarpalphalangeal joints (specifically related to grasp)</td>
<td>Depending on the nature of joint stability, a variety of taping practices could be implemented to provide support.</td>
</tr>
</tbody>
</table>

*Interventions derived from the Interview Guide/Handwriting Needs Assessment*
**Closed web space**

Utilizing neoprene thumb abduction splint.

Placing some type of spherical object on pencil shaft to maintain open web space. (As shown in Fig. 11)

![Fig. 11](image)

*Stetro and Grip Tec are brands of pencil grips that provide cushion and shape the client's hand in a mature grasp pattern. (Can be found at http://www.otideas.com/Items/PencilGrips.htm).

**Pencil Pal Rings** position the hand on the writing utensil through the use of loops and rings to position the pencil in the hand. (Can be found at http://www.otideas.com/Items/PencilGrips.htm).

***Handi-writer** is a device that positions the writing utensil correctly in the web space. (Can be found at http://www.otideas.com/Items/PencilGrips.htm).

## Ergonomics

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper extremity stability and mobility</td>
<td><strong>Interventions derived from the Interview Guide/Handwriting Needs Assessment</strong></td>
</tr>
<tr>
<td></td>
<td>Please refer to the section regarding anatomy interventions located on pages 18-19.</td>
</tr>
</tbody>
</table>
| Sitting posture | Ensure client is seated in properly fitted chair.  
| | Appropriate wheelchair fitting (if applicable).  
| | Utilize foot stool if feet do not reach ground.  
| | Therapy/exercise ball activities (e.g. have client sit on therapy ball and balance self while performing tabletop or reaching activities).  
| | Standing while folding laundry.  
| | Sitting with limited support/contact and participating in reaching activities.  

| Paper position | Tape on writing surface to serve as visual guideline for correct paper positioning. (As shown in Fig. 12)  
| | Position writing materials close to client.  
| | Paper should be slanted 25-30 degrees to the left if client is right hand dominant and 30-35 degree to the right if client is left hand dominant.  
| | Desktop slope of 15-20 degrees.  

| Paper | Utilize age-appropriate paper to facilitate client-centeredness. Avoid using paper that is utilized for teaching children handwriting skills. (e.g. lines with dashes in between)  
| | Utilize paper with different textures to provide sensory input to client.  

<table>
<thead>
<tr>
<th><strong>Paper</strong></th>
<th>Utilize graph paper for spacing and size of words if client has difficulties with spatial organization.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Utilize paper with raised lines to provide sensory input to client.</td>
</tr>
<tr>
<td><strong>Pencil grip</strong></td>
<td>Utilize prosthetic writing devices.</td>
</tr>
<tr>
<td></td>
<td>Teach client to use adapted tripod grasp.</td>
</tr>
<tr>
<td></td>
<td>Please see section regarding immature/nonfunctional grasp patterns.</td>
</tr>
<tr>
<td><strong>Writing tools</strong></td>
<td>Utilize large diameter writing utensils.</td>
</tr>
<tr>
<td></td>
<td>Utilize easy flow ink pens.</td>
</tr>
<tr>
<td></td>
<td>Utilize prosthetic writing devices.</td>
</tr>
</tbody>
</table>

**Fig. 12**
<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual-motor</strong></td>
<td>Interventions derived from the <em>Interview Guide/Handwriting Needs Assessment</em></td>
</tr>
<tr>
<td></td>
<td>Encourage client to continually monitor pencil point in order to stay on writing line and intersect points.</td>
</tr>
<tr>
<td></td>
<td>Complete mazes on paper.</td>
</tr>
<tr>
<td></td>
<td>Increase tracking ability by tossing ball vertically above head and catching it at chest level or bouncing it from floor and catching it at chest level.</td>
</tr>
<tr>
<td></td>
<td>Utilize bright lines/ink during writing tasks.</td>
</tr>
<tr>
<td><strong>Visual-perceptual</strong></td>
<td>Have client find items on a paper that has a distracting background. (e.g. picture find books)</td>
</tr>
<tr>
<td></td>
<td>Have client complete word finds.</td>
</tr>
<tr>
<td></td>
<td>Place finger between each word for proper spacing.</td>
</tr>
<tr>
<td></td>
<td>Utilize graph paper and leave a box open for correct spacing between words.</td>
</tr>
<tr>
<td></td>
<td>Complete parquetry designs.</td>
</tr>
<tr>
<td></td>
<td>Engage in matching games.</td>
</tr>
<tr>
<td></td>
<td>Have client complete symmetrical designs. (one half of design is complete, client is required to finish design by drawing other half)</td>
</tr>
</tbody>
</table>
## Proprioception/Kinesthesia

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor eye-hand coordination</td>
<td><strong>Interventions derived from the Interview Guide/Handwriting Needs Assessment</strong></td>
</tr>
<tr>
<td></td>
<td>Toss and catch ball.</td>
</tr>
<tr>
<td></td>
<td>Play table tennis.</td>
</tr>
<tr>
<td></td>
<td>Have client engage in beading tasks.</td>
</tr>
<tr>
<td></td>
<td>Play Jenga®.</td>
</tr>
<tr>
<td></td>
<td>Unscrewing/screwing nuts and bolts.</td>
</tr>
<tr>
<td></td>
<td>Utilize contrasting colors.</td>
</tr>
<tr>
<td>Poorly coordinated limb movements</td>
<td>Have client engage in any activity that promotes use of both hands at same time.</td>
</tr>
<tr>
<td></td>
<td>Play BINGO.</td>
</tr>
<tr>
<td></td>
<td>Play card games.</td>
</tr>
<tr>
<td>Limb position</td>
<td>Place tape on table to serve as guidelines for hand position.</td>
</tr>
<tr>
<td></td>
<td>Utilize grip (e.g. shelf liner) to assist client with maintaining arm position on table surface.</td>
</tr>
<tr>
<td></td>
<td>Ensure feet are flat on ground and utilize stool if they are not.</td>
</tr>
<tr>
<td>Upright body position</td>
<td>Utilize positioning devices to facilitate upright posture.</td>
</tr>
</tbody>
</table>

## Spatial Analysis/Relations

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inability to keep writing in lines</td>
<td>Interventions derived from the Interview Guide/Handwriting Needs Assessment</td>
</tr>
<tr>
<td></td>
<td>Utilize ink that contrasts in color from the paper being written on.</td>
</tr>
<tr>
<td></td>
<td>Place textured tape on writing lines to increase client’s awareness of where their hand is.</td>
</tr>
<tr>
<td></td>
<td>Utilize paper with raised lines (e.g. use puff paints to emphasize lines on paper).</td>
</tr>
<tr>
<td></td>
<td>Utilize paper with wide space between lines and decrease the spacing as client progresses.</td>
</tr>
<tr>
<td></td>
<td>Play BINGO.</td>
</tr>
</tbody>
</table>

## Bilateral Integration

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor bilateral integration</td>
<td>Interventions derived from the Interview Guide/Handwriting Needs Assessment</td>
</tr>
<tr>
<td></td>
<td>Folding laundry.</td>
</tr>
<tr>
<td></td>
<td>Stirring batter with both hands.</td>
</tr>
</tbody>
</table>
| Poor bilateral integration | Use both hands to pick up objects.  
  Encourage non-dominant hand to stabilize paper during handwriting tasks.  
  Consistent practice of letter formation.  
  Have client perform activities that require them to cross midline. |
|----------------------------|-------------------------------------------------------------------|
| Inability to stabilize paper and perform handwriting tasks | Utilize grip (e.g. shelf liner) to assist client with maintaining arm position on table surface.  
  Use bright colors on one side of paper to serve as visual cue for non-dominant hand placement.  
  Tape paper to writing surface to avoid movement during handwriting tasks.  
  Utilize paper weights to avoid movement of paper during handwriting tasks. |

**Cognitive Impairments**

<table>
<thead>
<tr>
<th>Dysfunction</th>
<th>Possible interventions</th>
</tr>
</thead>
</table>
| Poor attention span | **Interventions derived from the Interview Guide/Handwriting Needs Assessment**  
  Therapist should give directions to client in a clear and concise manner.  
  Extended time should be given to the client to process information.  
  Start with one step activities or directions and increase as client progresses.  
  Limit distractions. |
Poor attention span
Encourage client to complete one task at a time.

Limited memory
Provide multiple types of cueing (e.g. if a client has decreased auditory memory, utilize tactile and visual cues)
Group similar information into categories.
Have client complete activities with one or two steps.
Utilize memory recall activities.

Difficulty sequencing
Alphabetize names of family members.
Utilize cue cards with alphabet shown.
Provide step-by-step directions and decrease number of cues/directions as client progresses.

Writing Interventions
Once the client is able to successfully form letters (keep in mind they do not have to be perfect as they will continue to practice these skills), the following is a list of intervention ideas that promote client-centeredness. Please refer back to answers received from the Interview Guide/Handwriting Needs Assessment for further assistance with developing appropriate interventions.

- Complete Schedule for the day or therapy
- Complete grocery list for supermarket
- Write down questions to ask medical staff
- Write Thank-you notes for cards/flowers received
- Write letters to family
• Complete crossword puzzles or sudoku puzzles
• Write their goals that have been mutual developed with therapist
• Write out birthdays/anniversaries of family members and friends on calendar
• Write out children’s activities on schedule
• Keep a hand-written journal
Future Recommendations

Future recommendations for this product include the addition of comprehensive manuals that describe, in more detail, the shoulder, elbow, and wrist complex. An assessment should be developed that specifically addresses adult handwriting skills to further guide occupational therapy interventions. Another recommendation is that these guidelines are utilized and outcome measures are performed on its effectiveness.
References


CHAPTER V

SUMMARY

The product presented in Chapter IV is a guide for occupational therapists to teach handwriting skills to adults. The guide consists of a review of foundational knowledge of preparatory skills needed to complete handwriting tasks. It is intended to give occupational therapists a thorough base of knowledge regarding factors affecting handwriting and to provide them with ideas for interventions that are age-appropriate and client-centered for adults. To promote client-centeredness, an Interview Guide/Handwriting Needs Assessment is included in the product. To ensure age-appropriateness, principles of adult learning theory are incorporated throughout the product.

The Occupational Therapy Guide for Teaching Handwriting Skills to Adults is designed for occupational therapists working with clients who have neurological disorders that impact their hand function. This guide will serve as a reference for occupational therapists of all skill levels as it provides a comprehensive overview of all factors related to handwriting tasks. In addition to serving as a reference, this guide encourages continued use of client-centered interventions.

It is recommended that more research be performed on handwriting practices with adults to provide occupational therapists with comprehensive information and resources when providing interventions. The limited information on this topic results in occupational therapists experiencing difficulty providing appropriate interventions for
handwriting tasks with adults. With increased research on handwriting practices with adults, occupational therapists may feel more confident integrating these concepts into their practice.

It is recommended that an assessment be developed that specifically addresses adult handwriting skills to further guide occupational therapy interventions. This assessment should incorporate findings from the previously suggested research studies to enhance credibility. A thorough understanding of pediatric handwriting assessments is necessary as many of the concepts have been proven effective and may be applicable with adults.

In the future, it is recommended that these guidelines be utilized in occupational therapy practice and outcome measures be performed on its effectiveness. Outcomes should be measured by conducting research studies prior to using the guide and after using the guide. These findings should be published to promote evidence-based practice for adult handwriting within the field of occupational therapy. After completion of outcome studies, this guide should be adapted and expanded upon. To increase efficacy, author modifications will be necessary upon the implementation of these guidelines in practice.

After modifications have been made to the guide and efficacy has been determined, it is recommended that An Occupational Therapy Guide for Teaching Handwriting Skills to Adults be published. This publication should be available to all occupational therapists working with individuals who have incurred a neurological disorder and have identified the goal of remediating handwriting. Findings from research
studies performed on the guide will also be included in the publication to support its efficacy with adults.

Once effectiveness of *An Occupational Therapy Guide for Teaching Handwriting Skills to Adults* has been established, this guide should be modified to meet the needs of other diagnoses that can result in an impairment of hand function. For example, a guide that is applicable for retraining the contralateral hand of a person who has had an amputation of their dominant hand. With these modifications to the guide, occupational therapists will have the knowledge and resources necessary to provide therapy to all individuals who have experienced an impairment affecting their handwriting ability.

While this guide provides background information on factors affecting handwriting, intervention ideas, and principles of adult learning theory, there are infinite possibilities for further research on handwriting with adults. These possibilities include conducting further research on handwriting practices with adults, modifications to the guide, development of a handwriting assessment to use with adults, and publication of the guide. In summary, there is a dearth of literature and research on handwriting practices with adults; for that reason, the possibilities for addressing this need are endless.
REFERENCES


