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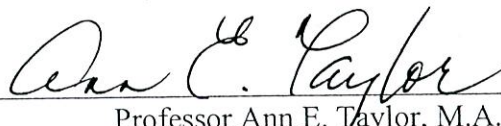
The Relationship Between Fine Motor Skills and Fluency in Handwriting of
Kindergarten and First Grade Children

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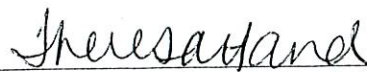
In Partial Fulfillment
of the Requirements for the Degree of
Master of Science in Occupational Therapy

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December 2005

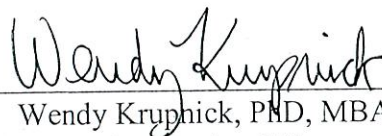
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Running head: FINE MOTOR SKILLS AND FLUENCY

The Relationship Between Fine Motor Skills and Fluency in
Handwriting of Kindergarten and First Grade Children

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Abstract

Kindergarten and first grade children are increasingly being referred to and receiving occupational therapy services in order to address the issues related to fine motor and handwriting skill deficits. The purpose of this study was to assess four children who have fine motor and fluency difficulties. Two of the four children were identified as being at risk for handwriting difficulties and were chosen as participants for the case studies. Participants were screened using a variety of standardized and modified assessments of fine motor and perceptual skills. With Occupational Therapy intervention techniques and practice, the participants demonstrated an increase in their ability to form legible letters as related to handwriting tasks.

The Relationship Between Fine Motor Skills and Fluency in Handwriting of Kindergarten and First Grade Children

Fine motor coordination is needed to fluently produce legible handwriting (Hill, Gladden, Porter, & Cooper, 1982). Fine motor skills can be viewed as the basis for all letter production (Hill et al.). Fine motor skills in handwriting are identified as hand grip (Yakimishyn & Magill-Evans, 2002), posture (Burton & Dancisak, 2000; Windsor, 2000), hand preference (Rosenblum & Josman, 2003) and arm positioning while the student is “writing” (Rosenblum & Josman; Tseng & Chow, 2000). Fluency in handwriting is identified as manuscript writing ability (Graham, Weintraub, & Berninger, 1998) and legibility (Daly, Kelley & Krause, 2003; Rosenblum, Parush & Weiss, 2003).

The amount of time spent on fine motor skills tasks changes proportionately during the first few years of school. Between pre-school and kindergarten, the amount of time spent involved in fine motor tasks increases an average of 9%. Pre-school children are asked to spend 32% less time than children in kindergarten on fine motor tasks that involve “writing” (Marr, Cermak, Cohn & Henderson, 2003). Students in kindergarten are just beginning to learn the general basis for handwriting. They have used crayons, markers, pens and pencils before, but may not have received any formal instruction regarding letter development and formation. During this kindergarten year, students are introduced to the letters as well as their formation and variations. Variations of the letters include capital and lowercase development. As the school year progresses and there is more practice, the refinement should increase as will the legibility of the child’s work (Daly et al., 2003) but only if fine motor development can support the handwriting production (Hill et al., 1982). Occupational therapy services have been shown to be

beneficial in children with fine motor delays, but with this age group the element of play needs to influence the treatment sessions (Case-Smith, 2000).

Hand Grip

How children grip their writing utensil has been examined to try to determine the most effective grip to produce the most legible handwriting. The Schneck and Henderson scale of grip formation has been found to be an effective tool when documenting children's grasps (Burton & Dancisak, 2000; Windsor, 2000). Schneck and Henderson's scale consists of ten different developmental stages of grips. Stage one: Radial cross palmar grasp with the thumb down. Stage two: Palmar supinated grasp with the thumb up. Stage three: Digital pronate grasp with the index finger extended. Stage four: Brush grasp with the eraser end of a pencil in the palm of the hand. Stage five: Grasp with extended fingers. Stage six: Cross thumb grasp. Stage seven: Static tripod grasp. Stage eight: Four finger grasp with four fingers in opposition. Stage nine: Lateral tripod grasp. Stage ten: Dynamic tripod grasp. Stage ten is considered to be a mature grasp in which, "the writing tool is stabilized against the radial side of the third digit by thumb, the index finger on top of the writing tool, thumb in full opposition, wrist slightly extended; fourth and fifth digits flexed to stabilize the metacarpophalangeal arch and third digit; localized movements of digits of tripod and wrist movements on tall and horizontal strokes; forearm resting on the table." (Burton, & Dancisak).

When examining grip, it is also necessary to determine whether or not the diameter of the writing utensil has any effect on handwriting legibility. It was discussed that children are, at first, presented with a larger diameter utensil and then gradually given smaller writing tools. The progression of larger diameter utensil to smaller diameter utensil did result in an increase in handwriting legibility in one study of 60 children (Burton & Dancisak, 2000). It has been

suggested that more testing be done regarding implement diameter in order to gather more information concerning this proposal (Windsor, 2000). Along with size, the shape of the writing utensil has also been tested in order to determine if this may affect handwriting legibility. It was determined in a single study of 126 kindergarten children that there was no significant difference of the child's writing ability between the three different tools used: a standard pencil, a large diameter pencil, and a triangular shaped pencil (Oehler et al., 2000). It has been suggested by multiple researchers that there be a continuation of these studies to determine if different media such as adaptive equipment could produce a different outcome in a study.

When determining grasp, examining the research on type of tool used by the child should be expanded to include the angle of the surface on which the child is working. In one study, 51 children, between the ages of 23 and 24 months, were given 3 different writing utensils: crayon, marker and colored pencil (Yakimishyn & Magill-Evans, 2002). The crayon was a small piece of a regular crayon, which required the children to grasp it with their thumb and the tips of their fore and middle fingers. The marker was chosen as a thick tool that most children are familiar with. The colored pencil was used instead of a regular pencil because of the color and its' relative size to a regular pencil. The children were then asked to draw on two different surfaces: the table top and a table top easel. Each child was observed during a total of 14 trials and it was discovered that children produced the most mature grasp when using the crayon and marker on a vertical surface than when compared to the use of any utensil on a flat surface. Yakimishyn and Magill-Evans associate this more mature grasp with the size and thickness of the tool that is being used as well as how the wrist and hand are positioned when participating in the vertical task. In general the children displayed a more mature grasp when using the easel as compared to drawing on the flat surface of the table top. It is thought, therefore, that a child can be influenced

into using a more mature grasp by the orientation of surface provided to complete a fine motor task such as handwriting (Yakimishyn & Magill-Evans).

Posture

Posture has always been a part of our daily lives. Parents and teachers are always admonishing their children to “sit up straight, put your feet flat on the floor, and face front.” The idea that posture can affect handwriting was studied because it was assumed that development of the body and postural control would affect the child’s ability to perform fine motor tasks such as handwriting (Rosenblum & Josman, 2003). The researchers administered the Bruinkinks-Oserestsky Test of Motor Proficiency (BOTMP) in order to determine arm and leg preference of the child prior to the administration of the tests.

The tests that were administered to the children included the balance subtest of the BOTMP and the Nine-Hole Peg Test (NHPT). The BOTMP is a standardized test that provides a comprehensive index of fine motor proficiency as well as separate measures of gross and fine motor skills (Rosenblum & Josman, 2003). For this article 2 versions of the NHPT were used in order to measure finger dexterity and the components of in-hand manipulation (translation and rotation). The adult version of the NHPT, typically used for ages 20-94, tested the finger dexterity by asking the participant to quickly place the pegs in the holes one at a time and then remove them one at a time. The children’s version of the NHPT is typically used for ages 5 and up. In this version for the translation task the participant was asked to pick up to 5 pegs out of the board, one by one, hide them in their palm and then bring the pegs back out of their palm and back to the board. The rotation task of the children’s version of the NHPT was to grasp a peg, turn it over and replace it in its’ original hole. The primary results of this study indicate that there was, indeed, a significant correlation between postural control and the child’s ability to perform

fine motor tasks. The article encouraged further research and testing due to a lack of consistency, limited variance in sample selection and small group size in the first test (Rosenblum & Josman).

Fluency and Fine Motor Development

Current and past research suggests a relationship between fine motor development and the level of fluency during handwriting tasks. A ten week study conducted by Hirsch and Niedermeyer (1973) focused on the types of training used in order to develop handwriting skills. The following four categories were established as a result of their study, these are copying, faded tracing, copying and letter discrimination training, and faded tracing and letter discrimination training. This study determined that all 50 kindergarten participants tested showed a significant increase in their letter formation ability. Letter discrimination training appeared to have no effect on the training process of the children, however those children placed in the copying group appeared to perform significantly better than those in the faded tracing group (Hirsch & Niedermeyer).

Manuscript writing has been defined as the introduction of handwriting skills through the use of “straight letters” (Graham, Weintraub, & Berninger, 1998). Children are taught straight strokes in the beginning stages of handwriting in order to make an easier transition to D’Nealian and cursive handwriting styles (Graham et al.).

Handwriting legibility can be described as how readable the portion of handwriting is to the reader. Researchers using the Developmental Test of Visual-Motor Integration (VMI) questioned if there was a “relationship between visual-motor integration and handwriting skills in kindergarten children” (Daly et al., 2003). The child’s performance on the VMI was then related to the child’s ability to copy 34 letterforms – this ability demonstrated a “strong relationship between visual-motor skills and the ability to copy letters legibly” (Daly et al.). The

researchers furthered their exploration of the children's abilities by studying the relationship between the children's score on the first 9 forms of the VMI and the score on the Modified Scale of Children's Readiness in PrinTing (SCRIPT). It was found that the "students who could correctly copy the first 9 forms on the VMI demonstrated higher scores on the Modified SCRIPT assessments (Daly et al.). With this study it was shown that the VMI is a tool that can predict a child's legibility score on the SCRIPT test if used appropriately.

There also seems to be a consistency in children's handwriting from their kindergarten year to the middle of their first grade year (Marr et al., 2003). Perceptual-motor measures as well as sustained attention were studied between children with slow and normal handwriting speed and it was found that a significant difference was noted in the areas of upper-limb coordination, visual memory, spatial relation, form constancy, visual sequential memory, figure ground, visual-motor integration and sustained attention between two groups (Tseng & Chow, 2000). Children's ability to write legibly may be affected by their perceptual-motor systems. These slow writing children may have a tendency to pause while writing causing the child to stop and start writing, which interrupts the fluency of the child's thought process as well as the legibility and smoothness of their handwriting (Rosenblum, Parush, & Weiss 2003).

OT Interventions

The effects of kinesthetic training on handwriting skill development were investigated with researchers conducting a randomized blind trial containing three groups: kinesthetic training group, handwriting practice group, and a no treatment group (Sudsawad, Trombly, Henderson & Tickle-Degnen, 2002). At the conclusion of the study, all 3 groups had shown an increase in legibility performance with no significant difference arising from the kinesthetically trained group, as judged by the teachers for all groups. The conditions of the treatment groups could not

add to the learning and practice that was on going in the classroom (Sudsawad et al.). Children in families with economic disadvantages were analyzed and it was found that with occupational therapy intervention the child's success with letter accuracy and writing tasks increased as compared to those of children who were not receiving occupational therapy interventions (Peterson & Nelson, 2003). Children from one urban community and one suburban community were observed to determine if the space size of manuscript paper, grade level (kindergarten vs. 1st grade) and school setting impacted the child's accuracy in the production of manuscript writing (Waggoner, LaNunziata, Hill & Cooper, 1981). It was found that the "suburban students performed better than urban students when using the large-spaced paper" (Waggoner et al.).

Assessments of Handwriting Skills

There are multiple evaluation tools that are used to evaluate children's handwriting ability. A review of the top 5 most widely used evaluation tools: Diagnosis and Remediation of Handwriting Problems, Minnesota Handwriting Test, Children's Handwriting Evaluation Scale-manuscript, Evaluation Tool of Children's Handwriting-manuscript, and Test of Legible Handwriting gives an overview of these main evaluation tools, as well as their limitations, allowing the researcher to determine which tool is the most useful for their purpose (Feder & Majnemer, 2003). An investigation of the validity of the Miller Assessment for Preschoolers (MAP) in predicting the outcome of preschool students in their later school endeavors was conducted with the conclusion that the MAP was able to predict student outcomes. The MAP assesses the "sensory, motor, perceptual, cognitive, and verbal performance" (Parush, Winokur, Goldstand & Miller, 2002, p. 548) skills of children. A student who scored poorly on the MAP at the beginning of the study also showed significant decrease in performance upon completion of the study (Parush et al.). When comparing the results of the Evaluation Tool of Children's

Handwriting (ETCH) to that of a child's teacher's perspective of the child's performance in handwriting legibility it was determined there was no significant relationship between the ETCH results and that of the teacher's completed questionnaires. Evidence did show that a child could score higher on the ETCH as compared to the opinions of the teachers questioned (Sudsawad, Trombly, Henderson & Tickle-Degnen, 2001).

The purpose of this study was to assess children, between the ages of 4 and 7 years old, who have fine motor and fluency difficulties. Four children were assessed and once identified, 2 of the 4 children were chosen as case studies in order to focus on overcoming these difficulties using occupational therapy interventions.

Methods

Participants

Four participants were chosen for assessment by the classroom teachers as being at risk for reading and/or handwriting difficulties. Two of the 4 identified children were chosen as the participants for the case studies. Participants were chosen from the kindergarten and first grade populations of a rural setting school in upstate New York.

Evaluation Techniques

Participants were evaluated using the Berry VMI and its subtests, the Minnesota Handwriting Assessment (for alphabet awareness), the Brigance Diagnostic Inventory of Early Development (draw a man), an informal fine motor/sensory skill checklist, and an emergent/early literacy check list. Testing occurred over two 45 minute sessions on consecutive days.

Fine motor assessment. As part of the week one evaluation, participants were evaluated through observation in the following areas: types of grasps used, dissociation, in-hand

manipulation, stereognosis, and sensation. Observations of hand use and grasp occurred by presenting the participant with a variety of small objects, such as toys and coins, and they were asked to pick them up. As a result of the participant's choice of grasp, the examiner was given a list of grasps to choose from and would check off each grasp as it was demonstrated.

Demonstration of dissociation was achieved through a hand imitation game consisting of: snapping fingers, shaking dice, twiddling thumbs, signing "I Love You", and making an alligator and bunny with their hands. During the in-hand manipulation examination, the participant was instructed to: pick up various sized coins and perform translational movements from the fingers to palm and vice versa, "walk" up and down a pencil (examining the participant's ability to perform shifting movements with the fingers), take a lid off of a bottle and replace it using simple rotation, pick up a stick and position it for writing (simple rotation task), and write their name and erase it as fast as they could (examining the participant's ability to perform complex rotation tasks). In order to perform a stereognosis screening, the participant was asked to close their eyes and their vision was also occluded by placing a manila folder beneath their chin. Then the examiner placed an object into the participant's hand and had them report what the object was through the use of sensation. Sensation was then examined by occluding the participant's vision and lightly running an eraser of a pencil over their hand in various places. The participant was asked to use the opposite hand to point to the area that had been touched. The fine motor assessment enables the examiner to screen a participant for the ability to maneuver objects, as well as screen for possible sensation difficulties in the hands. Therefore, the validity and reliability of this test depend completely on the examiner and the face value of the results.

Emergent literacy assessment. Week two testing consisting of identifying emergent literacy skills. This testing consisted of awareness and identification of book concepts using *If*

You Give a Moose a Muffin, and If You Take a Mouse to School both by Laura Joffe Numeroff, finding its title and author, the proper orientation of the book, and distinguishing between letters and words. Further, the participant's knowledge of the story schema was determined by using the wordless book, *Frog, Where Are You?* by Mercer Mayer, i.e. identifying the beginning, middle, and end, descriptive characteristics, character interactions, as well as cause and effect relationships. Invented spelling was assessed using the words *nose, house, eagle, monster* and *cat* and asking the participant to write the word from the evaluator's enunciation of it; the word was repeated clearly and slowly if the participant was having difficulty. The emergent literacy assessment was used to screen how the participants related to books, words, and letters. Its' validity and reliability again depend on the examiner and the face value of the results.

Draw a person. The Brigance Diagnostic Inventory of Early Development- Draw a Man subtest (Brigance, 1991) was used to evaluate performance skills within the following developmental domains: fine motor, general knowledge and comprehension of human form schema. This test is appropriate for children up to 7 years of age. Participants were asked to draw a picture of a person. The picture was then scored by determining the percentage of age-appropriate qualities the picture contained based on the Brigance scoring criteria. This test was used to identify participants who had difficulty creating an age-level appropriate drawing of a person. It has been found to be developmentally valid when predicting difficulties in distinguishing separate parts of one's own body.

Draw a picture and tell a story. Draw a Picture and Tell a Story testing was carried out to determine a child's ability to create a narrative based on the picture they chose to draw. The participant was assessed for their ability to include a beginning, middle and end to the story, any descriptive related to the picture, and was given prompting by the evaluator as needed. Draw a

Picture was scored based on picture presentation and narrative to follow, I = no story, II = short story reported, III = great elaboration. This test was used as a screening tool to determine the participants ability to tell a story. Its' reliability and validity are again the tools' face value in it's use in determining children with possible difficulties.

Beery VMI and its subtests. The Beery VMI and its subtests were administered to determine participants' ability to integrate their visual-motor abilities, as well as to determine participants' visual perceptual and motor coordination abilities separately. The Beery VMI and its subtests have been well tested and found to be valid and reliable. Children who perform poorly on the Beery VMI may have poor visual perceptual and/or motor coordination abilities or they may possess adequate abilities but are not yet able to coordinate these skills to work together.

The Beery VMI consisted of 30 geometric forms to be copied or imitated and can be administered in 10-15 minutes. Scoring was completed by giving one point for each copied or imitated item that meets specific scoring criteria for that form, allowing only three consecutive failures.

The visual-perceptual subtest consisted of 27 geometric forms that participants viewed and were then asked to locate the exact match from a list of forms located below it. Participants were given as much time as was needed to complete all 27 forms but only forms completed within 3 minutes were scored. Scoring was completed by giving one point for each correctly identified item, allowing only three consecutive failures.

The motor-coordination subtest consisted of 27 geometric forms to be traced without going outside double-lined paths. To greatly reduce the need for visual perceptual skills to complete this task correctly examples, starting dots, and paths acted as strong visual guides.

Participants were given as much time as was needed to complete all 27 forms but only forms completed within 5 minutes were scored. Scoring was completed by giving one point for each item that met all three criteria. Scoring continued for all items completed within the 5 minute time frame regardless of the number of consecutive failures.

After scoring was completed a raw score for each section was determined and based on the participant's age a standardized score was obtained. To maintain standardization the Beery VMI was administered first, followed by the visual-perceptual subtest, and the motor coordination subtest. The VMI and its subtests were administered to each participant individually.

Comprehensive handwriting screening. To gain as much information about the participant's handwriting skills as possible, two tests were administered, the *Minnesota Handwriting Assessment* (MTA) (Reisman, 1999) and the *Evaluation Tool of Children's Handwriting* (ETCH) (Amundson, 1995). Each participant was asked to write the alphabet from memory on the lined paper. When the participant was unable to complete this task, the evaluator used a sheet that had the alphabet written on it and the participant was asked to copy. When the participant was unable to complete this, the evaluator produced each letter, in front of the participant and waited for the participant to then produce the letter on their lined paper.

All of the handwriting screenings were completed on lined paper or textured lined paper. The spaces were one-inch in size. The textured lined paper had raised top solid, middle dashed and bottom solid lines. The goal was to successfully administer both tests, but after some preliminary evaluation, it was determined that the participants being tested had not yet acquired the skills necessary to complete the tests and derive a score. A discussion of how best to keep the

goals of the tests and not losing the necessary information of the student's handwriting skills ensued.

A modified method of scoring was established to ensure appropriate data collection. The MTA has been designed to assess the participant's ability to write manuscript. The test intends for the participant to near-point copy a sentence ("the quick brown fox jumped over the lazy dogs"). This sentence was not used for the participants, instead, the alphabet had been pre-printed onto a piece of paper as the stimulus. The ETCH assesses the participant's abilities to write letters and the speed of their writing, with specific criteria judging legibility such as letter formation, spacing, size and alignment. The modified testing procedure of the handwriting assessment initially began with the administration of both the MTA and the ETCH. Participants were also asked to write their names on lined paper before the start of the MTA and ETCH screening. The MTA was not completed if the participant was not able to complete the task of copying the lower case letters from the MTA sentence. The ETCH scoring criteria was then utilized and this was scored using three levels. The levels signify the degree of assistance a participant required to complete the task, I = no simplification and the student was able to complete the alphabet from memory, II = the student was able to complete the alphabet by copying from same page, III = the student was able to write the alphabet by imitating the letters made by the therapist. Legibility was determined using the ETCH scoring criteria. Whereas the ETCH scoring is reliable, using it with the directions modified from the MTA may reduce its validity.

Treatment Techniques

This study focused on fine motor emergent issues. The identified participants received direct occupational intervention from Sage Graduate College Occupational Therapy students

under the supervision of the primary investigator and supporting staff at the school. All treatment sessions were generated around the child's needs as determined by the evaluation process and were documented on a regular basis in order to show improvement throughout the intervention process.

Interventions used. The interventions used throughout the treatment sessions include finger and hand stretches, tracing of letters, letter identification, letter practice, coloring, an obstacle course, and positive reinforcement. For the finger and hand stretches the participant was asked to first name all of his fingers (thumb, first, middle, ring, and little) and then to stretch them out as far and as wide as he could. He was then asked to push against the examiner's hands as hard as he could with just his fingers. He was told that he could also push against the table instead of the examiner's hands. He was then asked to crunch his fingers into a tight fist. He was told to repeat the stretch-crunch 2 more times. The participant was then asked to make a bunny with his first and middle fingers as the ears and keep his thumb and other fingers tucked in against his palm. He was then asked to wiggle just his little finger, while all other fingers were tucked against his palm. These stretches were given to help the participant strengthen the intrinsic muscles of the hand in order to facilitate increased fine motor skills.

The letter tracing and practice allowed the participant to work individually with the examiner on how to form the letters of the alphabet. The coloring aspect of the interventions also worked on the intrinsic muscles of the hand to facilitate increased fine motor skills. Worksheets were provided by the participants' teachers and by the examiner.

The obstacle course consisted of gross motor activities designed to give many different kinds of input for the participants. The course required the participant to skip, maneuver through bowling pins on a scooter board, hop on first the left foot and then the right foot, do a somersault,

walk on a balance beam, hop on 2 feet, pull self on scooter board along a rope, shoot a basket with a knobby ball, lay under a weighted blanket on a vibrating pillow. It was possible for the participants to repeat the course as many times as they wanted to or could during the 45 minutes of the session.

The positive reinforcement was used each time a participant was able to adequately accomplish the task placed in front of him. Forms of positive reinforcement included high fives, smiley faces on the paper, the examiner saying "good job" or "well done".

Results

As a result of the assessments during the first 2 weeks of work with the 4 participants 2 individuals were chosen due to their fine motor deficits. The results of the assessments for all 4 participants are located in Table 1. Names of the participants have been changed to protect their anonymity.

Case Study #1: Isaac

Background. Isaac M. is a six year old boy of Hispanic decent. He resides with his mother, grandmother, and two older brothers (who also attend the same elementary school). Isaac attended a preschool prior to attending the elementary school.

While attending the preschool, Isaac was entered into the three year old classroom in which he was progressing developmentally with his peers until he stopped speaking. According to his mother, after attending his classroom activities, she felt that the classroom environment was very loud and distracting. She reported, "I don't blame him for feeling overwhelmed." At this point in time Isaac was categorized as a "Selective Mute." For an extended period of time, Isaac would only speak to his grandmother who is a retired teacher. Isaac was removed from the preschool and cared for by his mother and grandmother at home.

Currently, Isaac is in one of the first grade classrooms at an elementary school in upstate New York. Isaac has broadened his verbal circle to include his mother and siblings. Isaac's means of communication with others consists of smiling/frowning, thumbs up/down, and shaking his head yes/no. Since the beginning of the school year, Isaac has progressed socially in that he will read a book to his mother while she is recording him speaking. Usually the next day, Isaac brings in the cassette tape for his chance to "read" a story to his classmates. As the tape is playing he smiles to himself in a shy-like way while his classmates clap their hands at his accomplishment. Isaac's classmates seem to be very supportive of his inability to vocalize, but at times many of them question it because it is something that they do not understand. Isaac's teacher has been teaching for many years and is very respectful of his deficits. His teacher is working closely with Isaac's mother in order to keep Isaac ahead of the game in the reading area, so he is able to "read" to his classmates and participate socially. His teacher is a very dedicated person that incorporates many learning styles into her integrated classroom. Isaac appears to really enjoy school.

Assessments. During the first week, Isaac was able to complete all tasks associated with the fine motor check off. Isaac demonstrated the use of radial digital, lateral pinch, two point pinch (inferior), and tripod pinch (inferior) when ask to pick up a variety of small objects. During the hand imitations game, Isaac was able to dissociate the fingers and hands from each other while mimicking the test administer. Isaac was able to accurately translate coins within the hand (right and left) in both palm to finger and finger to palm directions without dropping the various size coins. He was able to accurately mimic the shift motion of walking up and down a pencil with both hands. When asked to complete tasks of simple and complex rotation, Isaac used a two handed approach. He used the right hand to perform the action, but used the left hand to assist in

the adjustment of the tool's position. Isaac demonstrated intact sensation through out the hands. When asked to participate in a stereognosis game, the instructions needed to be modified as a result of his Mute status. After the examiner gave an object to Isaac, he was asked to feel it with both hands while his eyes were closed. Then the examiner would give him choices to what was in his hand and he was to shake his head yes or no to the named object. Isaac was able to identify all objects and light touch areas with his vision occluded. During writing tasks, Isaac assumed a forward leaning position over the paper and used his left hand to stabilize as he wrote with his right hand. He was able to copy all objects (circle, square, cross, and triangle) without needing to imitate the motor plan used by the examiner. However, he tended to use more curved lines than straight. Isaac was asked to draw a person and was able to successfully complete this task using mostly a two dimensional approach. Finally, Isaac was able to legibly copy eight of nine given letters.

During week two, Isaac was given a series of reading and writing evaluation tasks. During the reading component of these tasks, the examiner taught Isaac some basic American Sign Language signs in order to facilitate a voice during questioning. After showing Isaac a book and asking him what it was, he responded with the ASL sign for book and when asked "What do we do with a book?" Isaac began flipping through the pages one by one pointing out the different characters and events that were occurring in the book entitled, *If You Bring a Mouse to School*. Isaac was asked to point out words, pictures, and letters throughout the book and was very successful at this task. Isaac was then given a blank sheet of paper and asked to place an "X" where ever he thought the title of a story should go and then place an "X" where you would begin writing the story. Isaac placed an "X" in the middle of the page to show where the title of the story would be and then flipped the page over and placed another "X" at the top of the page

with an arrow in the direction that the words would go. Isaac was then asked who the author of his story would be and responded by pointing to himself and smiling. Isaac was then presented with a wordless book. He began flipping through the pages and stopped. He looked up at the examiner and then pointed to the page as if saying, "Where are the words?" Since Isaac is unable to verbally communicate, he pointed to the different characters and events that were occurring in the story.

During the writing portion of the week two evaluations, Isaac was given the Beery Developmental Test of Visual-Motor Integration (fifth edition). The examiner administered the VMI, Visual Perception, and Motor Coordination tests. Isaac scored in the sixteenth percentile on the Berry VMI, the fifth percentile on the Visual Perception, and did not place in any of the percentile, but had a raw score of five on the Motor Coordination part of the evaluation. Isaac was asked to write the upper and lower case letters of the alphabet on a sheet of lined paper. This task lasted for a period of 85 seconds resulting in missing one letter completely with the upper case alphabet and missing six letters with the lower case alphabet. Isaac was able to print his name legibly on lined paper as determined by his classroom assignments. Finally, Isaac was given a spelling test consisting of the words: Nose, House, Eagle, Monster, and Cat. Isaac was able to successfully spell one of five words and the other four demonstrated a child's task of inventive spelling.

Strengths and Needs. Isaac demonstrates many strengths within the classroom. He can be very attentive and does not show signs of being easily distracted by others. He does not use any diversionary techniques to avoid an activity, such as playing with his pencil. He completes all classroom assignments, but is usually one of the last students done with their work.

Isaac has exhibited deficits in the area of motor control. He has a difficult time tracing lines, cutting on the line, and coloring inside of the lines. Letter placement, letter spacing, and letter legibility are also area of concern. Isaac is also very anxious to begin activities, which has decreased his sequencing ability and his attentiveness when following verbal directions from his teacher.

Goals. Over the six week treatment period, the goals for Isaac were to improve gross and fine motor movements, as well as to improve sequencing skills.

The first goal was to be met with the following criteria: with the paper tilted, preferred hand holding writing utensil with a dynamic tripod grip, and non-dominant hand holding to stabilize the paper, Isaac will consistently complete four classroom assignments in 30 minutes with no more than three redirects to task at hand. Isaac will be able to participate in a structured physical activity for 20 minutes during free class time and increase coordination and attentiveness as evidenced by completing an obstacle course in the allotted time after verbal instructions are given.

The second goal was to be met with the following criteria: Isaac will demonstrate ability to sequence a ten step story that involves coloring, cutting, and pasting of story squares in the correct order during a structured classroom activity as evidenced by completion of the activity in fifteen minutes with no more than one verbal redirection to task at hand. Isaac will be able to follow a ten step directional sequence in order to complete a structured classroom activity with no more than two verbal cuing to redirect to complete the task at hand within a twenty minute time period as evidenced by three separate instances.

Interventions. The intervention plan for Isaac consisted of completing classroom activities designed by his teacher as they incorporated many areas of fine motor use such as,

cutting, pasting, coloring, writing, etc. As mentioned previously, Isaac was introduced to the concept of using American Sign Language as a means of non-verbal communication with others. Sensory Integration techniques such as, brushing and joint mobilizations were incorporated into activities to encourage body and mind readiness to participate in an activity. Finally gross motor activities found in an obstacle course were added in order to address the larger muscle groups and to increase muscle strength and coordination during fine motor activities.

Results of Treatment Interventions. Over the period of six weeks, Isaac has appeared to show improvements. When comparing initial writing evaluation samples to those worksheets completed on the last day of intervention, Isaac's letter formation, spacing, and letter placement have improved (Figures 1-3). When brushing and joint mobilizations were completed prior to an activity, Isaac became more attentive and seemed more relaxed and interested in the task at hand. Through the use of an obstacle course, Isaac was able to expend excess energy, which also added to compliance during classroom activities. The obstacle course was designed to give proprioception and a variety of sensory stimuli to increase the body's awareness in order to prepare for fine motor activities. Isaac no longer needs cueing to correct his sitting posture during handwriting activities. He has been taught to sit with a straight back and feet flat on the floor in addition to tilting his paper and using his "helping" hand to stabilize his paper. Isaac is still taking his time when completing activities, but as a result, all of his assignments are more legible and he is able to follow verbal directions from his teacher without jumping ahead on the assignment or task at hand. Isaac is also beginning to use American Sign Language (ASL) with certain people. Due to this fact, his teacher has added an ASL poster to the classroom. She has encouraged the use of this system; as a result there has been a noticeable increase in the interaction between Isaac and his peers. Also, as last reported by his teacher, Isaac has begun to

vocalize with his mother in one of the offices of the school and will continue to speak with her if the speech pathologist enters the room. Isaac has made a lot of progress in six weeks and he should continue to make great strides as his confidence and communication abilities develop.

Case Study # 2: Cameron

Assessments. Cameron attends the afternoon section of kindergarten in a rural elementary school located in upstate New York. During the time spent with the examiner, he turned 6 years old. His classroom was open, organized, and directed so as to give the students many different learning opportunities. There is one teacher with multiple teacher's aides and parent helpers involved in the class. Cameron had been identified by his teacher as having difficulty with handwriting. His mother consented to allow the examiner to work with Cameron. Cameron's sister had previously attended the same rural elementary school and received Occupational Therapy while she was there.

Cameron willingly completed all of the assessments mentioned above. The fine motor assessment showed that Cameron had difficulty separating the two sides of his hand (thumb side and little finger side). He also had difficulty with simple rotation, complex rotation, and translation of an object from his palm to his fingers and fingers to palm. He was able to use a tripod grasp with his right hand but used his left index finger to guide the motion of his pencil.

During the emergent literacy assessment Cameron was able to identify a book, a word, a letter, where a story would begin on a blank piece of paper, as well as who the author would be. When asked to write the 5 invented spelling words, Cameron produced words consisting of D's, P's, O's and Q's. Cameron was able to read the wordless book and tell a brief story about what happened.

When asked to draw a person, Cameron drew a simplistic person, which was missing its hair, eyes, nose, ears, neck, shoulders, trunk, hands, and feet. Cameron drew a picture that the examiner was unable to determine what it depicted. Cameron did not provide a story to go with his picture due to time constraints. When the picture was presented to him during the next session, he was unable to describe what it was. Cameron's scores on the Beery VMI and its subtests indicated that he had some difficulty with visual-motor integration, visual-perception and motor-coordination.

During the comprehensive handwriting screening, Cameron required the highest amount of cueing. He was unable to at first recall the alphabet (even in song). He was then given the pre-written stimulus sheet and could not copy the letters from it, even with the examiner pointing to each letter. He was then shown how to produce each letter by the examiner who produced the letter over the pre-printed stimulus with a bright blue highlighter.

Interventions. As part of the intervention process, Cameron was given finger and hand stretches before starting any type of handwriting activity. He had some difficulty making the bunny and then wiggling his little finger, but did not seem upset about it; he continued to try to complete the task with little frustration and was eventually able to complete it with no verbal or physical cueing.

Following these finger activities Cameron was given a sheet of paper with bump lines and dots to indicate the middle. Cameron was asked to write his name at the top of the paper and then to produce the letter written by the examiner. Cameron was asked to practice each letter until he was able to correctly form the letter. He then moved to the next letter. When Cameron was able to correctly form the letter he was told "good job" and asked to give a "high five". He seemed to enjoy this positive reinforcement and try harder to earn it. It was noted that Cameron

had some difficulty distinguishing between lower case d's and b's (Figure 4). We worked on differentiating between these letters so that Cameron would be able to more accurately write his name and be able to begin functional reading. The lower case e was also a problem and many methods were tried in order to help Cameron correctly form this letter. The methods included trace the letter, connect the dots, and eventually the Affolter method. The sessions lasted between 30 and 45 minutes. If after 30 minutes Cameron began to fade, he was asked if he would like to continue to practice the letters or if he would like to return to his classroom group.

Each time Cameron was seen, he was given the same finger activities to do and then began to practice his letters. The positive reinforcement changed along with what Cameron would practice according to what was happening in the classroom. When it was noticed that Cameron was having difficulty with a specific letter in the word, he was allowed to finish the word and then asked to practice the formation of the problem letter after seeing the letter properly formed by the therapist. He was then given the opportunity to re-write the entire word (words were not longer than 3 letters long). When he wrote a word, he was asked if everything looked okay, if a letter was mis-formed he was able to identify the letter and then he was asked to try again (Figure 5). When he correctly formed the letter, he was given positive reinforcement.

Throughout all of the above activities Cameron was asked to place his left hand on the side of the paper rather than use it to guide the pencil in his right hand. When he was unable to keep his left hand on the side of the paper the student therapist gently took it and brought it to the correct position and held her hand lightly over his in order to remind him not to use it. Eventually, this physical cue was not needed and Cameron was able to use his left hand appropriately. All of these activities were chosen based on what was seen in Cameron's initial evaluations. Cameron was asked to monitor what he had written in order to have the chance to

self-correct. When he was able to do this, he was given positive reinforcement allowing him to see that it is okay to make mistakes if you are able to find them and correct them on your own.

Samples of Cameron's writing were kept from his second intervention on. These samples do show improvement in letter formation and recognition. By the end of the intervention sessions Cameron was able to correctly identify letters and the words that they were a part of, as well as practice forming the letters that made up the word (Figure 5). By having Cameron practice the entire word we were able to work on both letter legibility and letter spacing. Cameron was also able to correctly write letters he had previously gotten confused such as the lower case letter b and the lower case letter d (Figure 4). The interventions gave Cameron the opportunity to practice his letters in a safe environment with encouragement and praise. While his classroom provided him with these opportunities, the intervention sessions were individualized and more focused on Cameron's needs.

Discussion

Isaac

Working with Isaac provided the examiner with the opportunity to participate in classroom activities in order to address areas of concern. Isaac participated in all activities that were provided by the classroom teacher and the examiner without hesitation. During the Berry Visual-Motor Integration assessment and its subtests, it was found that Isaac exhibited deficits in the area of motor coordination. During the fine motor assessment, it was noted that Isaac had difficulty with complex rotation and manipulation of small objects. The comprehensive handwriting screen showed difficulties with letter formation, spacing, and legibility. As a result of the comprehensive handwriting screen, other handwriting samples were obtained throughout the intervention sessions. During the examination process, it was observed that Isaac expressed a

decreased level of attention and failed to follow verbal directions provided by the classroom teacher. These assessments provided the examiner with the needed information to develop an individualized treatment plan to address the deficit areas previously mentioned.

Isaac responded very well to the intervention techniques provided by the therapist. During intervention sessions, it was noted that Isaac became very attentive and focused to the task presented to him. He showed a high level of compliance to try new activities and/or suggestions provided by the therapist. Overall, Isaac demonstrated increased performance ability in the area of fine motor tasks, such as handwriting and object manipulation.

The interventions completed with Isaac are in agreement with Case-Smith (2000) stating that a focus on play is important to the development of fine motor skills. According to Marr and Cermak (2002) through the practice of fine motor skills and interventions, legibility of handwriting increases.

Cameron

Working with Cameron provided the examiner opportunities to observe how he handles novel tasks such as all of the assessment tools. Cameron readily participated in all activities set before him by the examiner with no need for persuasion. During the Beery VMI and its' subtests, it was observed that Cameron had some difficulty in each of the areas: visual motor integration, visual-perception, and motor-coordination. During the fine motor assessment it was noticed that Cameron had difficulty separating the two sides of his hand, as well as difficulty with simple and complex rotation; and translation from fingers to palm and vice versa. These assessments gave the examiner another opportunity to observe how Cameron worked with his hands and how this might affect how he participates in classroom activities. Cameron had difficulty in remembering his alphabet and actually writing the letters. Other than writing his name, Cameron was only able

to write words consisting of D's, P's, O's and Q's. Handwriting samples were obtained for 4 of the 5 intervention sessions. Having turned 6 years old during the evaluation sessions, Cameron's abilities sparked the examiners' interests and that was why he was chosen. The interventions done with Cameron are in agreement with Hirsch and Niedermeyer (1973) because it was found that, with tracing prompts, Cameron had more success than with any other type of prompt. Also, as Marr and Cermak (2002) suggest, the examiner found when working with Cameron that, the practice of fine motor skills and interventions, the handwriting legibility increased.

The environment at the school, while open and welcoming, did present some difficulties for the assessment stage of the study. The participants were either assessed in the back of their classroom while their classmates were working or in a hallway while other students were moving to and from lunch, or being taken in and out of classrooms. These distractions, while constraining during the assessments, allowed for a more natural environment during the intervention sessions. The participants were required to work daily in an environment where they needed to filter out the multiple things that were happening in order to participate in their activity. Had it been possible, the examiner would rather have worked with Cameron in his classroom so that he was in the least restrictive environment, but his teacher wanted to decrease the number of distractions the other children had to deal with.

Time seemed to be a constraint during the whole study as the examiners were changing classrooms and participants every 30 – 45 minutes. Upon contemplation of this, it was decided that it was helpful to have the time constraints as all occupational therapy sessions have similar time constraints. We were able to work within the time allotted and complete what was necessary for each session.

One major concern during the evaluation was the comprehensive handwriting screening. This screening was a combination between two different screenings, which in themselves are quite reliable. The fact that the administration of the screening was taken from the MTA (Reisman, 1999) and the scoring was taken from the ETCH (Amundson, 1995) made the standardization of both screenings unreliable. It must also be considered that these screenings were meant for children after January of 1st grade and the evaluations were done in October of kindergarten and 1st grade. In consideration of all the facts, the evaluations were informative with respect to the needs of the participants. In future studies, a more concise form of the comprehensive handwriting screening should be made, along with specific scoring criterion that could be standardized so as to have the ability to compare the participants with others in their age range.

Through a review of current literature and use of interventions during the case study process, it was noted that legibility occurs through the development of fine motor skills and the practice of letter formation during classroom activities. The examiners found there was a connection between fine motor development and fluency in handwriting. Fine motor deficits involving poorly developed intrinsic hand muscles led to a decreased ability to legibly form letters and disassociate the various parts of the hand. In addition to fine motor abilities it was noted that the level of attention to task affected the outcome of handwriting legibility.

Overall, the entire study process allowed the examiners opportunities to experience and observe different participants, their varying skills, and their varying needs. Working hands on with these participants allowed the examiners to gain hands on knowledge regarding the administration and scoring of the tests. This study also allowed the examiners to build working relationships with both teachers and other staff throughout the school.

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Table 1
Summary of Initial Assessments

Participants	Fine Motor Needs	Emergent Literacy Needs	Draw a person (years)	Draw a picture	Beery VMI (percentile)			Modified Minnesota	
					VMI	Visual Perception	Motor Coordination	Upper Case	Lower Case
Isaac	<ul style="list-style-type: none"> - uses right hand to perform simple and complex rotation with left handed - assist to adjust tool's position - use of curved lines vs. straight lines during the object copying portion of the test 	<ul style="list-style-type: none"> - selective mute 	8/12 or 66% of age appropriate inclusions	<ul style="list-style-type: none"> - drew a picture of a witch, no story due to his selective muteness; picture was drawn from a picture near him on a wall 	16 th	5 th	0 – does not register in percentile due to lowness of raw score	96.2 % Level I	78 % Level I
Cameron	<ul style="list-style-type: none"> - difficulty with dissociation between the two sides of his hand - left index finger guides motion of the pencil in his right hand - difficulty with simple rotation - difficulty with complex rotation - difficulty with object translation from fingers to palm and back 	<ul style="list-style-type: none"> - cannot yet read - difficulty remembering alphabet 	3/12 or 25% of age appropriate inclusions	<ul style="list-style-type: none"> - unable to understand what picture represents - no story given 	4 th	3 rd	12 th	65.4 % Level III	54 % Level III

	-difficulty producing written letters from memory and stimulus - produces only the letters D, P, Q, and O upon evaluation									
Veda	- left hand assists as right hand copies letters - Some difficulty isolating finger movement to create "bunny and Alligator"	6/13 or 46% of age appropriate inclusions	- Picture of girl under rainbow looking at the clouds looking at the sun - with description in pink pen	14 th	7 th	.02 nd	77 % Level I	92.3 % Level I		
Lauren	- Some difficulty with letter size and spacing	8/13 or 61.5% of age appropriate inclusions	-Picture of a horse that she had ridden with an aunt, very detailed description	30 th	32 nd	42 nd	92.3 % Level I	84.6% Level I		

Figure Caption

Figure 1. 1st handwriting sample for Isaac, obtained during assessment process.

Figure 2. 2nd handwriting sample for Isaac, obtained in the middle of the treatment sessions.

Figure 3. 3rd and final handwriting sample for Isaac, obtained the last day of treatment sessions.

Figure 4. Chronological depiction of how Cameron is able to write letter “d” during evaluation and intervention sessions.

Figure 5. Chronological depiction of how Cameron is able to write letter “k” as part of a word during evaluation and intervention sessions.

A M O F L T C H r

Figure 1.

Fall


Leaves

Figure 2.


yarn
vell
yarn


Figure 3.


1.  “d”


2.  “d”

3. 

4. 

5. 

6. 

7. 

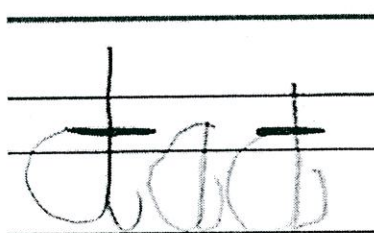
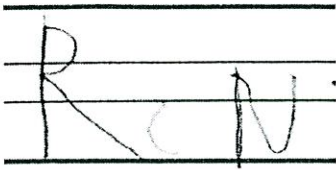
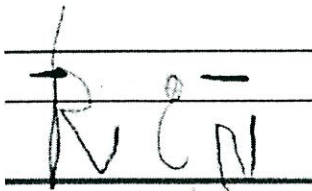
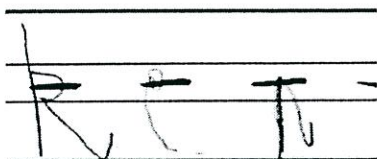
8. 

Figure 4.

1.  (kin)

2.  (kin)

3.  (kin)

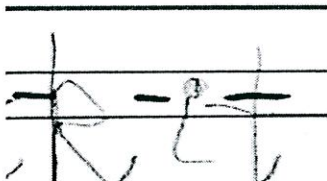
4.  (kit)

Figure 5.