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Effect of Proprioceptive Input Combined with “Handwriting without Tears” on the Handwriting of Children with Learning Disabilities

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EFFECT OF PROPRIOCEPTIVE INPUT COMBINED WITH "HANDWRITING WITHOUT TEARS" ON THE HANDWRITING OF CHILDREN WITH LEARNING DIABILITIES

by

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The purpose of this study was to investigate the effectiveness of "Handwriting Without Tears" on students' handwriting, and to explore if providing proprioceptive input before implementing "Handwriting Without Tears" has an effect on the legibility and accuracy of handwriting. Three first-grade and three second-grade students who received direct occupational therapy services were divided into two treatment groups. Those students in treatment group A received a combination of proprioceptive input and the "Handwriting Without Tears" program during their treatment session. Those students in treatment group B received only the "Handwriting Without Tears" program. Each student completed the Minnesota Handwriting Test (MHT) before and after the 8-week intervention period. Also, handwriting samples for weeks 3-8 were analyzed to show any changes that may have occurred on a per treatment basis. The visual analysis of both the "Handwriting Without Tears" and the MHT suggest that the combination of proprioceptive input and "Handwriting Without Tears" may be more effective when treating the handwriting of elementary-aged students. However, both treatment groups showed improvement on the six different scores of the MHT. Therefore these results suggest that with or without proprioceptive input, the "Handwriting Without Tears" program does affect handwriting in a positive way.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS ii

LIST OF TABLES v

LIST OF FIGURES vi

CHAPTER

I. INTRODUCTION 1

II. LITERATURE REVIEW 3

Current Trends Used by Occupational Therapists When Treating Handwriting 3

The Combination of Sensory Integration Training and Handwriting 14

Need for the Study 25

Research Question 26

III. METHOD 27

Participants 27

Instruments 28

Procedure 29

Intervention 30

Data Analysis 31

IV. RESULTS 32

Clinical Descriptors 32

Visual Analysis 32

Table of Contents – Continued

CHAPTER

V. DISCUSSION 42

"Handwriting Without Tears" 42

Minnesota Handwriting Test 43

Limitations 44

Implications for Further Research 44

Conclusion 45

REFRENCES 46

APPENDIX 48

Approval Letter From the Human Subjects Institutional Review Board 48

LIST OF TABLES

3.1. Weekly Schedule of Treatment Activities 31

LIST OF FIGURES

4.1.	Percentage of Letter Reversals Over Six Week Intervention Period	32
4.2.	Percentage of Improper Letter Formation Over Six Week Intervention Period	33
4.3.	Percentage of Letters That Cross the Line Over Six Week Intervention Period	34
4.4.	Percentage of Total Errors Over Six Week Intervention Period	35
4.5.	Rate Score of Pre- and Post-Tests of Minnesota Handwriting Test	36
4.6.	Legibility Score of Pre- and Post-Tests of Minnesota Handwriting Test.....	37
4.7.	Form Score of Pre- and Post-Tests of Minnesota Handwriting Test	38
4.8.	Alignment Score of Pre- and Post-Tests of Minnesota Handwriting Test	39
4.9.	Size Score of Pre- and Post-Tests of Minnesota Handwriting Test.....	40
4.10.	Spacing Score of Pre- and Post-Tests of Minnesota Handwriting Test	41

CHAPTER I

INTRODUCTION

One of the most important and complex childhood occupations is learning to transpose thoughts and information through written language (Amundson, 1992). Even with the increased use of computer word processing programs and assistive technology, handwriting is still a very large part of students' elementary education. In a survey of more than 900 school-based therapists across the United States, it was found that the most common reason for referral to occupational therapy was handwriting problems (Chandler, 1994). Occupational therapy literature is full of theories, principles, and strategies to promote handwriting and manipulation in school-age children (Case-Smith, 2002). Some feel that using a developmental approach that teaches handwriting using simple, vertical lines works well. Others feel that using a combination of multisensory, biomechanical and developmental approaches based on each individual student is best. Therefore, the question of what would happen when proprioceptive input was combined with the "Handwriting Without Tears" program to treat handwriting was raised. This combination was chosen after reading literature that supports using a multisensory approach when treating handwriting (Lockhart & Law, 1994, and Woodward & Swinth, 2002).

Developed by Jan Z. Olsen, O.T.R., "Handwriting Without Tears" is an easy way to teach pre-printing, printing, and cursive. The purpose of the program is to make handwriting an automatic and natural skill for children of all ability levels. According to Olsen (1977), it requires less than ten minutes a day of instruction for students to learn to write well. "Handwriting Without Tears" was chosen for this study because it is

developmentally based and uses multi-sensory teaching aids to teach the students to write. These aids consist of wood pieces and a slate chalkboard. By working/playing with the wood pieces, children learn shapes, recognize letters, improve fine and gross motor skills, and develop placement habits that will prevent letter reversals (Olsen, 1977). The slate board gives the child a "frame of reference" for where to begin the letter and for correctly printing capital letters and numbers. Since "Handwriting Without Tears" is a multisensory technique, using proprioceptive activities in conjunction with it should help to enhance the results that occur with a child's handwriting.

The word proprioception comes from the Latin word meaning "for one's own." This input is telling one about their own sensations from their muscles and joints. "Proprioceptive input tells the brain when and how the muscles are contracting or stretching, and when and how the joints are bending, extending, or being pulled or compressed. This information enables the brain to know where each part of the body is and how it is moving" (Ayers, 1991). Thus, if there was poor proprioceptive input from your hands, you would not be able to distinguish the amount of pressure you are using to hold onto the pencil, how hard you are pressing the pencil down on the paper, and what it feels like to be making the actual letter. Activities which can be used within a school setting to provide this type of input are performing a wheel-barrow walk, the crab walk, the inchworm walk, wall push-ups, paper punching/making confetti, popping bubbles in packing materials, games with rubber bands, and activities with theraputty/play dough (intrinsic stretch, thumb flexion and extension, thumb and finger adduction, opposition, and individual finger extension).

CHAPTER II

LITERATURE REVIEW

A large amount of literature exists on the topic of handwriting and the role of an occupational therapist in a school-based setting. For the purpose of this thesis, articles pertaining to the current trends used by occupational therapists when treating handwriting and articles pertaining to the combined use of sensory integration training and handwriting were reviewed. Therefore this literature review will be broken down into the two different areas.

Current Trends Used by Occupational Therapists When Treating Handwriting

Handwriting Error Patterns of Children with Mild Motor Difficulties

In 1995, Malloy-Miller, Polatajko, and Anstett completed a study with the purpose of identifying handwriting error patterns of children with mild motor problems and to examine the relationship between handwriting error problems and perceptual-motor abilities over a wide age range (7 to 12 years). The 66 subjects were selected at convenience from two clinical facilities. The children had been referred by parents or teachers for occupational therapy assessment and treatment of minor motor problems. All of the subjects had normal intelligence, normal hearing, and vision, but were judged to have significant motor coordination difficulties based on performance of 1 standard deviation below the mean on the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978). Also, none of the children had received therapy intervention and did not have specific neurological/physical or sensory deficits.

In order to evaluate the handwriting error patterns and their associations to perceptual-motor abilities, all of the subjects were evaluated by a test of handwriting

legibility and six different perceptual-motor tests. The seven different measures used were: the Handwriting Evaluation Scale (Malloy-Miller, 1985), the Developmental Test of Visual-Motor Integration, Revised (VMI) (Berry & Buktenica, 1989), the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978), the Motor-Free Visual Perception Test (Colarusso & Hammill, 1983), the Kinesthetic Sensitivity Test (Laszlo & Bairstow, 1985), the Southern California Sensory Integration Test of Kinesthesia (Ayres, 1972), and the Southern California Sensory Integration Test of Finger Identification (Ayres, 1972). Testing was completed by a research assistant who was trained in psychometric assessment. Data collection was completed at the child's school.

To address the objective of identifying factors of handwriting errors across the age range of 7 to 12 years, an R-common factor analysis of the pretest handwriting data was performed. To assist with the interpretation of the factors, correlations were computed between the perceptual-motor measures, age, speed of handwriting and the handwriting error factor scores. The factor analysis of handwriting error variables generated three factors with varying patterns of association to perceptual-motor tests, speed of handwriting, and subject's age. The authors of the study concluded that the results may assist therapists in the assessment and understanding of the handwriting of children with mild motor difficulties. The three factors included: Factor 1: Execution/Coordination is associated with visual-motor skill, sensory discrimination and slow speed with handwriting errors in line quality, closure and size of letters; Factor 2: The Aiming factor is correlated with visual-motor and fine-motor skills with errors in targeting the baseline; Factor 3: Visual-Spatial was not significantly related to perceptual-motor tests.

This study provided controls for intelligence and level of motor difficulty. However, the study did not examine if these trends are similar in children with below normal intelligence, or with extreme motor difficulties. Also the sample was of convenience, therefore the study does not represent the majority of the population. While this study does provide valuable information regarding the handwriting error patterns of children with mild motor difficulties, implications for further research are evident. For example, further research could evaluate the appropriate interventions to use to treat these children once their handwriting has been assessed.

Factors That Relate to Good and Poor Handwriting

In 1996, Cornhill and Case-Smith completed a study that investigated the differences between children with good and poor handwriting as identified by teacher report and the Minnesota Handwriting Test (MHT) (Reisman, 1993) on certain performance components identified in the literature as influential to handwriting legibility: eye-hand coordination, visual-motor integration, and in-hand manipulation. A second purpose was to investigate whether the scores on tests of these performance components can predict scores on handwriting performance as measured by the MHT. A convenience sample consisting of 49 typically developing first graders attending schools in one count of central Ohio was used in the study. The subjects were judged to be either good or poor handwriters by their teachers. A second criteria, as established by Reisman was applied to categorize the subjects into good handwriting and poor handwriting groups. Each subject completed the MHT as an assessment of handwriting legibility. Twenty-five children with good handwriting and 23 children with poor handwriting were then included in the study. Of the subjects in the poor handwriting group, 9 were girls

and 14 were boys: of the subjects in the good handwriting group, 19 were girls and 6 were boys. Thirty-nine subjects used their right hands for writing and nine used their left. The mean age was 7.3 years. Forty-five subjects were Caucasian, and three were African-American.

A co-relational, quantitative, quasi-experimental design was used. The subjects were tested individually in 20-minutes to 25-minute sessions. To test eye-hand coordination, the Motor Accuracy Test (MAC) (Ayers, 1980) was used. To assess visual-motor integration, the Developmental Test of Visual-Motor Integration (VMI) (Beery, 1989) was used. In-hand manipulation was tested by having the subjects complete two different tasks, translation and rotation, that required manipulation of a small peg within the fingers (Case-Smith, 1993; Pehoski, 1994). The MHT was then used to evaluate each subject's handwriting. Interrater reliability of 98% of 30 handwriting samples was achieved between the first author and Reisman. The handwriting test was administered at the end of the testing session to prevent the examiner from viewing the subject's handwriting before testing..

The authors analyzed the data using *t* tests to compare the two groups on each of the performance measures and correlations. Stepwise multiple regression was used to determine whether the performance component measures predicted the subjects' scores on the MHT. Discriminant analysis was used to assess whether the combination of performance measures correctly classified the subjects as good or poor handwriters. The subjects in the good handwriting group seemed to be clearly distinguished from those in the poor handwriting group. First, the agreement between the MHT scores and the teachers' categorization of the students with handwriting problems was remarkable. The

authors believed that this suggests that the MHT is a valid test of handwriting performance. In the results of this study, the correlation between the MAC and MHT scores was moderate (r = .594). VMI scores were significantly lower for the subjects with poor handwriting (15.0) than those for the subjects with good handwriting (23.6), t = 5.02, $p < .001$. In-hand manipulation was significantly different between the subject groups. The authors of the study concluded that when a student is identified as having handwriting problems, the performance components investigated in this study should be evaluated to gain understanding of the unique contributing factors to these problems. These components should then be focused on during occupation therapy treatment when the goal is to improve handwriting.

The study's design had several limitations. First, the sample was of convenience and did not represent a large group. Second, the examiner was not blind to the subject's handwriting classification during testing. Also, the groups did not consist of equal numbers, and the there was not an equal amount of girls and boys in each group. Finally, other variables can influence handwriting, such as cognition, and visual perception. Therefore, a larger study taking the already included performance components, and possibly other performance components should be considered for future research.

Does Fatigue Influence Children's Handwriting Performance?

In 1998, Parush, Pindak, Hahn-Markowitz, and Mazor-Karsnety completed a study to examine the assumption that poor handwriters would perform less well than good handwriters when writing long texts. There were a total of 157 subjects in the study. The study population was a convenience sample taken from regular schools throughout Israel. Children with neuromotor dysfunction, sensory loss, mental,

behavioral, or emotional problems were excluded from the study. The students in the study were grouped as either good handwriters or bad handwriters based on recommendation of their classroom teachers with help from a 16-item standardized and valid questionnaire, designed to determine handwriting quality (Lifshitz and Parush, 1993).

The authors of the study used the Hebrew Handwriting Evaluation (HHE) to assess the speed of handwriting, ergonomic factors, and the quality of the handwriting sample. The speed of the handwriting was measured by counting the number of letters a child wrote in 1 minute. Quality was measured in two different areas: letter formation and spatial organization. For ergonomic factors, pressure, pencil positioning, consistency of pencil grip, body positioning, paper positioning, and stabilization of paper were measured. Each subject was tested individually for approximately 15 minutes, in a quiet room during the morning hours. In order to explore the influence of fatigue on the subject's handwriting, they were required to first complete the HHE. They then wrote for an additional ten minutes copying from a third grade text book. This amount of time was determined by consulting eight third-grade teachers and after a group of third-grade students were observed in their natural school environment. After the ten minutes, the students once again completed the text from the HHE.

To analyze the data, the authors used univariate F-tests to compare both group's performances on each condition. For each measure, except for pressure, the univariate effect was significant at the 0.001 level, with the good handwriters scoring higher than the poor handwriters, under both conditions. Thus, the authors of the study concluded that although both groups were effected by the fatigue situation, the poor handwriters still

did poorer than the good handwriters in both conditions, on most of the variables, with the exception of pressure. The poor handwriters can be characterized as writing slower and less legibly than the good handwriters.

Due to the fact that his study was completed in Israel it makes it difficult to apply the results to children in America. Also, due to the exclusionary criteria, more work is needed in order to determine how fatigue may affect a child that suffers from neuromotor dysfunction, sensory loss, mental, behavioral or emotional problems. Further research is also needed to determine what type of intervention should be used with poor handwriters in order to build their endurance and decrease the effect of fatigue on their handwriting.

Handwriting: Current Trends in Occupational Therapy Practice

In 2000, Feder, Majnemer, and Synnes completed a study to describe assessment and treatment approaches commonly used by occupational therapists for children exhibiting handwriting and related fine motor difficulties. Secondarily, the application of weights as a treatment modality was also explored. A convenience sample of 50 occupational therapists with a minimum of 3 years experience in pediatrics, representing eight Canadian provinces, were interviewed by telephone by the first author. The sample of 50 respondents were selected by a) contacting occupational therapy departments within major pediatric institutions and/or rehabilitation centers in each province and soliciting volunteers and b) posting a notice at the CAOT national conference in 1996 and at a handwriting course by Benbow in 1996 inviting occupational therapists to participate in the survey.

The survey was designed by three occupational therapists and an epidemiologist/neonatologist experienced in research. Questions were formulated based

on a review of the handwriting literature and from clinical experience. The survey was piloted on three occupational therapists with expertise in the field of pediatrics after which portions of the survey were revised. The final version included a 3-part multiple choice survey consisting of demographic and general information questions, specific questions on the assessment and treatment of handwriting, and a final section focusing on the use of weights for therapeutic intervention. The last section of the survey was only administered to respondents who replied positively to the first question in the section: "Do you ever use weights during therapy sessions with clients?" The survey was comprised of eleven questions in total in Part 1 and 2, and six questions in Part 3.

Data from this survey were analyzed using t-tests to compare the number of years of experience in therapists who used versus who did not use each of the different treatment approaches. The Mantel-Haenszel test was also used to determine whether the therapist's work setting influences the treatment approach favored. In addition, multiple logistic regressions were carried out with setting and years of experience as independent variables and each treatment approach as the dependent variable. In the survey, therapists had a mean of 13.1 years of experience as an occupational therapist with a minimum of 3 years experience in pediatric occupational therapy. The sample surveyed included representation from a range of clinical settings. In terms of primary setting, the majority of respondents worked in either a hospital-based setting or a school-based setting, with the remainder working in a pediatric rehabilitation center or in private practice. Survey results revealed that in terms of assessment practices for children referred with handwriting and/or fine motor difficulties, therapists routinely assessed gross/fine motor skills, perceptual skills, quality of movement and motor planning. Just

over half the therapists surveyed also assessed sensory functioning. The assessment tools most commonly utilized by respondents were the Developmental Test of Visual-Motor Integration (Beery), the Bruininks-Oseretsky Test of Motor Proficiency, and the Test of Visual Perceptual Skills – Motor (Gardner). All respondents used an eclectic approach in treating handwriting and related fine motor problems, with the sensorimotor approach overwhelmingly the most frequently selected. Other commonly selected treatment strategies included: perceptual-motor, motor learning, cognitive training, biomechanical, sensory integrative, and neurodevelopmental approaches. The final section of the survey dealt with the use of weights as a treatment modality. Findings revealed that 68% of therapists responded positively to having used weights in their clinical practice. The majority of respondents reported using weights for poor motor coordination, tremor, hypotonia, poor postural stability or poor sensory awareness.

In this survey, there was a potential for bias as subjects were not randomly selected. Also, there may be some bias in the sample selection as a small portion of the recruitment was carried out at a handwriting course where perhaps respondents had a greater tendency towards using specific remediation strategies such as weights. There were also some limitations in the development of the survey. Standard definitions for specific treatment approaches were not stated in the survey. Also, the survey did not specifically ask respondents about informal assessment measures. Another limitation of this study was the small sample size. Due to the third part of the study and the small sample size used, a more specific study evaluating the use of weights in treating handwriting may be beneficial in providing therapists with another treatment approach for handwriting.

Effectiveness of School-Based Occupational Therapy Intervention on Handwriting

In 2001, Case-Smith evaluated the effects of school-based occupational therapy services on students' handwriting. The students were recruited by occupational therapists from five school districts in central Ohio and southern Illinois. Forty-four second-, third-, and fourth-grade students (31 with occupational therapy intervention, 13 without) were recruited and consented to participate in the study. The inclusion criteria for the intervention sample were: a) received special education and occupational therapy services, b) had poor handwriting as judged by their teachers and had handwriting goals on their individualized education programs (IEP), and c) demonstrated cognitive function within normal limits as documented in the school files. The students in the comparison group had poor handwriting as judged by their teachers but did not receive occupational therapy services.

A quasi-experimental research design was used for the study. The children either received direct occupational therapy services or they did not. Visual-motor, visual-perception, in-hand manipulation, and handwriting legibility and speed were measured at the beginning and end of the academic year and then compared between the two groups. The intervention group received a mean of 16.4 sessions and 528 minutes of direct occupational therapy services during the school year. According to therapists, visual-motor skills and handwriting practice were emphasized the most in intervention.

Three subtests of the Developmental Test of Visual Perception (Hammill, Pearson & Voress, 1993) were administered to measure position in space, figure ground perception, and copying. The subtests were selected because the skills that they measured have purported relationships to handwriting. During test development, a series

of reliability and validity studies were completed. Test-retest reliability for the DTVP ranged from r = .71 to r = .86 and was r = .96 for the total score. Two of the subtests for fine motor skills from the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1975) were administered. The visual-motor control subtest measures the ability to coordinate precise hand and visual movements. The upper-limb speed and dexterity subtest measures hand and finger dexterity and speed of arm and hand movement. Reliability and validity studies are reported in the test manual; the fine motor composite test-retest reliability was r = .77 and .88, and interrater reliability was r = .98 and .90. In-hand manipulation components – translation and rotation – were measured using the materials of the nine-hole peg test. The author did not report the reliability or validity of this assessment. Handwriting speed and legibility were measured with the Evaluation Tool of Children's Handwriting (Amundson, 1995). Fair to good reliability has been demonstrated for the ETCH. Interrater reliability for total letters and numbers ranged from ICC = .82 to ICC = . 84. For total legibility, test-retest reliability was r = .77.

Handwriting practice or activities designed specifically to improve handwriting were implemented in 77% of the sessions. The therapists administering the intervention reported emphasizing the particular skill areas that seemed to constrain or limit the student's progress in handwriting. That is, each therapist individualized the intervention emphasis according to the student's needs. Students in the intervention group showed increases in in-hand manipulation and position in space scores. They also improved more in handwriting legibility scores then the students in the comparison group. On average, legibility increased by 14.2% in the students who received services and by 5.8% in the students who did not receive services. The authors concluded that students who received

occupational therapy services improved in overall letter legibility but did not improve in numeral legibility or handwriting speed.

One of the limitations of this study is the limited sample size and geographic region. This makes it difficult to apply the results of this study to the rest of the population. Since the group sizes were not equal, the results may have skewed some of the statistical comparisons. Both the pre- and post-evaluations were completed by either the author or the collaborating therapists, therefore they were not blind to the group status of the students. Finally, intervention varied among each individual therapist. Thus the author is really unable to explain why the handwriting of those students who received occupational therapy services improved. Due to the combination of the above mentioned limitations and the positive results reported by the authors, implications for further research are evident. This research may include clinical trial of specific handwriting interventions in order to understand why occupational therapy intervention has a positive effect on the overall handwriting skills of the students who receive treatment.

The Combination of Sensory Integration Training and Handwriting

A Sensorimotor Program for Improving Writing Readiness Skills in Elementary-Age Children

In 1989, Oliver evaluated a writing readiness program used with three groups of children aged 5 to 7 years. The program combined occupational therapy treatment with a supplementary program implemented by school personnel or parents. The subjects were selected at convenience by the author. The project involved three groups of children. Group 1 consisted of 12 children of normal intelligence, as defined by a full scale IQ greater than 80 and a performance IQ greater than 80 on the Wechsler Intelligence Scale for Children-Revised (Wechsler, 1974). Group 2 consisted of 6 children, all of whom

had a significant disparity between verbal IQ and performance IQ (>15 points) on the Wechsler Intelligence Scale for Children-Revised. Group 3 consisted of 6 children. Five of these children were in special education classes. This group's mean IQ was 65. All 24 children included in this project had delayed writing readiness skills and were unable to learn these skills in a typical classroom environment.

As part of the diagnostic process, the Developmental Test of Visual-Motor Integration (Beery, 1985) was used to determine the developmental level of each child's writing readiness skills. The author administered and scored the test according to the test directions. The test was re-administered after 1 year. The change in each child's writing readiness developmental level was used to evaluate his or her progress. All children in the study received the same treatment. The therapy program used had two parts which were administered concurrently. One part of the intervention involved direct therapy, in which the author/occupational therapist saw each child individually once a week for 30 minutes. Activities during therapy focused on writing readiness skills and included multisensory stimulation and large movement patterns. The second part of the intervention involved a supplementary program that complemented the direct therapy. A classroom teacher, classroom aid, or parent, using the program outlined by the occupational therapist, worked with the child a minimum of three times a week for 10 minutes at a time. Comparing the initial scores and retest scores, the author concluded that special populations who have deficits in their writing readiness skills will benefit from individualized instruction that emphasizes multisensory training.

This study provided controls for the comparison of individuals in the treatment sessions, but there was no documentation to show that each child received the

supplementary program the same amount of times. The study did not examine a homogenous sample. Group 1 was twice as big as Groups 2 and 3, and there were not equal amounts of girls and boys. Also, overall, the children in Groups 1 and 3 were closer in age than were those in Group 2. Group 2's mean age was 5 months younger than Group 1's mean age and 8 months younger than Group 3's mean age. Although the writing readiness program proved to be effective with all three groups of children, we do not know which method of intervention was really more effective, direct therapy or a supplementary program. Also were the gains made in the program a result of the combination of the two methods, or was it just one of the interventions. Therefore implications for further research are evident.

Improving Handwriting Through Kinesthetic Sensitivity Practice

In 1991, Harris and Livesey evaluated the effects of kinesthetic acuity and kinesthetic perception and memory experience upon handwriting performance of children who were poor handwriters in their early school years. The authors also wanted to determine if there was a developmental effect (an age or handwriting experience effect) on the impact of kinesthetic practice upon the handwriting performance of poor handwriters. The subjects were selected on the basis of their poor handwriting performance from the 124 children in the kindergarten and year one (first grade) classes of two suburban Sydney, Australia primary schools. A sample of the handwriting of all 124 children was collected and two judges graded the sample on neatness, accuracy, and legibility following the procedure of Alston (1983). Each of the age groups was sorted separately so that comparisons were made only with others from the same age (experience) group. The judges independently rated the samples on a scale from 1 (very

poor) to 7 (very good). Inter-rater reliability was .91. The children receiving scores from 1 to 4 (low average) were selected as subjects for the experiment. There were 30 children thus selected, 15 from kindergarten with a mean age of 5.8 years and 15 from year one with a mean age of 7.1 years. The subjects from each year group were then assigned to the three practice conditions: handwriting, kinesthetic acuity or kinesthetic perception and memory, ensuring equal numbers of relatively poor and better handwriters were assigned to each of the groups (three poorest randomly assigned, then next three, etc.).

For kinesthetic acuity practice, subjects were required to discriminate the heights of two inclined runways as described by Laszlo and Bairstow in 1985. The perception and memory of movement task required subjects to trace a pattern under the masking box and then, after the pattern had been rotated, the mask was removed and the subject asked to restore the pattern to its original position. Prior to commencement of the practice sessions the 30 subjects were tested for kinesthetic acuity and kinesthetic perception and memory. Practice consisted of six 15 minute sessions per subject, one session per day over consecutive school days. No feedback was give as it was felt that the quality of feedback could not be equated across groups. Subjects in the handwriting practice group were presented with a different seven or eight word sentence to copy for 15 minutes in each practice session. This was, therefore, not a handwriting remediation activity but simply a period of handwriting practice comparable in time to the other conditions. On the day following the completion of the practice sessions all 30 subjects were re-tested on both kinesthetic acuity and perception and memory. A second handwriting sample was taken from all of the original 124 children. Two teachers from a different primary school then rated all 248 sample, applying the same scoring procedure as used initially. The

only information they were given was that the samples were from kindergarten or year one (first grade) children. They were unaware that they were rating two samples from each child.

Utilizing two-way ANOVA to compare the mean and standard error or scores in the pre- and post-practice stages on handwriting (sum of the ratings of the two raters), kinesthetic acuity (percentage of the 30 trials correct) and kinesthetic perception and memory (mean error in degrees over the 30 trials) for the two age groups under each of the three practice conditions, the authors concluded that kinesthetic sensitivity practice of both sorts, when given to poor handwriters at the appropriate age, does produce an improvement in handwriting performance. This improvement was not found with handwriting practice alone. The older group showed greatest benefit from this practice with marked improvement in handwriting produced by both types of kinesthetic sensitivity practice.

Given the fact that subjects were selected on the basis of poor handwriting scores without regard to kinesthetic sensitivity, any effect of sensitivity is likely to be obscured by variability in scope for improvement. A future study testing the effects of training given to children who were poor on both the paper and pencil skills and kinesthetic sensitivity could be done. Another limitation to this study is that it was done in Australia, thus the ability to apply the effects to American children may not be accurate. The study could be replicated within the United States in order to control for the specific handwriting styles and techniques used here.

The Effectiveness of a Multisensory Writing Programme for Improving Cursive Writing Ability in Children with Sensorimotor Difficulties

In 1994, Lockhart and Law completed a study to evaluate the effectiveness of a multisensory writing program for improving the cursive writing ability of four children with sensorimotor difficulties. The subjects were recruited from the Hamilton-Wentworth school system. The children who were selected were referred to the Occupational Therapy Department at Chedoke-McMaster Hospitals, Hamilton, Ontario for assessment. All four children were then identified as having sensorimotor difficulties and accompanying writing problems. The four children had been identified as having a specific learning disability. Children who were receiving drug therapy, had structural language difficulties, and physical disabilities, or had been identified as intellectually exceptional were excluded from the study.

A single case with multiple baselines across behaviors design was used. The behaviors were the cursive writing of five, randomly taught, distinct letter groups. The program consisted of five one-hour sessions conducted in the child's school at the same time every other week. Each of the five sessions focused on remediation of a targeted group of letters. All of the sessions consisted of a series of activities and exercises following a specific format: 1) tracing large letters on a blackboard with chalk, 2) tracing letters over a rough surface with a marker, 3) forming letters in rice with a finger, 4) copying large letters and groups of letters on paper over a rough surface, and 5) tracing and copying letters and groups of letter on regularly line paper. The child was also required to complete 15 minutes of writing "homework" each evening.

Evaluators who were blind to the study measured the speed and quality of cursive writing. To measure speed of writing, the evaluator recorded the length of time that the

child was actually forming the letters, starting a stopwatch at the beginning of each combination of letters when the child placed the pencil on the paper, and stopping it when that combination had been completed. To measure quality of writing, the evaluator followed a set of criteria developed by the researcher in order to award points to errors in formation of letters. Before and after the study, the teacher of each child completed a questionnaire regarding the child's neatness and legibility, and the child's ability to write at the rate of the rest of the class. The authors of the study also used the Handwriting component of the Test of Written Language (TOWL) developed by Hammill and Larsen (1983). They selected the TOWL because it is an assessment tool that is easy to administer and provides a goal picture of a child's' writing legibility.

The authors analyzed the data from each subject individually using visual and statistical analyses and the trends across the four different cases were examined. For the purpose of statistical analysis, the authors also used a test of ranks. Performance means were established for each series of six trials, for each letter group, in both outcome measures. All four children demonstrated substantial trend in changes on visual analysis in quality scores of one or more letter groups following intervention; however, in only one of the four children was the change in each of the letter groups great enough to yield significance overall. Due to the variance in the results across the four cases in terms of changes in quality and speed scores, the authors were unable to draw any overall conclusions about the effectiveness of the multisensory program. The results suggest that there are effects; however, more research needs to be conducted.

Using a single case design makes it difficult to generalize the results for a large group. This study was conducted on all boys making it difficult to interpret how girls

would be affected by the intervention. Developmentally, manuscript/printed writing is learned first, and this study only examined cursive writing in children; therefore the results may have been more prominent if this approach was used with younger children. Due to the specifics of the population used in this study, more work is needed in order to determine the most effective method for improving handwriting and meeting the needs of a specific population.

Testing the Effect of Kinesthetic Training on Handwriting Performance in First-Grade Students

In 2001, Sudsawad, Trombley, Henderson, and Tickle-Degnen evaluated the effects of kinesthetic training on handwriting performance in 45 first-grade students, 6 to 7 years of age, who had kinesthetic deficits and handwriting difficulties. The subjects were recruited from 24 elementary schools within 2 school districts in the greater Boston area, with the only exclusion criterion being that a child could not be on medication to improve attention span. A randomized-blinded three-group research design was used where the children were assigned to either a kinesthetic training group, and handwriting practice group, or a no treatment group. For those subjects in the kinesthetic training group, the two training tasks were presented in a counterbalanced order over a 6-day training period. In each session of the runway task training, the child was asked to differentiate, with vision occluded, the height of his or her arms on two table-top runways. In each session of the pattern task training, the child was asked to reorient one of six stencil patterns presented in order of the least to the most complex. For those subjects in the handwriting practice group, six training sessions comparable in time and attention to the kinesthetic training group were conducted. The child was given letters, words, and sentences to copy. Verbal and visual feedback were provided for letter size,

alignment, and spacing. The subjects in the no treatment group continued to participate in their usual academic activities in the classroom.

Kinesthesis and handwriting were measured before and after intervention. Teachers' judgments of handwriting legibility in the classroom setting were sought at 4 weeks after the intervention to see whether any improvement gained would be maintained in the natural setting. Kinesthesis was assessed using the Kinesthetic Sensitivity Test (KST) developed by Laszlo and Bairstow (1985). The article reported that the KST contains two subtests/tasks, and that the test-retest reliability coefficients of the Runway task were reported to be .69 for 6-year-olds and .52 for 7-year-olds. Handwriting was assessed using the Evaluation Tool of Children's Handwriting (ETCH) developed by Amundson (1995). The ETCH was designed for used with 6-year-olds to 12-year-olds and is composed of assessments for two types of handwriting: manuscript and cursive. The authors only used the assessment of manuscript in this study. The test-retest reliability coefficients of this test for first-grade and second-grade students are .63 for total numeral legibility, .77 for total letter legibility, and .71 for total word legibility. The authors used two-way repeated-measures analysis of variance for data analyses. The authors concluded that kinesthetic training did not improve handwriting or kinesthesis in the children.

This study only used the kinesthetic intervention proposed by Laszlo and Bairstow and may not have represented all of the available kinesthetic interventions used by school-based occupational therapists. The study only examined children with kinesthetic or handwriting difficulties, the results may have been different with those children suffering from learning disabilities, emotional impairments, attention deficits,

sensory integration disorders, etc. Finally, the study did not provide controls for activities performed outside of the classroom. For instance, some of the children may have spent more time working on handwriting in class than others. Since the authors concluded that the finding of this study offered no support for the use of kinesthetic training to improve handwriting legibility in first-grade students, implications for further research are evident.

Multisensory Approach to Handwriting Remediation: Perceptions of School-Based Occupational Therapists

In 2002, Woodward and Swinth completed a study to determine what multisensory modalities and activities U.S. school-based occupational therapists currently use in the remediation of handwriting problems in school-age children and to compare these practices to current literature on the subject. For the purpose of the study, multisensory approach to handwriting remediation involves using a variety of sensory experiences, media, and instructional materials to control the sensory input and tap into the child's sensory systems, including the proprioceptive, vestibular, tactile, visual, auditory, olfactory, and gustatory senses (Amundson & Weil, 1996). A sample of 313 occupational therapists out of approximately 5,000 was randomly selected by the American Occupational Therapy Association's (AOTA) direct mail service. Therapists eligible for selection were those members who identified themselves as working in a school system as their primary employment setting, recognizing however, that their employer may be a hospital or private clinic; they may be an independent contractor with the school system, or both. Of the 313 surveys that were sent out, 198 were returned and analyzed descriptively, resulting in a response rate of 63.3%.

Each therapist in the sample received a three-part survey by mail. The first part focused on demographic information. The second part consisted of a list of 25 multisensory modalities and activities and a 5-point Likert scale for respondents to indicate the frequency of use of each modality and activity. It also included three-close ended questions and one open-ended question in order to expand/explore the 25 modalities and activities. The third part of the survey was a comment section, asking respondents to clarify, add to, or comment on any of the survey's contents. The survey was designed for one-time use; therefore, reliability and validity are unknown. Content of the survey was based on an extensive literature review and feedback from the researcher's faculty advisor and five pilot study participants with extensive experience in schools, research, or handwriting remediation.

The authors analyzed the data with the Statistical Package for the Social Sciences (SPSS, 1995). Frequency distributions were used to describe the sample demographics, the use of each of the 25 modalities and activities and the primary sensory systems the respondents believe each modality and activity addresses, the number of modalities and activities used per student, and the characteristics of the rationale described in response to the open-ended question. Measures of central tendency were used to describe mean years of experience and mean caseload. The authors of the study believe that a multisensory approach to treating children with handwriting problems is important and a frequent part of practice for school-based occupational therapists as indicated by the significantly large percentage of respondents (92.1%) that report to use this approach. More than 130 different multisensory modalities and activities were mentioned in the data of the study. Twenty-five of these had previously been reported in the literature, the other 114 were

documented, by respondents, within the "other" category. Most respondents reported using 5 or more modalities and activities per student, the most frequent being chalk and chalkboard. No consensus among respondents is apparent about the primary sensory system stimulated by the modalities and activities. Therefore, the authors of the study concluded that the large variety of modalities and activities being used is far greater than what is currently reported in the literature and further research needs to be done.

The major limitations of the study that were reported by the authors were the unclear wording of certain survey questions, all respondents being members of AOTA, and missing data. The authors should have provided the respondents with a universal definition of multisensory approach to handwriting, versus assuming the respondents knew what they were looking for. Also, since the sample was of convenience and only consisted of AOTA members, the results may not represent all school-based therapist. Due to these limitations a modified survey that represents a larger population should be sent out in the future. Also, future research that examines the effectiveness of the modalities and activities used to treat handwriting is still needed.

Need for the Study

In 1994, Chandler analyzed surveys that were returned from more than 900 school-based occupational therapists across the United States and found that the most common reason for referral to occupational therapy was handwriting problems. However, as can be seen from above, occupational therapy literature is full of different strategies and theories to promote good handwriting in school-age children. It can be difficult for occupational therapists to know what type of treatment is really the best and will be the most effective in treating handwriting. The goal of this study is to provide a

pilot-study that may help to answer this question in the future. Results from this study might then help school-based occupational therapists to answer whether using both sensory integration and a highly recommended handwriting program that is reported to be used by many therapists is an efficient way to treat handwriting. At the same time, if using this technique proves to be successful, it can then be used with students who display poor handwriting at any age. This could then possibly decrease the number of adults who display poor handwriting because it will decrease the amount of poor handwriting habits that are picked up as a child and then carried over as an adult.

Also, other than the information published by Olsen, there have been no studies that explore the effectiveness of "Handwriting Without Tears." According to Olsen, the program is widely used by therapists, so it would be beneficial to have some more literature about it.

Research Question

The purpose of this study is to answer two questions. First, is "Handwriting Without Tears" an effective way of teaching handwriting to elementary school-aged children with learning disabilities? Also, does providing proprioceptive input before implementing "Handwriting Without Tears" have an effect on the legibility and accuracy of handwriting in elementary school-aged children with learning disabilities?

CHAPTER III

METHOD

Participants

The students for the study were recruited from children who had been referred to the researcher's caseload through the Ingham Intermediate School District, which services the greater Lansing area in Michigan. The students were representative of four of the districts within the intermediate school district. Parents signed informed consent forms, and the students signed assent forms that were read to them before participation in the study occurred. Both of these forms and the study were approved by the Human Subjects Institutional Review Board (HSIRB) of Western Michigan University before any part of the study was completed. Please see the Appendix for the HSRIB approval letter. Also, approval from the private investigators supervisor, and administrators from each of the four districts was received.

Three first-grade and three second-grade students were recruited and consented to participate in the study. None had diagnosed medical conditions or vision or hearing problems. In addition to parent consent, the inclusion criteria for the students in the study were: (1) received special education and occupational therapy services, (2) had handwriting goals on their individualized education plan (IEP), and (3) demonstrated cognitive function within normal limits as documented in the school files. Of these six children five were males and one was female. However, it should be noted that the female only completed the first three weeks of the study, due to relocation of her family to a different school district. Therefore there were only five sets of scores recorded in the data.

As the student's parent consent forms were turned in the students were randomly assigned to treatment groups. For example, when child 1's consent form was turned in they were placed in either treatment Group A or treatment Group B by the use of a coin toss (heads was Group A, tails was Group B). If they were placed in Group B, then child 2 automatically went into Group A. A coin toss was then done again for child 3 and child 5. Thus, the study started with 3 students in each group. However, due to the one student moving, Treatment Group A only had 2 children complete the entire study.

Instruments

Data was collected using two different instruments: the Minnesota Handwriting Test (MHT; Reisman, 1999) and handwriting samples from weeks 3- 8. The handwriting samples were analyzed to show any change that may have occurred on a per treatment basis.

As mentioned above, Cornhill and Case-Smith (1996) completed a study that suggested that the MHT is a valid test of handwriting performance. Therefore it was chosen for this study. The MHT was developed to quantify selected aspects of students' printed handwriting samples in order to support other subjective judgments of poor quality and slow rate. The MHT results in six different scores: rate score, legibility score, form score, alignment score, size score and spacing score. The MHT was standardized with a sample of 1,100 first and 926 second graders from 9 states (Reisman, 1999). Reliability and validity studies are reported in the test manual; interrater reliability between experienced scorers was .99 for the total sample, with a range of . 90 on form, which is more subjective, to .99 for alignment and size, which is measured using

a ruler. Test-retest reliability over a 1-week interval was .72 for accuracy and .50 for speed.

In order to measure progress on a weekly basis, weekly measurements were also taken from the handwriting samples collected from the actual treatment intervention. Measurements were taken starting with week 3 when sentences were written. Measurements were not taken for week 1 and 2 because of the procedures for administering the "Handwriting Without Tears" program. The first week focuses only on capital letters, and since only 5 lower case letters were taught during the second week, there were no sentences that could be scored. Beginning with week 3, part of the "Handwriting Without Tears" program consists of writing three sentences as a part of a review of the previously learned letters. Thus the paper with the three sentences was measured. Measurement consisted of letter reversals, crossing either the top or bottom boundary line, and improper formation of a letter. These measurements were scored individually and then totaled for a total of four measurements for weeks 3-8. Due to the varying lengths of each sentence and amount of letters in each sample, a percentage of errors was then found for each measurement.

Procedure

The primary investigator, an occupational therapist, completed all testing, and made the subjective measurements from the weekly handwriting samples. However, to eliminate subject bias, a blind-reviewer scored both the pre-tests and post-tests from the MHT. The data was also mixed when the blind-reviewer received it. This way she could not assume anything about the differences in pre-tests and post-test. This reviewer was a PhD level occupational therapist trained in scoring the assessment. The standardized

instructions and procedures were used for test administration. All measures were completed in the first weeks of September and November, 2002. The study took place at the beginning of the academic school year in order to control for what the different teachers were doing in the classroom to work on handwriting.

Each student was evaluated during the regular school day in a separate room from their classroom. All testing was completed in single one-on-one sessions, approximately 30 minutes in length. During this time the students also wrote the alphabet in both upper-case and lower-case letters, numbers 1-10, and a sentence of their choice. However, these handwriting samples were not used for any types of measurement.

Intervention

Intervention was provided by the primary investigator. Treatment sessions were completed in a one-on-one session once a week and were 30 minutes long. Those students in treatment group A received a combination of proprioceptive input and the "Handwriting Without Tears" program during their treatment session. Those students in treatment group B received only the "Handwriting Without Tears" program. The entire study was a total of 10 weeks. During weeks 1 and 10, testing and observations were completed. Treatment was delivered during weeks 2-9.

Each child in the study learned/worked on the same letters each week and spent approximately 10-15 minutes working on handwriting. The only difference was that those children in treatment group A spent the first 10 minutes of their treatment session doing a proprioceptive activity such as, manipulating theraputty, doing animal walks, paper punching, and popping packaging bubbles. They then did their handwriting. Those children in treatment group B started out the treatment session with handwriting.

Then in order to stay in compliance with other IEP goals, treatment sessions were finished working on other fine motor activities such as cutting, tying their shoes, stringing beads, etc. The table below summarizes the schedule of weekly treatments within the two groups.

Treatment Week	Letters Addressed	Proprioceptive Activity
Treatment Week 1	Capital Letters	Activities with Theraputty
Treatment Week 2	Letters c, o, s, v, w	Animal Walks
Treatment Week 3	Letters t, a, d, g	Paper Punching
Treatment Week 4	Letters u, i, e	Popping Packaging Bubbles
Treatment Week 5	Letters l, k, y, j	Activities with Theraputty
Treatment Week 6	Letters p, r, n	Animal Walks
Treatment Week 7	Letters m, h, b	Paper Punching
Treatment Week 8	Letters f, q, x, z	Popping Packaging Bubbles

Table 3.1: Weekly Schedule of Treatment Activities.

Data Analysis

The data from each subject were analyzed using clinical description and visual analyses. Clinical description was used to find the mean age of the subjects. Line graphs were used to visually analyze the data collected from the weekly handwriting samples. Each measurement was analyzed individually, with each graph containing five different lines in order to represent each subject. Bar graphs were then used to visually analyze the data collected from the pre- and post-test scores. Each of the six different scores were analyzed individually, with each graph containing five different sets of bars in order to represent each subject. In all ten of the graphs, Subjects 1 and 2 represent treatment group A, and Subjects 3, 4, and 5 represent treatment group B.

CHAPTER 4

RESULTS

Clinical Descriptors

Of the original sample of 6 children, 5 (2 in treatment Group A, 3 in treatment Group B) completed the study. The one child that did not complete the study moved to a different school district. The five children that completed the study were all males. Two of them were in 1st grade, and the other 3 were in 2nd grade. The mean age of the 5 children was 89.8 months. However it should be noted that the age of four of the five students was between 82 and 88 months. The fifth child was 108 months old.

Visual Analysis

"Handwriting Without Tears"

Letter Reversals

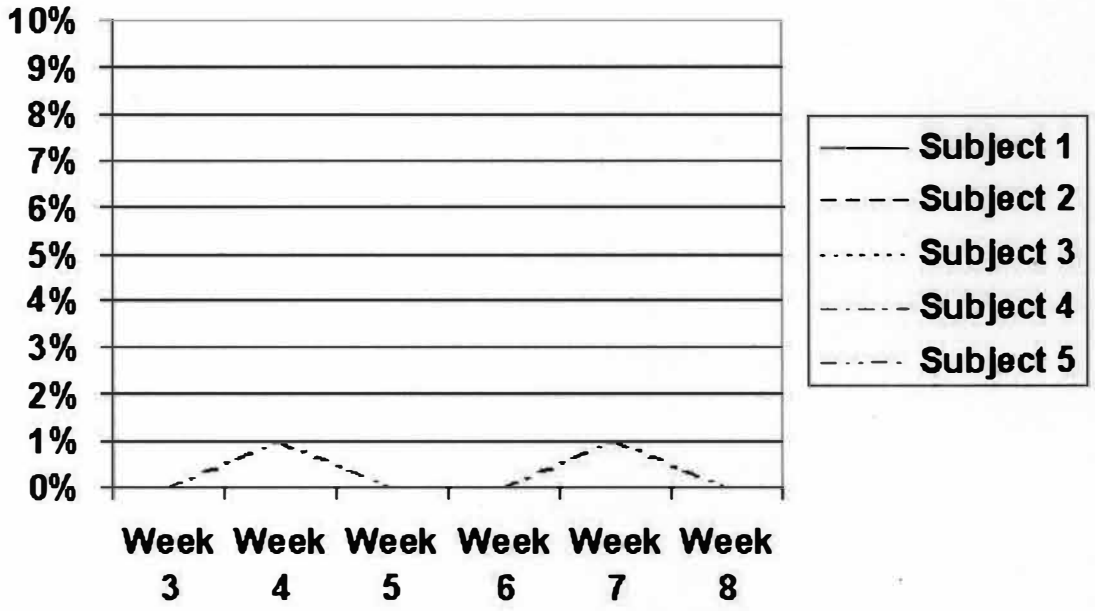

Figure 4.1: Percentage of Letter Reversals Over Six Week Intervention Period

Figure 4.1 shows that neither of the interventions had a substantial effect on the percentage of letter reversals during the last six weeks of intervention. Of the 5 subjects,

four of them did not have problems with reversing their letters and remained at baseline. Subject 4 reversed one letter in the week 4 and one letter in the week 7 writing samples.

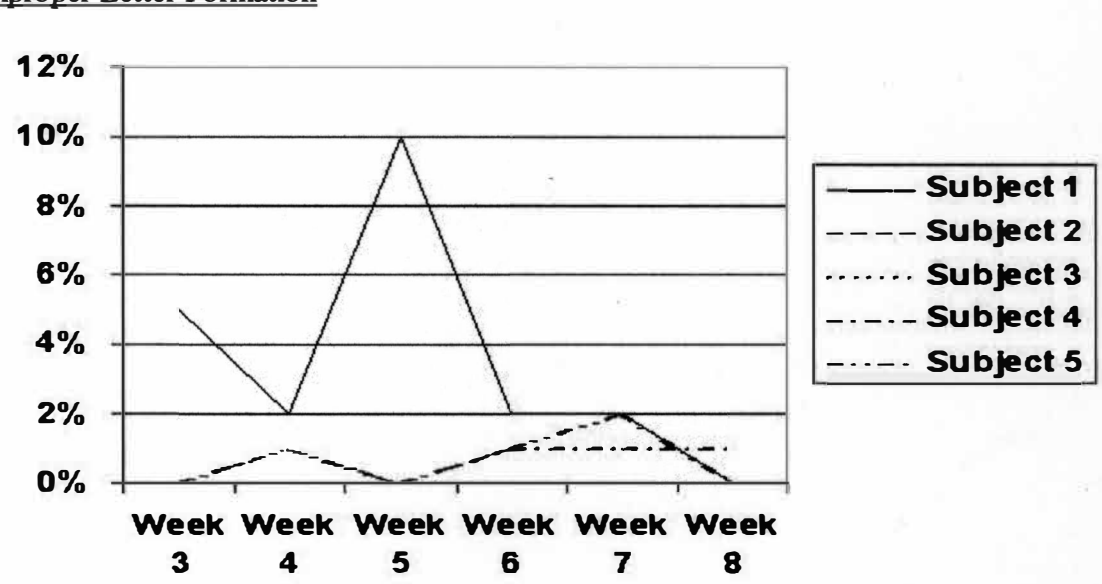

Figure 4.2: Percentage of Improper Letter Formation Over Six Week Intervention Period

Figure 4.2 shows that neither of the interventions had a substantial effect on the percentage of improper letter formation during the last six weeks of intervention. Of the five subjects, Subject 2 and Subject 3 remained at baseline the entire time. Subject 1 improperly formed 3 percent of their letters at week 3, 2 percent at week 4, but then went up to 10 percent at week 5. The following 2 weeks, Subject 1 dropped back down to 2 percent, and then reached baseline at week 8, and did not form any letters wrong that week. Although Subjects 4 and 5 both formed letters improperly throughout the intervention period, and there was a small amount of change. However, the change was not significant.

Letters That Cross the Line

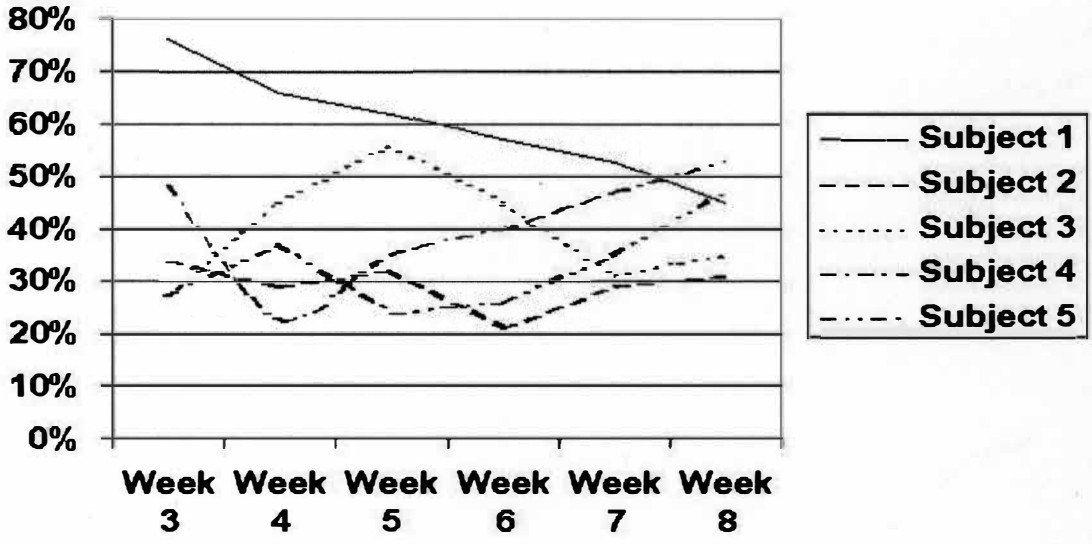

Figure 4.3: Percentage of Letters that Cross the Line Over Six Week Intervention Period

Of the five subjects, only Subject 1 demonstrated a substantial change in the number of letters that crossed the line during the last six weeks of intervention. At week 3, Subject 1 crossed the line with 76% of his letters. Over the following five weeks of intervention, his scores continued to drop, and at week 8, he only crossed the line with 45% of his letters. There was also a small change from week 3 to week 8 with Subject 2. He received a score of 34% of his letters crossing the line during week 3, and only 31% of his letters crossed the line during week 8. However, the percentage of letters that crossed the line for Subjects 3, 4, and 5 increased over the intervention period.

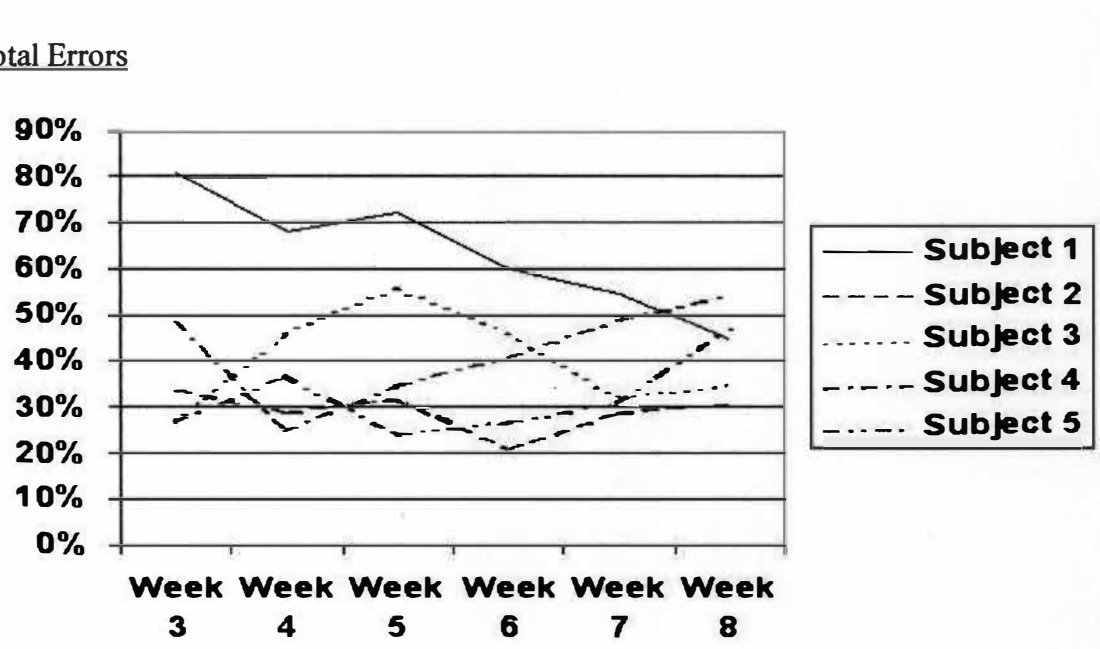

Figure 4.4: Percentage of Total Errors Over Six Week Intervention Period

Figure 4.4 shows similar results as figure 4.3. Subject 1 demonstrated a substantial change in the percentage of total errors during the last six weeks of intervention. At week 3, Subject 1's percentage of total errors was 81%. Over the following five weeks of intervention, his scores continued to drop, and at week 8, his total percentage of errors had fallen to 45%. There was also a small change from week 3 to week 8 with Subject 2. During week 3, his percentage of total errors was 34%, and at week 8, his percentage of total errors was 31%. It should be noted that Subject 2's percentage of total errors dropped as low as 21% during the intervention period. As in Figure 4.3 the percentage of total errors for Subjects 3, 4, and 5 increased over the intervention period.

Rate Score

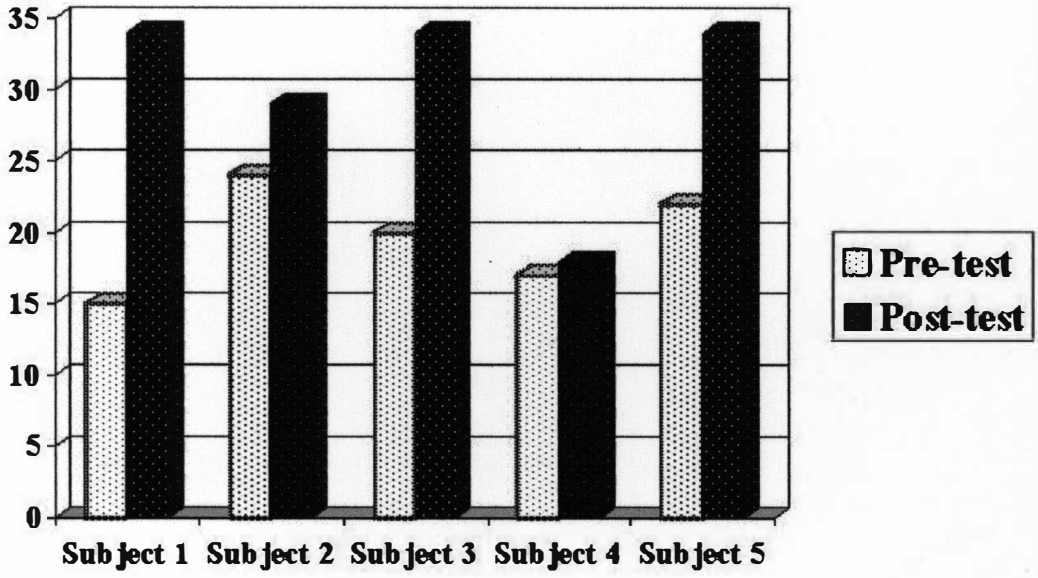

Figure 4.5: Rate Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.5 shows that all five subjects improved in Rate Score on the MHT. Subject 1 made the greatest amount of improvement going from a score of 15 to a score of 34. Although all five subject's scores improved, Subject 4 only improved by one point. Also Subjects 1, 3, and 5 all reached the maximum score available of 34 points. The average amount of improvement in rate score between the five subjects was 10.2 points. Thus both treatment interventions appear to have had a positive effect on the rate of handwriting for all five subjects.

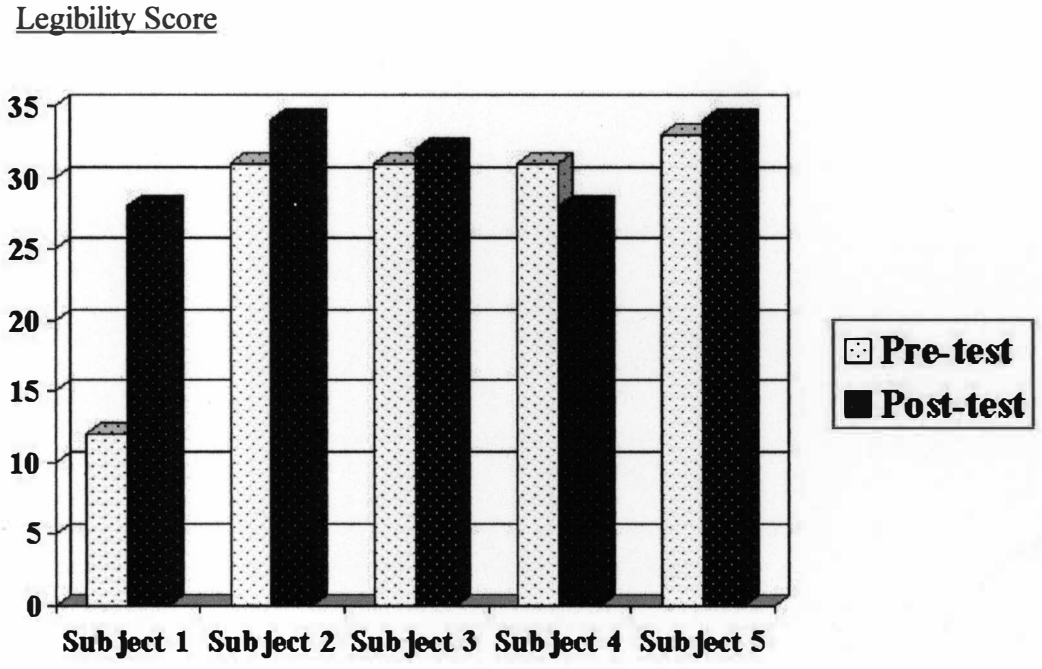

Figure 4.6: Legibility Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.6 shows that four out of the five subjects improved in their Legibility Score on the MHT. Subject 1 made the greatest amount of improvement going from a score of 12 to a score of 28. Subject 4's score decreased by an amount of 3 points. Subjects 2 and 5 reached the maximum score available of 34 points. The average amount of improvement in legibility score between the five subjects was 3.6 points. Although Subject 4's scores went down between the pre-test and post-test, overall both treatment interventions appeared to have had a positive effect on the legibility of handwriting.

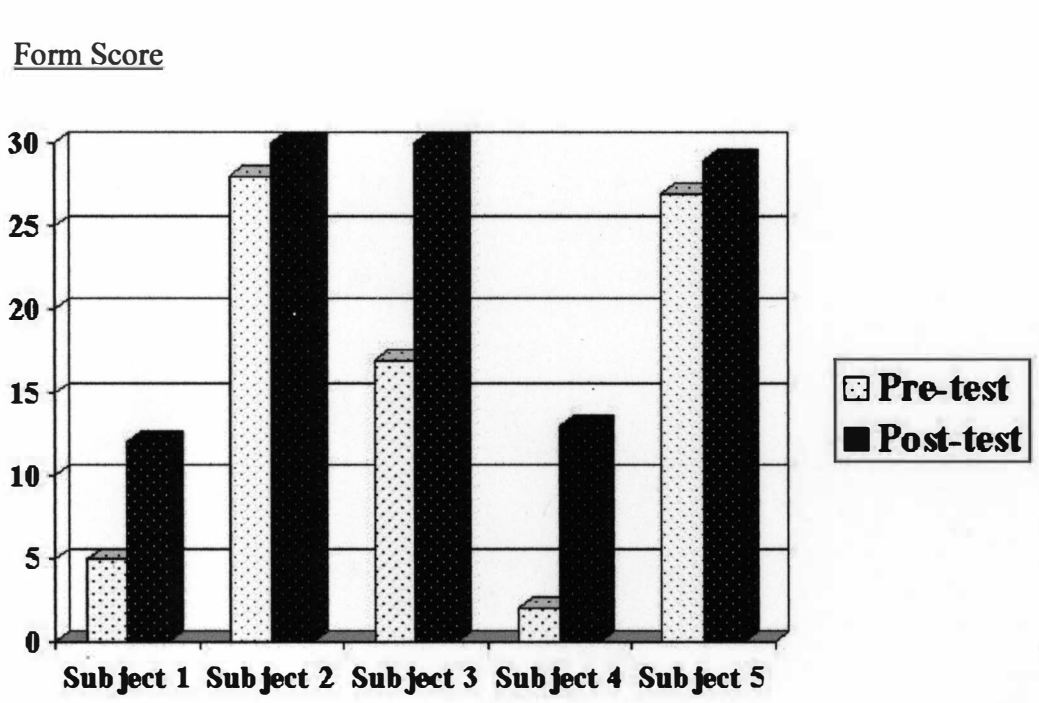

Figure 4.7: Form Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.7 shows that all five subjects improved in Form Score on the MHT. Subject 3 made the greatest amount of improvement going from a score of 17 to a score of 30. The smallest amount of improvement was only two points, which was done by Subjects 2 and 5. The average amount of improvement in form score between the five subjects was 7 points. Thus both treatment interventions appear to have had a positive effect on the form of handwriting for all five subjects.

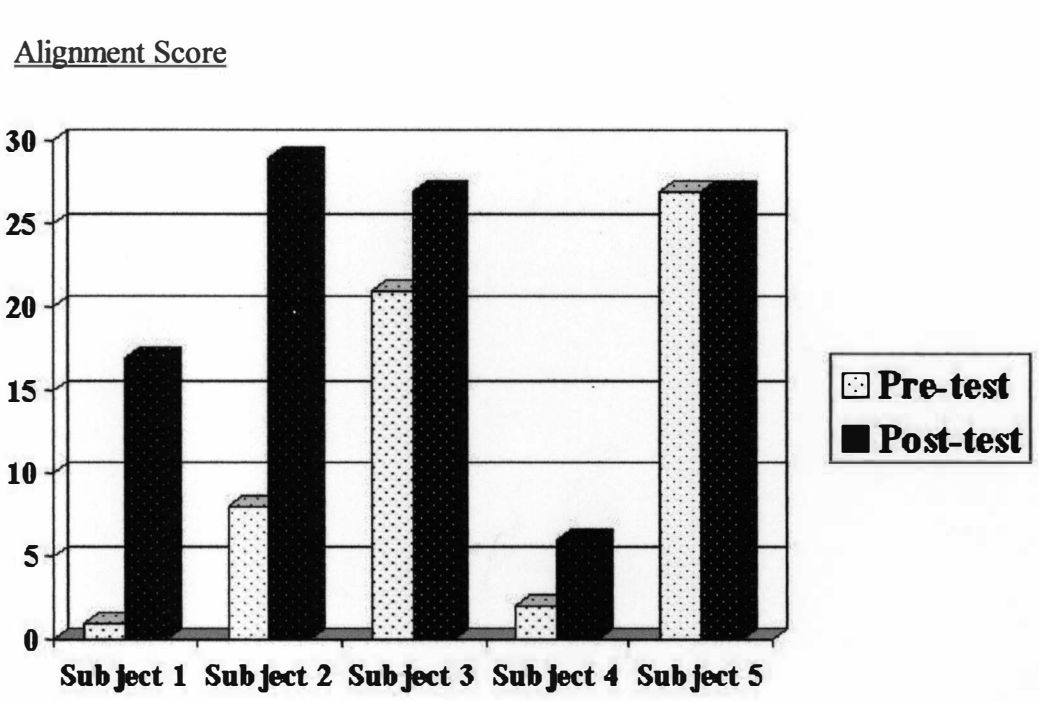

Figure 4.8: Alignment Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.8 shows that four of the five subjects improved in Alignment Score on the MHT, and Subject 5's score stayed the same. Subject 2 made the greatest amount of improvement going from a score of 8 to a score of 29. The average amount of improvement in alignment score between the five subjects was 9.4 points. Although Subject 5's scores showed no change between the pre-test and post-test, overall both treatment interventions appeared to have had a positive effect on the alignment of handwriting.

Size Score

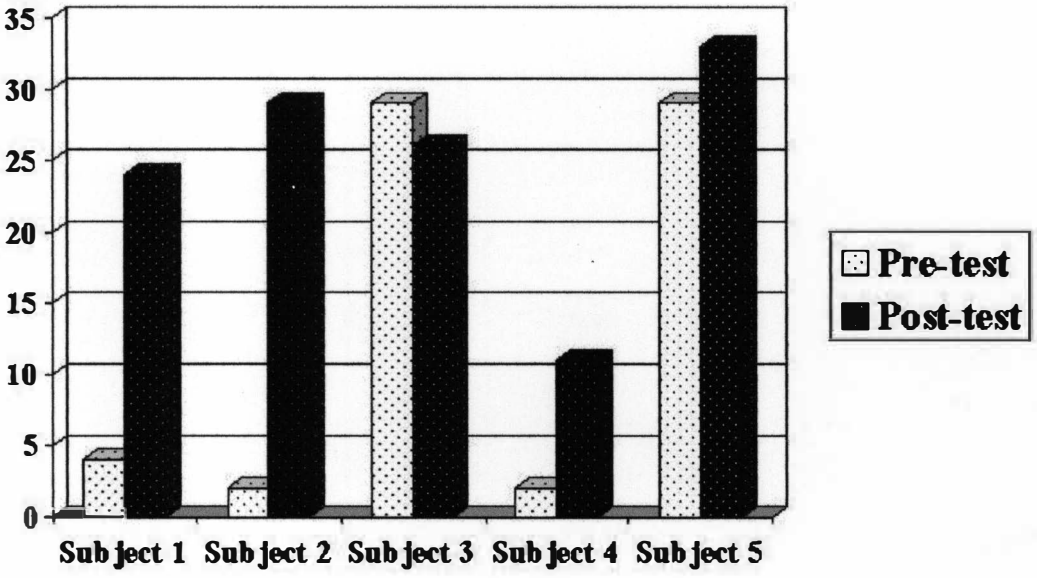

Figure 4.9: Size Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.9 shows that four out of the five subjects improved in their Size Score on the MHT. Subject 2 made the greatest amount of improvement going from a score of 2 to a score of 29. Subject 3's score decreased by an amount of 3 points. The average amount of improvement in size score between the five subjects was 11.4 points. Although Subject 3's scores went down between the pre-test and post-test, overall both treatment interventions appeared to have had a positive effect on the legibility of handwriting.

Spacing Score

Figure 4.10: Spacing Score of Pre- and Post-Tests of Minnesota Handwriting Test

Figure 4.10 shows that three out of the five subjects improved in their Spacing Score on the MHT, and Subject 5's score stayed the same. Subject 1 made the greatest amount of improvement going from a score of 4 to a score of 21. Subject 2's score decreased by an amount of 8 points. The average amount of improvement in spacing score between the five subjects was 3.4 points. Although Subject 2's scores went down between the pre-test and post-test and Subject 5's scores stayed the same, overall both treatment interventions appeared to have had a positive effect on the spacing of handwriting.

CHAPTER 5

DISCUSSION

"Handwriting Without Tears"

Of the five subjects, only one child (Subject 1) demonstrated substantial improvement on visual analysis of the four different weekly measurements that were taken during the intervention period. However, Subject 2 also demonstrated a very minute amount of positive change on visual analysis of the four different measurements. Both of these subjects were in Treatment Group A, and received proprioceptive input prior to working on the handwriting worksheets.

On the other hand, the other three subjects from Treatment Group B, who only completed the handwriting worksheets did not show any improvement on visual analysis of the four different weekly measurements that were taken during the intervention period. There was change from week to week, but the change was not consistent for all three subjects. Their scores fluctuated from week to week, i.e., going down one week, but then going back up the next week. Also, for all three of the subjects, their scores for week 8 were higher than their scores for week 1.

The improvement that occurred over the eight weeks of intervention in both subjects of Treatment Group A could be due to the proprioceptive input that the received before writing. The different activities could have served to warm-up their muscles before they wrote. Also since the proprioceptive activities were done for eight weeks, the students strength and endurance may have improved, causing the improvement in handwriting. This supports what Parush, Pindak, Hahn-Markowitz, and Mazor-Karsnety (1998) found and that fatigue can effect the performance of handwriting. However, since

the visual analysis does not show a large amount of improvement in both of the subjects, this conclusion may not be statistically significant.

Minnesota Handwriting Test

All five of the subjects demonstrated some amount of trend changes on visual analysis of one or more of the MHT scoring areas following intervention. However, in only one of the five subjects was the change in each score large enough to yield substantial change overall. Of the six different scoring areas, all five subjects showed improvement in rate score and form score. There was also no negative change in alignment score, however, Subject 5's score between pre-test and post-test stayed the same.

When comparing the average amount of change in scores between treatment groups, Treatment Group A appeared to show the most improvement in five of the six different scores. The average amount of change in rate score for Treatment Group A was 12 points, and for Treatment Group B it was only 9 points. For legibility score, Treatment Group A's average was 9.5, and Treatment Group B's was 1.6. It should be noted that one of the subject's score in Treatment Group B dropped 3 points on the legibility score. The average amount of change in alignment score for Treatment Group A was 18.5, and only .3.3 for Treatment Group B. For size score, Treatment Group A's average amount of improvement was 23.5, and Treatment Group B's was 3.3. Again, one of the subject's score in Treatment Group B dropped by 3 points. The final score that Treatment Group A improved more than Treatment Group B was the space score, where there was a difference of 1.8 points in the averages between the groups. The one score that Treatment Group B appeared to make a larger improvement than Treatment Group A

was form score. The average change from Treatment Group B was 8.7 and only 4.5 for Treatment Group A. Thus, it appears that the results support the above mentioned literature and using the combination of sensory integration training and a handwriting program to work and a child's handwriting.

Limitations

The major limitations to this study were the sample size, only one gender and the use of a very small geographic region. Also, the use of only descriptive and visual analysis limits the interpretation of how effective the two interventions really were, and if they were effective, why. Information about each subject's academic program and other services was not collected, thus making it difficult to control for the different teaching styles in the five different classrooms. Although the pre-tests and post-tests of the MHT were scored by a blind reviewer, they were completed by the private investigator, who was not blind to the group status of each student. Finally, the unequal size of the two treatment groups creates problems in data analysis.

Implications for Further Research

The results of this study indicated the more research is needed in order to determine if using proprioceptive input and "Handwriting Without Tears" is an appropriate intervention when treating handwriting. In order to do a study that has higher generalizability you could use one classroom in several different schools and divide each classroom in half. One half would receive Treatment A, and the other half would receive Treatment B. This would then increase the sample size and help to control for what is also going on in the classroom. You could then compare the different treatment groups,

but also the different classroom results to see if teaching style or geographic region makes a difference in the effectiveness of the intervention.

Conclusion

The visual analysis of both the "Handwriting Without Tears" and the MHT suggest that the combination of proprioceptive input and "Handwriting Without Tears" may be more effective when treating the handwriting of elementary-aged students. On the other hand, the variance in the results across the measurements taken during weekly intervention, and across the scores of the MHT make it difficult to draw conclusions that can be generalized about the effectiveness of the two different treatment techniques. When looking at the average amounts of change on the six different scores of the MHT, there was an increase in each score. Therefore, these results suggest that the "Handwriting Without Tears" program does effect handwriting in a positive way. However, the extent and scope of this effect are still inconclusive.

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Appendix

Approval Letter From the Human Subjects Institutional Review Board

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Centennial
1903-2003 Celebration

Date: August 16, 2002

To: Diane Dirette, Principal Investigator
Jodie Guy, Student Investigator for thesis

From: Mary Lagerwey, Chair Mary Lagerwey

Re: HSIRB Project Number 02-07-02

This letter will serve as confirmation that your research project entitled "Effect of Proprioceptive Input Combined with "Handwriting Without Tears" on the Handwriting of Children with Learning Disabilities" has been **approved** under the **full** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: July 17, 2003

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