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**THE EFFECTS OF FINE AND GROSS MOTOR OCCUPATIONS
ON HANDWRITING LEGIBILITY OF FIRST GRADE STUDENTS**

**A Master's Thesis presented to the Faculty of the
Graduate Program in Occupational Therapy
Ithaca College**

**In partial fulfillment of the requirements for the degree
Master of Science**

by

Patricia A. Cole

October 05

Ithaca College

School of Health Science and Human Performance

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CERTIFICATE OF APPROVAL

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Abstract

The purpose of this study was to determine if participation in fine motor or gross motor occupations prior to handwriting instruction affect first grade students' handwriting legibility as measured by the Test of Handwriting Skills (Gardner, 1998). A convenience sample consisting of 52 students between the ages of 5 and 7 from 4 first grade classrooms were assigned to one of two pre-writing programs or to control groups. One pre-writing program was based on Mary Benbow's approaches and included neurokinesthetic fine motor strategies (Benbow, 1995). The second pre-writing program was modified from Mary Benbow's gross motor approaches (Benbow, 1995) and Brain Gym methods (Dennison & Dennison, 1986) to consist of neurokinesthetic gross motor strategies. The classroom teachers conducted the pre-writing programs daily for 3 consecutive weeks prior to typical handwriting instruction in the classrooms. The participants in the two control classrooms were pre- and post-tested for comparison with students in the pre-writing program classrooms, but no modifications to the classroom programs were made.

At the conclusion of the program, a statistical correlation between groups was demonstrated on 1 out of 10 subtests on the Test of Handwriting Skills. No statistically significant differences were noted between classes in handwriting legibility on the other 9 subtests of the Test of Handwriting Skills. These results suggest that the addition of a motor program prior to handwriting instruction does not affect legibility in any of the conditions stated in the research questions. There is a need for future research related to prewriting programs for the purposes of handwriting acquisition.

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Chapter 1: Introduction

Background

Handwriting is perhaps the most complex occupation mastered by human beings. Handwriting requires a highly developed coordination of cognitive thoughts, visual feedback scanning, fine and gross motor skill coordination, language processing, tactile perception, and meaning association (Exner, 1989). Like other learned skills, appropriate environmental factors as well as basic abilities must be integrated for optimal functioning (Cunningham Amundson, 1992).

McHale and Cermak (1992) reported that students spend approximately 30-60% of their class time at school engaged in fine motor tasks such as coloring, cutting, and pasting. Of significant concern is “that 10-34% of school-aged children experience difficulties with handwriting due to a variety of challenges” (Rosenblum, Weiss, & Parush, 2003, p. 44). Since fine motor tasks are such an integral part of elementary education it is likely that the quality of a child’s skill of handwriting will affect academic performance (Rosenblum, et al., 2003). Schweltnus & Lockhart (2002) suggest that difficulties with the mechanics of writing may interfere with the development of written language skills. Ultimately, deficits in fine motor skills can lead to lowered self-esteem and frustration, as well as poor school performance (McHale & Cermak, 1992).

Although handwriting encompasses a large portion of a student’s day, it is not often taught in uniform and structured manners in the public school system. For example, classrooms vary significantly in length of time and frequency of days allocated for handwriting instruction due to teacher style, classroom organization, and curriculum used (McHale & Cermak, 1992). The format of handwriting instruction also varies in that

handwriting may be emphasized in a structured manner three days of the week and assessed only through homework assignments two days of the week. The classroom variation related to learning to write appears to be a widespread concern of teachers, parents, and therapists (Ediger, 2001).

A major arena of occupational therapy service provision is work with school-aged students who have delays in acquisition of skills needed for classroom occupations (Cunningham Amundson, 1992). School-based occupational therapy intervention focuses on the student's potential for participation and learning in the school environment. Without development of appropriate fine and gross motor skills, functional activity and learning could be a major challenge. Handwriting is one such skill that is dependent on adequate development of fine and gross motor skills. "Children's handwriting performance is of concern to occupational therapists, educators, and parents because it is an essential skill required to participate in educational activities successfully" (Sudsawad, Trombly, Henderson & Tickle-Degnen, 2002, p. 26). Therefore, acquiring and maintaining proper handwriting skills is integral to academic success, and handwriting dysfunction is the most commonly treated problem in school-based occupational therapy.

Occupational therapists as well as educators are concerned with handwriting and its impact on a student's environmental demands since "learning to write legibly is a major occupation of childhood" (Cunningham-Amundson, 1992, p 63). The new English Language Arts test (E.L.A.) and Scholastic Aptitude Test (S.A.T.) require students to respond in essay form to open-ended questions (Einhorn, 1999). Research indicates that legible essays are assigned higher grades than essays with poor penmanship even though

both essays have a comparable level of content (Graham, Harris & Fink, 2000b; Peterson & Nelson, 2003). Legible handwriting is also necessary for successful completion of daily occupations such as writing messages, taking notes in class, completing examinations, and homework assignments (Feder, Majnemer, & Synnes, 2000; Woodward & Swinth, 2002). The present educational milieu is comprised of children with diverse developmental levels taught collectively in the classroom. The variation of ability levels within one classroom requires that handwriting instruction be carefully considered and examined by the teacher. When handwriting presents a barrier to a child's education, occupational therapists may be called upon by teachers for added support in this area. Teachers and OTs should monitor the students' handwriting ability, and also "focus on the skills and subskills necessary to ensure consistent success with this high-level skill" (Benbow, 1995b, p. 256). An occupational therapist's role in the school setting is to aid in this skill proficiency so that students will benefit from the entire educational experience. "By integrating strategies to address students' needs into daily routines and activities, occupational therapists can help ensure that the student achieves success at school" (Polichino, Clark, & Chandler, 2005, p. 15).

Since handwriting is the principal method used by an elementary aged student to express his or her learning in all scholastic subjects (Case-Smith, 2002), it is important to remediate areas of deficit before secondary failures ensue. "Handwriting research has identified what factors are correlated with poor handwriting, but little research has tested the efficacy of handwriting interventions in controlled experiments" (Peterson & Nelson, 2003, p. 153). Therefore, occupational therapists must rely on untested theories and models of practice as a basis for treating handwriting.

Several theories, models, and practices have been proposed to support handwriting in school-aged children (Case-Smith, 2002). The most frequently used classroom-based curricular programs include Zaner-Bloser, D'Nealian, and Palmar penmanship programs (Gardner, 1998). To supplement these programs occupational therapists utilize focused approaches based on perceptual motor, visual motor, ergonomic, kinesthetic, and multisensory techniques. Feder, et al. (2000) found that most therapists use an eclectic approach to treatment, with a sensorimotor approach used more consistently. "Although theories and strategies to remediate handwriting problems have proliferated in recent years, empirically based evidence documenting handwriting intervention effectiveness is minimal" (Case-Smith, 2002, p.17; Clark-Wentz, 1997; Graham, Harris, & Fink, 2000a).

Other theories for treating students with handwriting difficulties are summarized in the literature, and include sensory integration, motor learning, perceptual-motor, and cognitive-behavioral methods. Even with this wide selection, there is minimal consensus on the most effective treatment strategy (Bonney, 1992). One of the most popular strategies is the neurokinesthetic approach. The neurokinesthetic approach is based on the premise that it is easier to complete fine motor tasks after motor input to the body. In keeping with the kinesthetic school of thought, gross motor training preceding handwriting instruction should increase legibility. Kinesthesia is the "sense of movement and position of the limbs that arises from information from the muscles, joints, and skin" (Sudsawad, et. al., 2002, p. 26). Use of the child's kinesthetic sense and the development of postural reactions are core concepts. It is believed that kinesthesia and postural reactions provide the stability needed for hand and finger mobility (Levine, 1991). For

example, without good postural alignment, balance and symmetry of the hand will be compromised and would result in poor handwriting ability. “Through movement the child acts upon his or her external environment and receives internal impressions” (Etemad, 1994, p.11; Woods, 2001). Activation of the whole body is presumed to have physiological effects on the child that will help him or her to attend to task (Etemad, 1994). Benbow is a major proponent of the kinesthetic approach (Hopkins & Smith, 1993) and has designed many pre-writing tasks to increase skill. Research has shown that handwriting can be enhanced by developing specific perceptual and motor skills integrated into movement activities (Addy, 1996; Dennison & Dennison, 1986; Grabmeier, 2005; Lacey, 2002; Levine, 1991; Sheffield, 1996). There is speculation about whether gross and fine motor kinesthetic work or repeated handwriting practice is more effective at treating handwriting deficits (Sudsawad, et al., 2002; Cunningham Amundson, 1992; Feder, et al., 2000). Although the kinesthetic approach is widely used, there are authors who suggest that repeated handwriting practice is more effective than the use of gross and fine motor kinesthetic work (Manning, 1988; Milone & Wasyluk, 1981; Peterson & Nelson, 2003).

Programs for use in classrooms have been developed based on sensory motor activities, and support the concept that gross motor input is necessary prior to fine motor participation (Kerr, 1995). One such program is the Alert Program. The foundation of the Alert Program focuses on helping children learn to recognize, monitor and change their level of alertness appropriate to task demands. In order “to attend, concentrate, and perform tasks, one's nervous system must be in an optimal state of arousal” (Barrett

Family Wellness Center, 2005). As stated by the designers of the Alert Program for Self Regulation:

"If your body is like a car engine, sometimes it runs on high, sometimes it runs on low, and sometimes it runs just right. The main idea shaping this program involves students learning what they can do before a spelling test or homework time to attain an optimal state of alertness for their tasks" (Williams & Shellenberger (1994), as cited in TherapyWorks, 2005, para. 3).

Techniques from the Alert Program facilitate students' and teachers' identification of the connection between states of arousal, attention, learning, and actions, which may be integrated into classroom instruction ("How does your engine run," 2000). The Alert program, therefore, encourages students to hone their self-monitoring skills as a means for improving handwriting and other academic abilities.

Henderson & Pehoski (1995) believe that children do not require a gross motor prerequisite prior to fine motor performance. The traditional approach of learning through practice supports this concept since most children are relatively skilled at writing by the age of six or seven years (Cox, 1999; Cunningham Amundson, 1992; Manning, 1988). Many methods of handwriting instruction involve repetition and tracing, and in general, educational theory promotes skill acquisition through rote practice (Milone & Wasyluk, 1981; Peterson & Nelson, 2003; Woods, 2001). Marr & Cermak (2003) believe that "developmental maturation, academic instruction, and practice may account for any initial lack of skill" (p. 161). The traditional education approaches strengthen the understanding that writing may be improved through practice, repetition, feedback, and

reinforcement (Cunningham Amundson, 1992; Milone & Wasyluk, 1981; Peterson & Nelson, 2003, p. 154).

The relative lack of research in the area of handwriting acquisition results in an inadequate understanding of how to prepare children for the handwriting process. To compound the problem, handwriting is no longer a primary emphasis in the curriculum for educational degree programs (Gladstone, 2000). As a result, teachers may not be up to date on current research and approaches for teaching handwriting (Gladstone, 2000; Starr, 2005). Handwriting instruction should be a collaborative process in which all members of the educational team (i.e. teacher, therapist, parent(s), student) contribute (Hammerschmidt & Sudsawad, 2004).

Although there are many research articles on handwriting, very few are directed at the issue of preventing handwriting deficits through occupational therapy service delivery. Findings from studies indicate that “supplementary handwriting instruction early in the primary grades may be a critical factor in preventing writing difficulties, at least for children who do not master it easily” (Graham, et al., 2000b, p. 621). The effects of participating in gross or fine motor occupations prior to engaging in handwriting have not been clearly established in the literature (Case-Smith, 2002; Sudsawad, et al., 2002). It would be beneficial to occupational therapists, educators, parents, and children to understand which precursors are more effective for improving handwriting legibility.

Problem Statement

There is limited evidence regarding the effects that gross motor or fine motor preparation programs have on first grade students’ handwriting legibility. Research is needed to discover if either fine or gross motor occupations incorporated into a student’s

school day will improve a child's performance in skills such as handwriting. Handwriting is a primary occupation in which a child engages to express his or her learning. By gaining knowledge in this area occupational therapists will begin to understand how students acquire more legible handwriting skills. This knowledge will allow therapists to plan treatment sessions that will be most effective to help a student communicate his or her understanding of academic content.

Rationale

“Educators and occupational therapists need to know whether poor handwriting ability is a consistent trait in early elementary students so that appropriate classroom strategies and therapeutic interventions can be developed” (Marr & Cermak, 2003, p. 161). Research conducted by Watson (1997), showed that “85% of elementary school class time is spent on paper-and-pencil tasks and 15% of class time spent on manipulative tasks” (p. 163). This emphasis on paper-and-pencil tasks raises the question of whether or not students with fine motor difficulties are receiving appropriate handwriting instruction and education in the standard classroom (McHale & Cermak, 1992). Two approaches being purported for the acquisition of children's handwriting skill are: (1) gross motor activity as a precursor to development of fine motor skill and (2) fine motor practice.

Etemad (1994) theorizes, “students who are actively engaged in their own learning tend to retain and grasp information better than those who process information only through visual or auditory channels” (p. 3). Consequently, Etemad (1994) suggests that movement is a necessary component that needs to be incorporated into the classroom schedule in order to enhance the learning process. Conversely, proponents of fine motor work suggest that the traditional method of teaching handwriting through practicing

strokes is most beneficial for competency in handwriting (Cox, 1999; Manning, 1988). Advocates for fine motor strategies also support the idea that printing can be improved through practice, repetition, feedback, and reinforcement (Milone & Wasylyk, 1981; Peterson & Nelson, 2003, p. 154).

Elementary school children in typical classrooms are being encouraged at an early age to conform to formal skills and classroom expectations such as prolonged periods of sedentary activity completing seatwork requiring that the students sit still for extended and unsafe periods of time while working on fine motor skills (Lacey, 2002). Nonetheless, Cunningham Amundson (1992), Kaminsky & Power (1981), and Marr & Cermak, (2003) recognize that periods of stationary activity during which practice and repetition of letter formation are reinforced may promote legible penmanship. Evidence has found that “90% of children with learning difficulties demonstrate fine motor and handwriting difficulty” (Watson, 1997, p. 163). With such a substantial number of students displaying difficulties, and with a significantly shortened amount of time allocated to handwriting instruction in the classroom, there are many concerns about whether these students are receiving proper handwriting instruction (McHale & Cermak, 1992).

This study addressed handwriting programs that incorporated large motor or fine motor occupations and investigated whether one motor program is more effective than the other. Although multiple skills are involved in handwriting this study investigated readiness of the body, rather than concentrating on factors such as cognitive processing or visual-perception.

Outcomes of this study may impact the strategies and methods used by occupational therapists and educators in the school system. If results are significant it could lead to proposing changes in the handwriting curriculum. Results will also be able to help school-based occupational therapy clinicians determine the best approach to handwriting intervention. If it is demonstrated that participation in gross or fine motor occupations improves a student's handwriting legibility, therapists and teachers will be able to utilize the most effective handwriting technique within the classroom.

Purpose of Study

The purpose of this study was to evaluate whether participation in gross or fine motor occupations prior to handwriting affected first grade students' handwriting legibility as assessed by the Test of Handwriting Skills by Morrison Gardner (1998). By discovering the effects of gross or fine motor occupations, a therapist could begin to understand the most appropriate type of intervention to utilize for remediating handwriting dysfunction.

Key Terms

Gross Motor Skills: producing an action involving "large muscle groups," for the purpose of controlled, goal-directed movements, as in "balancing, running, and throwing" (Thomas, 1997, p. 825).

Fine Motor Skills: "motor behaviors involving manipulative, discreet finger movements and eye/hand coordination" (Jacobs & Jacobs, 2004, p. 87).

Handwriting: "the act of placing or inscribing characters on a surface by hand with the aid of a marking instrument such as a pen or pencil" (Gardner, 1998, p. 10).

Legibility: the ease with which groups of symbols are clearly and correctly identified as a letter or a word, with the result that the reader perceives meaningful sentences (Plain Language Association International, 2005).

Occupation: “dynamic relationship among an occupational form, a person with a unique developmental structure, subjective meanings and purposes, and a resulting occupational performance” (Nelson & Thomas, 2003, p. 90).

Occupational Therapy: “service that can be provided to facilitate the student’s abilities to participate adequately in the educational settings. Within the practice of OT, the assessment process is an important aspect of defining strengths and needs of children and families so that appropriate intervention plans can be developed” (Liang Hwang, Davies, Taylor, & Gavin, 2002, p. 48).

Education: “an area of occupation, including activities needed for being a student and participating in a learning environment” (Commission on Practice, 2002, p. 54).

Kinesthesia: “sense of movement and position of the limbs that arises from information from the muscles, joints, and skin” (Sudsawad, et al., 2002, p. 26).

Skill: “expertness, practiced abilities showing deftness, dexterity, and confidence in functional performance” (Case-Smith & Pehoski, 1992, p.14).

Alertness: “the ability to regulate one's level of arousal so that it is not too high or low” (Barrett Family Wellness Center, 2005).

Arousal: a state of the nervous system describing how alert one feels (Barrett Family Wellness Center, 2005).

Readiness: “foundation skills present before a child learns a new task” (Slavin, Karweit, & Wasik, 1994).

Biomechanical: “having to do with the mechanics of human movement” (Crepeau, Cohn & Boyt Schell, 2003, p.1026).

Proximal: “nearest the point of attachment, center of the body” (Thomas, 1997, p. 1582).

Distal: “farthest from the center, from a medial line, or from the trunk” (Thomas, 1997, p. 562).

Chapter 2: Literature Review

The Importance of Handwriting and its Relation to Early Academics

Children are expected to attain a level of handwriting competency that allows them to make proficient use of handwriting for completion of academic work (Graham and Weintraub, 1996). Learning how to write is an integral component of the educational curriculum in the initial years of school (Cunningham Amundson, 1992; Woodward & Swinth, 2002). Even in a technology-driven society, handwriting remains one of the most essential and complex occupations in school. Computers, although convenient, are not always available in the classroom when needed. Young, school-aged children are not familiar with the keyboard arrangement, and therefore may compromise their writing speed and content (Preminger, et al., 2004). This impact on writing is especially true for children, who use handwriting as the primary method for expressing their learning within the academic setting (Case-Smith, 2002). Einhorn (1999) claims “if our ideas aren’t expressed legibly on paper, we lose ground in a main form of communication” (p. 38). The skill of handwriting is a necessity for communication of learning in most elementary classrooms in the United States; thus, competence in handwriting should be a goal that all teachers and students strive for in the beginning stages of learning how to write (Ediger, 2001; Woodward & Swinth, 2002). Mastering this skill will help promote successful written communication throughout the educational process.

The development of a child’s handwriting ability depends on a variety of readiness skills. Competent handwriting requires integration of cognitive functioning, visuomotor skills, perceptual skills, spatial relations, in-hand manipulation, and motor Planning, (Feder, et al., 2000). The actual performance of handwriting involves

coordination of one's eyes, arms, hands, body posture, base of support, pencil grasp, and letter formation (Ayres, 1972; Benbow, 1990; Erhardt, 1994; Exner, 1990). Activation of the body in general is thought to help one prepare one's body for participation in an occupation such as handwriting, and also helps one to attend to and focus on an educational task. Activation of the body may be achieved through fine or gross motor input that will help to prepare body systems (Cunningham Amundson, 1992). This input may also heighten the child's awareness of how his or her body works, the environmental factors influencing the occupation, and the task demands that are challenging the child (Schoen & Anderson, 1999). With heightened body awareness the child will have more potential for using "handwriting as a vehicle for expression" (Vail, 1987, p. 63).

Case-Smith & Pehoski (1992) suggest that success with handwriting impacts a student's overall performance in education, personal confidence, and sense of belonging. Therefore, it is critical for students to learn handwriting in the most effective manner so that physical, mental, social, and emotional development may be supported.

Unfortunately, many professionals disagree about which approach is the most effective for teaching handwriting (Bonney, 1992; Feder, et al., 2000).

The Importance of Handwriting to the Student Role & Academic Achievement

Handwriting and academic achievement are closely associated. McHale and Cermak (1992) determined that elementary school children spend 30-60% of their class time in fine motor and writing activities, with writing designated as the predominant task (McHale & Cermak, 1992). Bonney (as cited in Feder, et al., 2000) describes "handwriting as a functional activity that can affect an individual's satisfaction, creativity, productivity and academic achievement" (p. 198).

Handwriting achievement can be assessed on a spectrum from legible to illegible. Hagin's (1983) research study illustrated that "legible writing serves as a tool for learning whereas poor writing serves as a barrier" (p. 266). In school, neater classwork papers are assigned higher grades than papers with poor penmanship even though the two papers are comparable in content (Bonney, 1992; Ediger, 2001; Feder, et al., 2000; Graham, 1992; Graham, Harris, & Fink, 2000b; Sweedler-Brown, 1992). Thus, children who are unable to demonstrate knowledge via writing tend to receive lower grades; this is also true in testing. Studies by Graham, Berninger, Weintraub, and Schaffer (1998) and Woods (2001) have shown that when language arts tests are administered, students with poor handwriting skills consistently score lower than students with better handwriting skills, even when teachers are directed to focus on content rather than penmanship. Peterson & Nelson (2003) and Simner (1982) found that frequent handwriting mistakes might place a student in a position of failing the first and second grades. Academic failure can result from any of the problems associated with poor handwriting (Case-Smith, 2002, p. 17; Tseng & Cermak, 1993). Thus, the quality of handwriting directly impacts on the academic achievement of school-aged children (Berninger et al., 1997; Graham, et al., 2000b; Jones & Christensen, 1999; Rosenblum, et al., 2003).

Legibility

"When examining a child's handwriting, the first question the teacher may ask is, Is it legible?" (Cunningham Amundson, 1992, p. 67). In the past, handwriting legibility was judged by the time it took to read a child's handwriting sample. Recently, researchers have begun to judge legibility in terms of letter formation, alignment, spacing, and size

(Ziviani and Elkins, 1984). Difficulty with any of these factors may impact the readability of one's handwriting.

Legibility is dependent on several factors with each one as important as the next. Recognition of letters is a factor that is often relied upon when judging legibility. Letter recognition signifies that each letter can be distinguished from any other letter, with ease by the reader (Bell, 2001). Letter formation is another factor in legibility that refers to the specific pattern or stroke used to write each letter or number (Cunningham Amundson, 1992, p. 67). Alignment refers to the placement of the letter relative to the writing line (Bell, 2001; Cunningham Amundson, 1992). Spacing refers to the way letters are distributed spatially within words and how words are distributed within sentences (Bell, 2001; Cunningham Amundson, 1992). When looking at size of letters or numbers, Bell (2001) and Cunningham Amundson (1992) suggest that the height and proportion should be uniform throughout the entire handwriting sample. When assessing legibility, quality of the written line may also be judged (Bell, 2001). Bell (2001) advises that a firm, clear line, not too light or too heavy is ideal; this requires that the child use an appropriate amount of pressure when moving the pencil on the paper.

The Impact of Poor Handwriting Skills

Prevalence of handwriting difficulties.

Hammerschmidt & Sudsawad (2004) discovered that up to 20% of school age children in the United States are significantly impacted by poor or illegible handwriting, boys more often than girls. Rosenblum, et al. (2003) reported that the "prevalence of handwriting difficulties among school-aged children varies between 10-34%" (p. 44). In

comparison to other academic areas such as reading, little attention has been directed at prevention of writing difficulties (Graham, et al., 2000a).

Communication of learning.

Malloy-Miller, Polatajko, & Anstett (1995) attested that “illegible handwriting is found to have secondary effects on school achievement and self-esteem” (p. 258).

Students who have difficulty with handwriting must consciously pay attention to correct formation of letters, which may interfere with their concurrent ability to process the subject material or the teacher’s instruction (Case-Smith, 2002, p. 17; Graham, et al., 2000a). Handwriting difficulties can also interfere with the ability to compose the message during the act of writing. Ultimately, “children who experience difficulty mastering this skill may avoid writing and develop a mind set that they cannot write, leading to arrested writing development. Poor penmanship may influence perceptions about a child’s competence as a writer” (Graham, et al., 2000b, p. 620).

Lack of competence in writing is likely to impact one’s communication of learning (Woods, 2001; Woodward & Swinth, 2002). McHale & Cermak (1992) found that a child unable to communicate effectively is also at a much greater risk of lower self-confidence, poor self-esteem, and overall academic failure. Various studies by other researchers have shown that handwriting illegibility may impact a student’s academic success & self-worth (Case-Smith, 2002; Graham, et al., 2000b; Hammerschmidt & Sudsawad, 2004).

It is assumed by some that the training of handwriting skills can be disregarded because of the opportunity to use alternative methods of communication, such as the computer and speech producing medias (Graham, 1992). However, students are still

required to complete most of their assignments by hand, and they are likely to in the future as well (Graham, 1992). Thus, handwriting is expected to continue to affect academic performance. Graham (1992) asserts that the necessity to use writing in school and in other contexts emphasizes the importance of writing even as we progress through a technological age.

Changes in How Handwriting is Taught

The teacher is primarily responsible for handwriting instruction in the classroom. In the past, school curricula allowed teachers to spend up to 50 minutes a day for instructing students in the fine art of handwriting (Ghezzi, 2001). Today, teachers in kindergarten through sixth grade spend an average of only 30 to 60 minutes per week teaching handwriting (Peterson & Nelson, 2003, p. 153; Simner, 1982). What has changed in handwriting is the time teachers devote to instruction, as well as the style of handwriting taught (Ghezzi, 2001). Classroom handwriting instruction has become less structured allowing students to develop their own style of writing (Francis, 2000). Instead of using the intricate Palmer Method of handwriting, school districts are now selecting writing programs that offer simplicity (Ghezzi, 2001). Swadener (as cited in Francis, 2000), an occupational therapist and presenter for Handwriting Without Tears, has noticed a decline in handwriting. She believes that the popularity of the whole language approach to reading and writing de-emphasized the focus on teaching handwriting skills, and instead focused more on content (Francis, 2000). "Teachers in the school setting need to emphasize quality handwriting across the curriculum. Quality handwriting means that the written content is easy to read in either manuscript or cursive form" (Ediger, 2001, p. 1).

The amount and type of handwriting instruction can vary from one school system to the next. In schools that employ formal handwriting instruction, students generally learn to print in kindergarten or first grade, and progress to cursive handwriting in late second or third grade. In addition, instruction typically takes place as a group activity and includes minimal individualization for specific student needs. The varying methods of handwriting instruction and the time devoted to this skill are most likely due to the fact that curricular content has expanded without a corresponding extension of the length of the school day (Wallace & Schomer, 1994). “In recent years, there has been a tendency to downplay or even eliminate handwriting instruction as part of the writing program, as approaches such as whole language and process writing have placed greater emphasis on content and process and much less emphasis on form” (Graham, et al., 2000b, p. 633). This change in emphasis may place beginning writers who are trying to master the details of handwriting in jeopardy of experiencing greater difficulties with this skill (Graham, et al., 2000b).

Legislative Influence on Occupational Therapy Service Delivery

In the early 1900s, principles and practices of occupational therapy (OT) were emerging in various contexts (Schwartz, 2003). Despite this early expansion, services were somewhat unfamiliar in the public school systems until the mid 1970s. Prior to 1974, many children with disabilities were educated in segregated private schools or institutions. Since the implementation of “Section 504 of the Rehabilitation Act of 1973” (Punwar, 2000, p.175) and “Public Law 94-142 in 1975 (the Education for All Handicapped Children Act), occupational therapy...in the educational setting has become more well-known and accepted by educators, parents, and school personnel”

(Cunningham Amundson, 1992, p.63). This law required public schools to educate and provide educationally related therapy services to children with disabilities.

Occupational therapy is included as a related service under the Individuals with Disabilities Education Act (IDEA) of 1990. Part B of IDEA mandates that “children with disabilities have available to them a free and appropriate public education that emphasizes special education and related services designed to meet their unique needs, as necessary, within the school system” (Owens, 2004, p. 5). This educationally based intervention will help support student participation and success in the school-based context (Clark, Polichino, & Jackson, 2004).

Under the guidelines of this law, elementary school children with conditions and deficits that impact their educational success may receive occupational therapy services if the handwriting problems affect the child’s ability to learn or successfully communicate in the classroom (Public and Private Laws, P.L. 105-17, IDEA, 1997). It is estimated that 20% of children struggle with the acquisition of handwriting skills (Hammerschmidt & Sudsawad, 2004). Therefore, the implementation of handwriting programs has become a major emphasis for occupational therapy in the school system (Woodward & Swinth, 2002).

School-Based Occupational Therapy and Handwriting

The American Occupational Therapy Association (AOTA) describes occupational therapy in the school setting as a “health profession that utilizes the application of purposeful, meaningful, and goal-directed activity in the assessment and treatment of persons with special needs” (1989, sec. 6-3). In the educational setting, occupational therapy emphasizes the performance of fine motor occupations as an important aspect of

service delivery, and one of the most complex fine motor tasks is handwriting (McHale & Cermak, 1992). Occupational therapists are trained professionals in the issues of hand control, motor performance, and activity analysis and therefore serve as a valuable resource in addressing handwriting needs in the school environment.

Approximately 20% of elementary school students have difficulties with handwriting and are a common source of referrals for occupational therapy services (Hammerschmidt & Sudsawad, 2004). Therefore, handwriting is one of the main areas of concentration for school-based occupational therapy (Hammerschmidt & Sudsawad, 2004). Cunningham Amundson (as cited in Case-Smith & Pehoski, 1992) explained that “referrals from educators and parents frequently include that the child’s handwriting is not readable, laborious, distorted, or child does not complete homework assignments” (p. 63). This difficulty may have a detrimental impact on the learning process of students throughout their education.

The role of the occupational therapist in a handwriting program is to discover why the child is having difficulty and to determine what steps are necessary to correct the problem (Woodward & Swinth, 2002). The occupational therapist assesses the student to determine what is hindering the child’s level of functioning. Perceptual ability, gross or fine motor skills, the context of the environment, ergonomics, or a combination of these factors could obstruct the child’s handwriting abilities. After the cause has been determined, the occupational therapist formulates an intervention approach to assist the student in establishing necessary skills for writing proficiently (Hammerschmidt & Sudsawad, 2004; Woodward & Swinth, 2002). Intervention services are provided in several ways including collaborating and consulting with the classroom teacher and work

with students on a day-to-day basis in the classroom (Hammerschmidt & Sudsawad, 2004; Polichino, et al., 2005). While classroom “teachers are primarily responsible for the instruction of handwriting in the classroom, school-based occupational therapists often support teachers by identifying and treating deficits interfering with the development of this skill” (Woodward & Swinth, 2002, p. 306). Together, the teacher and occupational therapist serve as a team in targeting the most effective approach to take in the teaching-learning process of handwriting for children with deficits.

The occupational therapist may also influence how handwriting is taught when a child has been identified as needing therapy for handwriting problems. An occupational therapist may focus on postural, motor, sensory, or perceptual deficits that may be interfering with handwriting skills. Therapeutic interventions for these deficits are often rendered in a separate therapy room, rather than the natural classroom environment where the child participates in the most writing. The segregated setting affords the opportunity for better focus to task, but at the same time may not adequately prepare the child for the distractions of the classroom (Clark-Wentz, 1997). However, this “supplemental handwriting training early in primary grades may be a critical factor in preventing writing difficulties, at least for children who do not master handwriting easily” (Graham, et al., 2000b, p. 621). Remediation of handwriting problems should be planned in conjunction with the child’s teacher so that a consistent and individualized approach to teaching handwriting is used for that specific student. Practice with letter formation is certainly a necessary component of remediation (Einhorn, 1999). In addition, the child’s motor skills and sensory processing abilities that contribute to and produce good handwriting are also important to consider (Tseng & Cermak, 1993).

Evolution of Handwriting Intervention Theories in Occupational Therapy

Numerous approaches for instruction and remediation of handwriting have been proposed (Cunningham Amundson, 1992; Feder, et al., 2000). In the 1960s, several theories addressed handwriting issues. The behavioral and perceptual-motor approaches analyzed tasks for their component parts so that handwriting could be taught to children in a simple step-by-step manner (Cunningham Amundson, 1992). For example, a component part of handwriting may include demonstrating how to form the letter “A” in the air with the entire arm before writing the letter “A” on paper with a pencil. Shaping (reinforcing the child as his or her response becomes more and more like the target behavior), chaining (breaking down complex behaviors into simple steps) of sub skills, and reward for accomplishment drove the theory of behavioral intervention (Royeen & Duncan, 1999).

In the neurodevelopmental handwriting approach, emphasis was placed on inhibiting the development of muscle tone or undesirable conditions to promote performance (Schoen & Anderson, 1999). Another method, known as the functional compensatory approach, helped to address fine motor problems by making adaptations to the task or environment (Henderson & Pehoski, 1995, p. 198) such as providing appropriate seated positioning, changing the angle of the paper, or using a smaller writing instrument to enhance the student’s grasp. These approaches support the foundation for a comprehensive study of handwriting; however, no full-scale study has been completed. Instead, discrete components of handwriting, such as grasping, have been the focus of most studies related to handwriting (Daly, Kelley, & Krauss, 2003; Smith-Zuzovsky & Exner, 2004; Tseng, & Cermak, 1993).

In the 1970s, the concept of improving the body's motor control through manipulation of muscles became popular, and earlier theories continued to evolve. The neurodevelopmental approach, a hands-on treatment for central nervous system deficits, progressed from using body positioning to reduce unwanted muscle contraction, to techniques that produce positive responses through the stimulation or calming of muscles (Schoen & Anderson, 1999). Additionally in the 1970s, the sensory integration theory became an area of concentration. Emphasis in the sensory integration theory was placed on integration of the senses that moderate one's reaction to changes in body position in relation to the earth (balance and equilibrium), awareness of limb and muscle movement and touch sensation (Henderson & Pehoski, 1995, p. 198).

Another widely used theory proposed for handwriting remediation was the proximal-distal theory of development. Henderson and Pehoski (1995) stated that the muscular control of the trunk and shoulders matures earlier than the hands and fingers. Therapists were taught that control of muscles close to the trunk (proximal) precedes hand and fingertip control (distal), therefore, trunk and shoulder stability should be emphasized first. It was thought that gaining control of the trunk and shoulder first, and proceeding out to the arm, hand, and fingers provided for a more purposeful outcome. This stabilization of the trunk region allows for large, imprecise movements to develop into highly refined movements for skills such as handwriting. Children who are unable to develop the needed trunk stability for development of fine motor skills could be assisted through the use of specially designed seating (Levine, 1991).

By the early 1980s, the focus of handwriting approaches shifted to a larger view of a child's level of functioning. More specifically, how the child functioned in his or her

educational environment became a major concern (Henderson & Pehoski, 1995). The authors of biomechanical approaches explained that sitting posture, pencil grasp, and position of paper are all ergonomic factors to which the occupational therapist must attend for the student with handwriting dysfunction (Cunningham Amundson, 1992; Tseng & Cermak, 1993).

Benbow (as cited in Case-Smith & Pehoski, 1992) wrote:

It is recommended that the child be seated at a height so that both feet are firmly planted on the floor, providing support for weight shifting and postural adjustments while writing. She also suggests the desk surface be at a height two inches above the flexed elbow when the child is seated in the chair. This position allows the child stability and symmetry for performing written classwork (p.74).

The biomechanical theory assumes that any one part of the body affects all other parts. In order to be competent in motor skills the entire body needs to be working as a whole, which may be achieved by enabling activities such as strengthening exercises, muscle endurance training, and repetitive exercise (Colangelo, 1999).

Another approach that concentrates on the interaction between a person and his or her environment is the multisensory approach. This approach involves varying the sensory input that the child's nervous system experiences so that it may integrate information proficiently in order to produce quality motor output (Case-Smith & Pehoski, 1992). Activities that are used to treat handwriting problems under this approach might include forming letters with pipe cleaners or play dough, writing with water on a chalkboard with sponges or paintbrush, or writing to music.

In recent years, the educational model reemerged to decrease rote practice of handwriting. This model is concerned with the normal growth and development of children, so that the student can achieve mastery of the skills needed to function in the school setting (Schneider & Watkins, 1996). The educational model recommends handwriting be taught simultaneously with the child's natural development of movement (Woods, 2001). Activities should be structured so that the child's potential for mastery is at the level where he or she has the ability for independent performance and the level where he or she can complete the task only with adult collaboration (Exner, 1990).

School-based approaches to guide programs for handwriting delays in public school systems.

School systems have many handwriting programs from which to choose. Many of the current handwriting programs used in grade school were based on the Palmer style that was the only program used in the early 1900s (Norwitch, 2004). The Palmer handwriting curriculum includes upright manuscript with wide characters. Zaner-Bloser is now the most frequently used handwriting program in the United States (Zaner-Bloser, 2002). The Zaner-Bloser handwriting curriculum consists of a continuous stroke alphabet with upright manuscript and tall extenders, and develops habit in reproducing letters of the alphabet. The D'Nealian handwriting program was developed in the 1960's, and features a distinctive manuscript alphabet that reflects the cursive form of each letter (Audio, Visual, Kinesthetic, and Oral Multisensory Educational Research Foundation, 2005). Letter formation begins at the baseline and moves upward as does cursive. These three handwriting curricula are considered to be the more traditional approaches to teaching handwriting in the primary grades.

The approach that is currently gaining more attention in the school systems is the Handwriting Without Tears program developed by Jane Olsen (2001), an occupational therapist. "Olsen's handwriting curriculum uses a developmental approach, which groups the letters by difficulty and teaches a handwriting style that uses simple, vertical lines" (Case-Smith, 2002, p. 18). What is unique about the Handwriting Without Tears program is that it uses only two writing lines (a baseline and a center line) that are clearer than the typical school handwriting paper that uses three lines. The Handwriting Without Tears system also incorporates techniques that target prewriting skills (Clark-Wentz, 1997).

Occupational therapy intervention strategies for handwriting delays.

As previously described, theoretical approaches that apply to handwriting intervention include motor learning, neuromuscular, kinesthetic, acquisitional, sensory integrative, biomechanical, cognitive-behavioral, and motivational views (Cunningham Amundson, 1992, p. 69; Feder, et al., 2000, p. 198). Many existing theories, although unsupported by research, suggest ways to improve the handwriting process. However, there is little agreement on the most effective treatment strategies with eclectic approaches appearing to be most prevalent (Feder, et al., 2000).

Woodward and Swinth (2002) investigated the use of multisensory modalities in remediation of handwriting problems in school-aged children. They found that a multisensory approach to handwriting treatment was being used by 92.1% of school-based occupational therapists (Woodward & Swinth, 2002). In a similar study surveying 50 experienced pediatric occupational therapists, Feder, et al. (2000) found that most therapists use approaches that are eclectic in nature to treat handwriting and related fine motor problems, with the sensorimotor approach being used most frequently (90%).

These findings indicate that “multisensory modalities such as chalk and chalkboard, markers or felt pens, verbal description of letter shapes while the student writes, viscous substances for finger writing, and copying and tracing letters on regular lined paper” were common (Woodward & Swinth, 2002, p. 308). Therapists often use a combination of approaches such as sensorimotor, neurokinesthetic, motor control, or ergonomic components (Cunningham Amundson, 1992).

“Other commonly selected treatment strategies include perceptual-motor (74%), motor learning (68%), cognitive training (64%), biomechanical (64%), sensory integrative (50%) and neurodevelopmental approaches (42%)” (Feder, et al., 2000, p. 200). Despite the program variety, research regarding these programs provides little evidence about their effectiveness.

Neurokinesthetic approach.

The neurokinesthetic approach is one specific type of multi-sensory approach. Benbow (1990, 1995a) proposed the neurokinesthetic approach to handwriting remediation based on the biomechanical principals of hand movement, developmental sequences, and integrated sensory perception of movement. She hypothesized that handwriting is primarily a kinesthetic skill that improves when the hand is “biomechanically, motorically, and perceptually prepared to hold utensils and create written symbols” (Case-Smith, 2002, p. 18). Kinesthesia is the ability to sense the degree, direction, or weight of body movement (Sudsawad, et al., 2002). The development of mature postural reactions is the ability of the body to maintain balance automatically and remain upright during alterations in position (Crepeau, et al., 2003, p. 1032). Together, kinesthesia and mature postural reactions are core concepts that the neuorkinesthic

approach addresses. It is believed that kinesthesia and postural reactions provide the stability needed for distal mobility. For example, without good postural alignment, balance and symmetry of the hand could be compromised and, as a result, handwriting could be illegible.

Based on the neurokinesthetic approach, Benbow (1990) developed a program that teaches children the fundamental movements of how to form a letter by practicing basic strokes. Her curriculum also incorporates visual and kinesthetic cues to support the child's awareness of those movements (Case-Smith, 2002). Benbow (1995c) suggests that kinesthetic input prior to completion of a handwriting task is more effective in eliciting better handwriting (p. 265).

Benbow and other neurokinesthetic theorists suggest that gross motor activity is an essential precursor to the appropriate development of fine motor skills (Dennison & Dennison, 1986; Etemad, 1994). Therefore, the neurokinesthetic approach for handwriting remediation can be used as a guide for assessing a child's gross motor postural control and stability prior to engagement in fine motor activities (Cunningham Amundson, 1992). The effectiveness of a kinesthetic training program to improve handwriting in children has been investigated in a few studies with varied results (Sudsawad, et al., 2002, p.27). In a study conducted by Sudsawad, et al. (2002) results indicated that kinesthetic training did not improve handwriting or kinesthesia in children tested. These findings provided no evidence for the use of kinesthetic training to enhance handwriting legibility in first grade students (Sudsawad, et al., 2002); in contrast, Harris & Livesey's (1992) findings supported the use of kinesthetic sensitivity practice for improvement in handwriting performance. Differences in research measures may account

for the discrepancy in findings.

Prior to learning how to control an object, such as a pencil, a student must initially gain control over his body through kinesthetic awareness (Vail, 1989). Laszlo and Bairstow (1984) report that “one-third of the children in the six- and seven-year-old age groups, who were tested with their [the author’s] test of kinesthetic sensitivity, showed such a low level of kinesthetic ability that learning and performance of tasks such as printing letters and numbers were hindered” (p. 211). Levine (1991) suggested that many students in the early grades may fail to meet writing expectations set for their developmental level because they are not kinesthetically ready to master the demands of the occupation. As a result, educational tasks are likely to be completed at lower than average levels for young children (Levine, 1991). Further research on the neurokinesthetic approach may help school-based occupational therapists discover an effective method for preparing the child for handwriting.

The research presented by Sudsawad, et al. (2002) further examined handwriting remediation through a pre and post-test study of 45 first-grade students who were randomly assigned to either a kinesthetic training group, a handwriting practice group, or a no treatment group. After their program was completed, the researchers concluded that they did not find improvement of a child’s handwriting ability through the use of kinesthetic training as measured by the Evaluation Tool of Children’s Handwriting (Sudsawad, et al., 2002). Sudsawad, et al. (2002) did find that all teachers identified improvement of handwriting legibility throughout all groups in the classroom context, which may be the result of practice with pre-testing, or the outcome of maturational growth. In addition, the researchers discovered that each group showed significant

improvements in kinesthesia overall. These findings do not support the use of kinesthetic training to improve handwriting legibility, but instead provide evidence for improving a child's kinesthetic awareness, which is a fundamental skill needed for handwriting.

The Importance of Fine Motor Skill Acquisition for Promoting Handwriting Legibility

Benbow states that kinesthesia of distal joints, such as wrist and finger joints, is as important as kinesthesia of proximal joints when preparing one's body for handwriting (Benbow, 1995b). Fine motor skills have a profound impact on the development of a child's handwriting ability. Since students are required to utilize handwriting throughout their education, the successful development of fine motor skills tends to have a direct effect on students' academic achievement (Tseng & Cermak, 1993). "A student who tries to support strong conceptual work with weak mechanical skills is heading for a huge school problem" (Vail, 1989, p.63). For this reason, fine motor skill development associated with the occupation of handwriting needs to be encouraged.

Fine motor skills play a significant role in many of our schools today. McHale and Cermak (1992) found that all of the classrooms observed in their study showed a high level of fine motor demands that consumed 31% to 60% of the academic day. The majority of these fine motor tasks involved pencil and paper writing activities. Any student learning to write is expected to have requisite skills of organization, differentiation, sequencing, and memory along with postural control and eye-hand coordination (Cornhill & Case-Smith, 1996).

Jeanette Farmer, a handwriting specialist, has been arguing for several years that traditional penmanship instruction should be more widely accepted by school systems (n.d., as cited by Cox, 1999). Her reasoning is that the act of writing helps children's

brains develop and improves their self-control. Farmer (n.d., as cited by Cox, 1999) and other authors explain that fine motor skills involved in writing, play an essential role in teaching the brain how to use its intrinsic ability to communicate through written language (Sheffield, 1996).

Use of Rote Writing Practice versus Fine Motor Tasks

Some theorists believe that a substantial amount of seatwork and handwriting fosters the performance of fine motor skills through practice and repetition (Marr & Cermak, 2003; Peterson & Nelson, 2003). The fine motor skill of handwriting is being taught in elementary schools today through various methods of practice. Currently, most therapeutic approaches being used in the classroom to improve handwriting skills are paper and pencil tasks, which prevail over other types of service provision (McHale & Cermak, 1992). This method of teaching handwriting is structured around tracing, repetition, practice, feedback, and reinforcement (Milone & Wasyluk, 1981; Peterson & Nelson, 2003, p. 154).

Case Smith & Pehoski (1992) found the following:

Through the mechanism of sensorimotor feedback, provided through practice, a skill progresses from a cognitive task to an automatic activity. What is important is that, without practice, a fine-motor task such as writing, will not develop to the level of skilled performance necessary for daily life tasks (p. 81).

Ultimately, students will gain prowess in how to produce and confidently compose letters of the alphabet from the addition of specific and enhanced handwriting instruction (Manning, 1988).

Through use of the traditional approach of practicing strokes, many children by the age of six or seven years are fairly proficient at writing in the school setting (Cox, 1999; Cunningham Amundson, 1992; Manning, 1988). However, students with learning disabilities, developmental delays, or neurological impairments often struggle to write legibly for years when solely guided by the standard handwriting curriculum within the regular and special education classrooms.

On the other hand, some handwriting experts feel that interaction with, and manipulation of small objects helps children learn how to hold a pencil correctly while moving it precisely and rapidly (Case Smith, as cited in Grabmeier, 2005). Pencil movement across paper requires the ability to isolate and coordinate individual finger and thumb movements, skills that children can rehearse by playing with small items. Grabmeier (2005) agrees and asserts that “practice with a pencil or crayon isn’t very helpful for young children because the hand and finger muscles they need aren’t developed yet” (para. 7). Ultimately, the most appropriate means for developing fine motor skills must be utilized so that students may enhance their ability to write.

The Importance of Gross Motor Skill Acquisition to Handwriting Legibility

Handwriting methods incorporating a combination of both gross and fine motor skills for the development of handwriting competence are slowly regaining popularity in the school setting. With this trend now reappearing, most schools are beginning to consider curricula that work to enhance handwriting through physical activity. Numerous researchers (Addy, 1996; Dennison, 1986; Grabmeier, 2005; Lacey, 2002; Levine, 1991; Sheffield, 1996) purport that handwriting can be enhanced by developing specific perceptual and motor skills. These researchers are discovering that “through movement

the child acts upon his or her external environment and receives internal impressions” (Etemad, 1994, p. 11; Woods, 2001).

Lacey (2002) states that “young children in the classroom setting are being pushed earlier and earlier into meeting the demands of formal skills” (para. 2). Lacey claims that a scheduled period of time should be incorporated into a student’s day for running, jumping, lifting, and balancing in order to develop gross motor movement, which will subsequently enhance fine motor skills. Gross motor activity seems to focus ones’ energy and help ones’ body to connect so that learning will occur (Addy, 1996).

Montessori also provided valuable information on the development of a child’s handwriting skills (Woods, 2001). She challenged the conventional method of handwriting instruction (i.e. practicing letter formation) as being incompatible with the child’s typical development of movement. Rather, she accentuated the value of movement that is needed to manipulate objects, perform occupations, and learn from the environment. Montessori’s work (as cited in Etemad, 1994) suggests that the brain, sensory organs, and muscles must all work together in order for an activity to be carried out precisely; movement is the needed catalyst to begin this cycle of performance. Montessori also believed that “development of the child’s mind comes through movement and therefore should be coupled with it, as cognitive growth is dependent on movement” (p. 12). Thus, a strong emphasis on physical activity or movement and its connection to learning has been proposed in the past.

More recently, Dr. Dennison (1986), founder of Brain Gym and Educational Kinesiology, is a researcher who supports the idea of movement to enhance readiness skills. Brain Gym is the study and application of exercises that activate the brain for

optimal storage and retrieval of information. The Brain Gym program incorporates a series of quick, fun, and effective activities that enhance performance in all areas by supporting whole brain integration. “Educational Kinesiology is a systematic approach to re-educating the whole mind/body system for accomplishing any skill or function with greater ease and efficiency. The intention is to support and nurture the learner’s innate and organic unfolding of skills and intelligence” (Brain Gym International, 2003, para. 14).

Dr. Dennison (1986) and Montessori (Etemad, 1994; Woods, 2001) suggest that ample time should be allocated for development of gross motor activity. With the physical need for movement satisfied throughout the day, it is hypothesized that fine motor skills will improve and “may influence the quality and quantity of the child’s learning and achievement in the classroom” (McHale & Cermak, 1992, p. 898). To achieve the greatest academic success these fine motor skills need to develop correctly to allow for legible handwriting.

The Importance of Gross and Fine Motor Control in Combination

The ability to control the shoulder, arm, and wrist while using finer and more exact movements of smaller muscles of the hand and fingers, develops from birth progressively into the early school years (Levine, 1991). The capability to coordinate shoulder, arm, wrist, and finger movements helps allow a student to operate scissors or a pencil accurately. The ability to perform these tasks becomes progressively essential for functioning within the classroom setting, as fine motor demands increase as a student moves to a higher grade level (Levine, 1991). “Without the stabilization of the shoulder, elbow, and wrist, the speed and dexterity of the hand’s intrinsic movements when

manipulating the writing tool become impeded. These insufficient neuromuscular mechanisms commonly interfere with legible handwriting” (Cunningham Amundson, 1992, p. 65). Acquisition of gross motor skills will therefore allow a student to successfully maintain a level of functioning so that he or she can meet the demands of fine motor tasks without having to consciously plan motor output.

Summary and Implications

Legible handwriting is clearly associated with academic performance and the development of self-esteem. However, handwriting is receiving less emphasis in the elementary classroom setting compared to that in the past. Delays in handwriting, which interfere with an ability to communicate in written form, are areas of eligibility for related therapeutic services under Individuals with Disabilities Education Act.

Occupational therapists are related service providers who are skilled in the remediation of handwriting delays. Based on the literature it is clear that there is discrepancy about the most effective treatment strategy for improving handwriting legibility. This discrepancy further emphasizes the need for an experimental research study to be conducted on the effectiveness of fine or gross motor activities on the acquisition of handwriting legibility in the classroom.

Chapter 3: Methodology

Methods and Procedures

The purpose of this study was to investigate the effectiveness of participation in either a gross or fine motor program on first grade students' handwriting legibility. The research questions that were addressed in this study were:

- 1) Does the provision of gross motor occupations prior to handwriting instruction elicit increased legibility?
- 2) Does the provision of fine motor occupations prior to handwriting instruction elicit increased legibility?
- 3) Is it more effective to teach handwriting after engagement in fine motor occupations or gross motor occupations?

Research Design

For the purpose of this study, a pre-test, post-test quasi-experimental design was utilized to collect data. Children in four elementary first grade classrooms were assigned to either an experimental or control group. The dependent variables were generated by the Test of Handwriting Skills (Gardner, 1998). This grouped, pre- and post-testing method allowed a large population to be accessed, which increased the sample size in anticipation of increasing the generalizability of the results. Quasi-experimental studies can generate objective data about cause and effect interactions (DePoy & Gitlin, 1998). This type of research also provides for greater generalization than anecdotal research.

Participants

Participants were recruited from four first grade classrooms in the Altmar-Parish-Williamstown school district in rural Upstate New York. Two of the classes engaged in

pre-writing motor programs prior to the typical handwriting instruction that occurred in the classroom. Two classes served as the control groups and received only the typical handwriting instruction that occurred daily in the classroom (see Figure 1).

Students in this district are assigned to classrooms by a stratified random distribution of high, moderate and low level functioning students, and by distribution of personality types. The intent of the school district is to compose classrooms in such a way that relatively equal numbers of children from all achievement and personality criteria exist in each classroom. Therefore, it was assumed that the 4 classrooms were generally equally mixed by skill level. All students in the selected classrooms who had parental permission were eligible for participation in the study. Females and males, between ages of five and seven years old, were included. A demographic form was developed and sent to parent(s)/guardian(s) in order to obtain data for describing characteristics of participants.

Inclusion criteria for participants in the study were: (a) enrollment in one of the four first-grade classrooms in the specified school district; (b) informed consent from a parent/guardian; (c) attendance for at least 8 of the 15 days of the study.

Exclusion criteria included: (a) students receiving occupational therapy services for handwriting remediation or those who had a diagnosed condition that impeded their handwriting ability; (b) students without a signed informed consent from a parent/guardian; (c) any student who was eight years of age; (d) any student with more than 8 absences. The cut-off age of eight years was used due to maturational effects and developmental milestones associated with the age range that could influence handwriting performance and serve as a confounding factor.

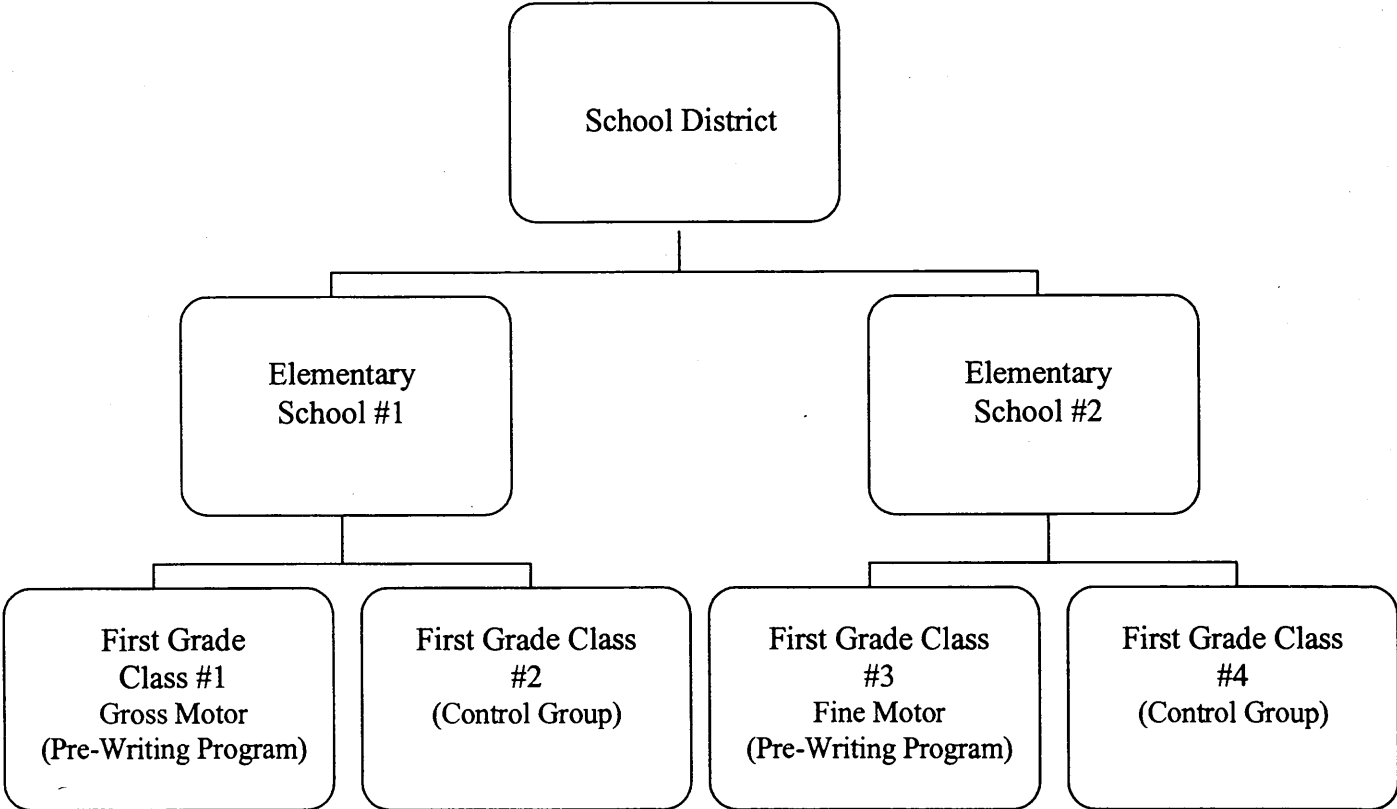


Figure 1. Layout for recruitment of participants from four first grade classrooms.

Variables

Handwriting legibility as measured by handwriting scores generated by the Test of Handwriting Skills (THS) by Morrison Gardner was the primary dependent variable of interest in the study. Handwriting legibility was operationalized through administration of the THS assessment that measures how a child motorically produced letters, words and numbers spontaneously, from dictation, and from copying. This assessment also determines the speed of producing letters spontaneously, however this variable was not of main concern in the study.

Variables that were manipulated in the study included fine and gross motor occupations prior to handwriting instruction, as well as the timeframe of the study. Fine motor occupations (Appendix G) were adapted from Mary Benbow's suggested pre-writing activity ideas (Benbow, 1995a) and gross motor occupations (Appendix F) were adapted from Brain Gym concepts (Dennison, & Dennison, 1986). Pre-existing factors that co-existed included the subject's age, gender, and hand dominance. There were some confounding factors such as teachers' level of interest in this study and years of experience that may have affected the results.

Measurement Instrument

A preliminary search of handwriting assessments was performed to find tools that could serve as a pre-test and post-test measure. Assessments researched included the Evaluation Tool of Children's Handwriting (Amundson, 1995), the Test of Handwriting Skills (Gardner, 1998), the Denver Handwriting Assessment (Anderson, 1983), the Minnesota Handwriting Assessment (Reisman, 1999), and the fine motor component of the Bruininks Oseretsky Test of Motor Proficiency (Bruininks, 1978). The Test of

Handwriting Skills (THS) developed by Morrison F. Gardner (1998) was chosen to collect handwriting samples for several reasons.

The THS assesses both manuscript and cursive handwriting. The assessment for manuscript handwriting was used in this study because first grade students are only required to use manuscript writing during educational activities, and had not yet been taught cursive. According to Gardner (1998), the Test of Handwriting Skills is a standardized and norm referenced test designed to meet the needs of occupational therapists when measuring handwriting legibility. The Test of Handwriting Skills (Gardner, 1998) “measures how a child produces motorically with his or her hand letters of the alphabet and numbers from memory and by copying, it is not a test to measure a child’s memory of language symbols or general intellectual functioning” (p. 11). It also incorporates three styles of handwriting: D’Nealian, Palmer, and Zaner-Bloser. The THS is convenient because it can be administered individually or to a classroom of students. The THS was designed for children from five through eleven years of age. The ten THS subtests measure a number of handwriting skills including spontaneous writing of upper and lower case letters in sequence, writing upper and lower case letters and words from dictation, writing numbers from dictation, and copying letters, words, and sentences (see Table 1).

Scores from this assessment include means, standard deviations, and numerical data. The Test of Handwriting Skills was also chosen due to its easy administration procedures, simple scoring criteria, and available normative data. The testing booklets used for the Test of Handwriting Skills are also simple for students to use and subtest

pages are labeled with non-language symbols for easy identification. Test booklets for the THS are available in both the manuscript and cursive format.

Reliability and validity of the THS has been established. Item total correlation ranged from -.01 to .45 and internal consistency of reliability was established at .51 to .78 (Gardner, 1998). Two of the ten subtests' (Bicycle and Horse) reliabilities are fairly low due to a small number of items given whereas other subtests are stronger. Gardner (1998) encourages studies on THS content and construct validity so that analytical levels may be determined.

Pre-test and post-test assessments were administered in the cafeteria (see Figure 2) of the elementary school at which the students were currently enrolled. The classroom setting provided cues that influenced the students' handwriting skills such as alphabet cards; therefore, there was a need to use an alternative environment in order to eliminate the cues. The cafeteria setting consisted of tables and chairs, tile flooring, fluorescent lighting, retractable wall, windows, and bathroom area.

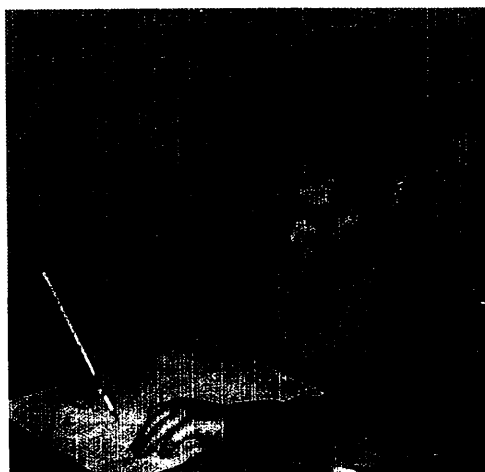


Figure 2. Student demonstrating testing conditions.

Table 1. Description of Test of Handwriting Skills Subtests by M. Gardner (1998)

Subtest Number	Subtest Name	Description
1	Airplane	Spontaneous upper-case letters of the alphabet A to Z in sequence, circle letter written after 20 seconds.
2	Bus	Spontaneous lower-case letters of the alphabet A to Z in sequence, circle letter written after 20 seconds.
3	Butterfly	Upper case letters of the alphabet from dictation, no sequence.
4	Frog	Lower case letters of the alphabet from dictation, no sequence.
5	Bicycle	Nine numbers from dictation no sequence.
6	Tree	Copy twelve upper case letters, no sequence.
7	Horse	Copy ten lower case letters, no sequence.
8	Truck	Copy six words in upper and lower case.
9	Book	Copy two sentences in upper and lower case.
10	Lion	Six words from dictation in upper and lower case.

Note: Table developed from narrative in Gardner, M. (1998). *Test of Handwriting Skills Manual*. Novato, CA: Academic Therapy Publication.

Scoring Criteria

“Evaluation of handwriting has traditionally involved the use of handwriting scales in which legibility is rated through comparison to a series of graded samples” (Feder, et al., 2000, p. 198). The THS handwriting sample is scored based on a scale of zero to three; zero being the poorest and three being the best possible performance (Gardner, 1998, p. 16). Criteria for scoring a child’s handwriting functions are listed in the THS test manual (see Figure 3). “A score of 0 indicates the inability to write a letter or the letter has missing parts/added parts; a score of 1 indicates closure problems, lines that are broken/unattached, or double lines for single lines; a score of 2 indicates overextended lines or broken lines but attached; and a score of 3 indicates accurate writing” (Gardner, 1998, p. 30). Raw scores are then converted into standard, scaled, stanine, and percentile ranks scores (Gardner, 1998).

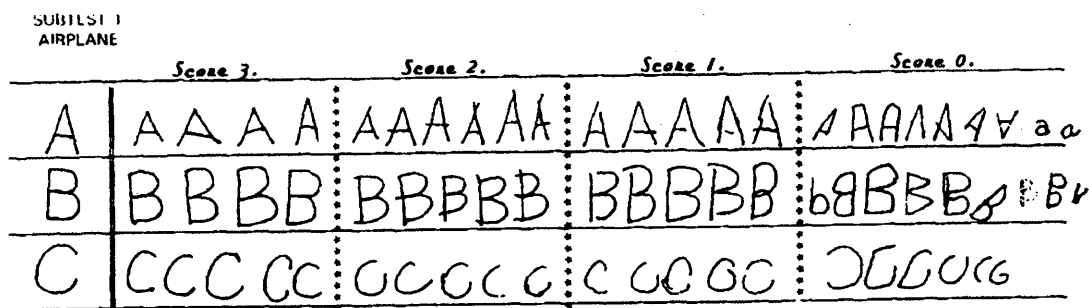


Figure 3. Sample of scoring criteria for airplane subtest.

Procedure

Ithaca College’s Human Subjects Institutional Review Board approved the study. The principals of the elementary schools were contacted by phone and a formal letter

explaining the study and requesting permission to conduct the study within their school building was hand delivered (Appendix A). Consent was obtained from both building principals. The parent(s)/guardian(s) of the students identified as potential participants were sent a packet containing a recruitment letter (Appendix B) explaining the purpose and conditions of the study, an informed consent form (Appendix C), and a demographic form (Appendix D) via student folders sent home by the classroom teacher. Of a possible 82 first-grade participants, 52 parent/guardian consents were received by the building principals. All signed consent and demographic forms returned by the parent(s)/guardian(s) were coded numerically by the building principals to ensure confidentiality and anonymity of the study. The principal was the only individual who knew what tests corresponded to what student.

To examine the effects of fine motor versus gross motor preparation for handwriting legibility this study employed Benbow's theory to create both a fine motor and gross motor program. The researcher designed pre-writing occupations based on either gross or fine motor activities and detailed the protocol for each day and the occupations to be utilized. The classrooms were designated as either an experimental group (a pre-writing program of either fine or gross motor occupations) or control group (no pre-writing program) based on the teacher's perceived ability to add the pre-writing program into the classroom schedule. Thus, participants were assigned to a particular group by virtue of participation in the designated classrooms. Prior to initiation of the study, teachers of the four classrooms were instructed on the principles and techniques used with their class. Teachers received approximately one hour of group instruction presented by the researcher and were also provided with the researcher's contact

information to allow access for further questions or comments during the study. In addition, teachers were provided with all necessary materials for the motor program and individually instructed on the protocol for the pre-writing motor program being taught in their classroom. Teachers reported that all classes were being taught handwriting using the Handwriting Without Tears program in a manner consistent with the program guideline.

The teachers of the experimental groups were scheduled to integrate either fine or gross motor occupations into the handwriting curriculum prior to handwriting instruction for fifteen consecutive school days. The fine and gross motor occupations were conducted in a safe, carpeted area in the students' assigned classrooms. Teachers were also contacted once a week via email or phone to allow for the opportunity to address concerns or answer questions. All teachers were supplied with contact information if they had any additional questions between scheduled contacts. Each teacher also administered sub-test #9 of the THS on Mondays, Wednesdays, and Fridays to serve as a short-term measurement of the effects of the added occupations.

In the pre-testing and post-testing phase of the study, the students were removed from the classrooms for administration of the Test of Handwriting Skills. In relation to the classroom schedule, the pre- and post-testing occurred in the morning beginning either at 9:30am or 10:30am. The researcher administered the Test of Handwriting Skills pre-test and post-test to all students. The building principal then coded each test booklet of handwriting samples and student names were removed in order to ensure confidentiality of the students. A research assistant conducted a second coding procedure

to blind the researcher to the classroom assignment prior to the scoring of the handwriting samples by the researcher.

At the initial pre-test session, students were seated in a chair at a cafeteria table and the Test of Handwriting Skills Assessment was administered in standard format for group administration (Gardner, 1998). The pre-test took approximately thirty minutes to complete. All data was recorded on the score sheets and was coded as described.

Teacher-directed, pre-writing programs were then implemented for a 3 week (15 school day) period. One teacher directed prescribed gross motor occupations every day prior to handwriting instruction for three weeks; and the other teacher directed prescribed fine motor occupations every day prior to handwriting instruction and after typical seatwork time. Thus, the gross motor group was significantly more physically active than the fine motor group prior to handwriting instruction. The time of day for completion of the handwriting assessment, pre-writing motor program and handwriting class was mid-morning to correspond to the time that handwriting instruction typically occurred in the classroom. Teachers in the classrooms that were used as control groups conducted class according to their typical school day schedule. The amount of physical activity in the control classrooms prior to handwriting instruction was not tracked.

After the completion of this three-week program, students were re-assessed in the cafeteria using the Test of Handwriting Skills by the researcher. The students were assessed during a time period that did not conflict with academic curriculum or “specials” such as gym, music, art, or recess. This study was completed the 1st 3 weeks of November, to avoid conflict with state education tests.

Analysis of Data

The researcher completed scoring of the THS handwriting samples by scoring not more than 10 per scoring session to control for fatigue over a period of 4 weeks. The researcher was blind to participant and class assignment. Therefore, the researcher did not know which participants were in the experimental or control groups. Data collected from the ten subtests on the Test of Handwriting Skills and the demographic forms were entered in the statistical package for social science (SPSS) version 12.0 for analysis (SPSS for Windows, 2001). Data collected were predominantly numerical. Means and standard deviations for standard scores on the THS were based on the derived norms listed in the test manual, which have a mean of 100 and a standard deviation of 15.

Scores on each of the subscales were transformed into T-scores in order to standardize the values so that comparisons between subjects of different ages could be made (see Appendix K). The T-scores for each subscale of the THS were analyzed using a 2 X 2 X 2 ANOVA (Activity by Practice by Time) with repeated measures on the last factor. The independent variables included group (fine motor versus gross motor), activity (control versus experimental) and time (pre- versus post-test). The dependent variables included fine versus gross motor pre-writing programs, control versus experimental group, and pre versus post-test. Post-hoc analysis of significant F values included gender variance. The alpha level was set at 0.05 for all analyses. The scores on the THS were analyzed using a 2 x 2 x 2 factor analysis of variance (ANOVA) grouped by practice (fine motor and gross motor), activity (control and experimental) & time (pre- to post-test), using a comparison of means, and repeated measures (grouped by time) to see if a significant difference was present, and if the pre-writing programs were effective.

A repeated measure analysis of covariance (ANOVA) was used to analyze the difference between pre- and post-test scores on the THS for experimental and control groups.

An ANOVA adjusts for selection differences that may exist and is also useful in research when random assignment to groups is not possible (Depoy & Gitlin, 1998). An ANOVA was used to statistically control for differences in pretest THS scores because it was not possible to randomly assign students to experimental and control groups since whole classes were used for the groups. Raw scores from the THS handwriting samples were used to develop scatter plot graphs for a few reasons: the researcher wanted to use the true raw scores before values were converted into mean and standard deviation equations required for SPSS analysis to secure a more precise representation when plotting data in charts, and to more easily see patterns of intermittent change (see chapter 4 charts). These were the main statistical analyses conducted for the study and provided an overall strategy to determine whether the intervention was effective.

Limitations and Delimitations

This study utilized a sample of convenience, which influences the ability to generalize the results to a larger population. The participants only represented one school district in Upstate NY, which limits one's ability to view results as universal; thus, it is not representative of the total sample of first grade students. Assigning classrooms to pre-writing or control groups based on the teacher's perception of scheduling the program into their classroom agenda added the limitation of teacher program follow through and ultimately biased results. The majority of students in the study were of Caucasian backgrounds. Participants were limited to children between the ages of five and seven years old. Children with conditions and/or disabilities that impeded their handwriting,

and children receiving services such as occupational therapy, physical therapy, and speech language therapy were not included in the study. Results may only be generalized to children who have similar characteristics to those who participated in this study. The selection of participants in this study also limits the ability to generalize findings to students in differing grade levels.

Choosing only to assess the fine motor skill of handwriting limited the ability to broadly view the effects of the motor programs on other fine motor occupations such as cutting, coloring, or lacing. Removing the students from their naturalistic classroom context for administration of the THS served as a limitation. Although it was necessary to eliminate the influence of classroom cues, the additional limitation of improper seated positioning of students became a factor.

Assumptions

The following assumptions were made as part of the investigation:

- The population of first grade students was a representative sample of the population of interest
- The participants were first grade students who are typically developing
- The parents would fill out the demographic forms accurately and honestly
- The teachers would conduct the intervention program accurately
- There would be a beneficial effect of gross or fine motor pre-writing occupations
- The nature of the handwriting assessment would generate accurate data and would gather the data intended for the purpose of the study.

Chapter 4: Results

Demographic Overview

A sample of convenience was used for the purpose of this study. Originally, 82 students were available to participate, however, 30 were excluded due to lack of parental consent, student identification as receiving a related service, or as having a diagnosed condition that impeded his or her handwriting ability.

The majority of participants were typically developing first grade students who were of Caucasian descent. At the conclusion of the study, no children were excluded due to absenteeism. This sample included 34 females (65%) and 18 males (35%) between the ages of five and seven years old. The majority of students were 6 years old ($n = 42$; 81%), with the remaining sample comprised of 5 year olds ($n = 3$; 6 %) and 7 year olds ($n = 7$; 13%). Forty-three of the children were right handed, five were left handed, and four were not sure of hand dominance. Table 1 depicts the number of students per classroom.

Of the fifty-two participants, forty-three used their right hands (83%), five used their left hands (10%), and four were not sure which hand they used when writing during the test (8%).

Research Questions

The results will be discussed by answering the original research questions.

- 1) Does the provision of gross motor occupations prior to handwriting instruction elicit increased legibility?
- 2) Does the provision of fine motor occupations prior to handwriting instruction elicit increased legibility?

Table 2. Number and percentage of participants per study grouping.

Group	n	Percentage of Total
Fine Motor	13	25%
Control Group for Fine Motor	12	23%
Gross Motor	12	23%
Control Group for Gross Motor	15	29%

- 3) Is it more effective to teach handwriting after engagement in fine motor occupations or gross motor occupations?

After completing analysis using SPSS 12.0, ANOVA charts (see Table 3 and Appendix L) and scatter plot graphs (see Tables 4-33) were developed to determine patterns of significance to assist in answering the research questions.

The results of the ANOVA were statistically insignificant for all but one subtest. The butterfly subtest was the sole subtest in the THS assessment that was statistically significant when analyzed ($F = 4.66$, $p = .036$). Table 3 shows the statistical analysis for the butterfly subtest on the Test of Handwriting Skills. See Appendix L for ANOVA results of all other subtests.

A visual analysis of the data from the Monday, Wednesday, and Friday teacher-administered handwriting subtest indicated that no significant differences were elicited on a bi-daily basis. In light of the visual analysis and the insignificant findings of the pre and post data, further analysis was not done.

Gross Motor Effects

Does the provision of *gross motor* occupations prior to handwriting instruction elicit increased legibility?

The incorporation of gross motor occupations in the pre-writing program did not improve handwriting legibility in these students. The findings of this research question offer no support for the use of gross motor occupations prior to handwriting instruction to elicit better handwriting legibility in first-grade students.

Table 3. ANOVA scores for experimental and control groups for the butterfly subtest on the Test of Handwriting Skills.

	Butterfly	
	F	p
Practice (fine / gross)	0.45	0.505
Activity (treat / control)	1.85	0.180
Time (pre / post)	15.61	0.000
Practice x Activity	0.62	0.436
Practice x Time	9.64	0.003
Activity x Time	1.45	0.234
Practice x Activity x Time	4.66	0.036

Note: practice = fine versus gross motor activity; activity = treatment versus control group;

time = pre versus post-testing.

Tables 4 - 13 display the results of the THS subtests that note the pattern of intermittent scatters of significance, which indicate that no overall effect is seen. Table 6 illustrates the butterfly subtest, which was the sole subtest in the THS assessment that was statistically significant when analyzed.

Fine Motor Effects

Does the provision of *fine motor* occupations prior to handwriting instruction elicit increased legibility?

The incorporation of fine motor occupations in the pre-writing program did not improve handwriting legibility in these students. The findings of this research question offer no support for the use of fine motor occupations prior to handwriting instruction to elicit better handwriting legibility in first-grade students.

Tables 14 – 23 display the results of the THS subtests that note the pattern of intermittent scatters of significance, which indicate that no overall effect is seen (see Tables 14 - 23). Table 16 illustrates the butterfly subtest, which was the sole subtest in the THS assessment that was statistically significant when analyzed.

Gross versus Fine Motor Effects

Is it more effective to teach handwriting after engagement in *fine motor* occupations or *gross motor* occupations?

The incorporation of fine or gross motor occupations in a pre-writing program did not improve handwriting legibility in these students. The findings of this research question offer no support for indicating whether teaching handwriting after engagement

Table 4. Airplane Subtest for Gross Motor Class versus Gross Motor Control Class.

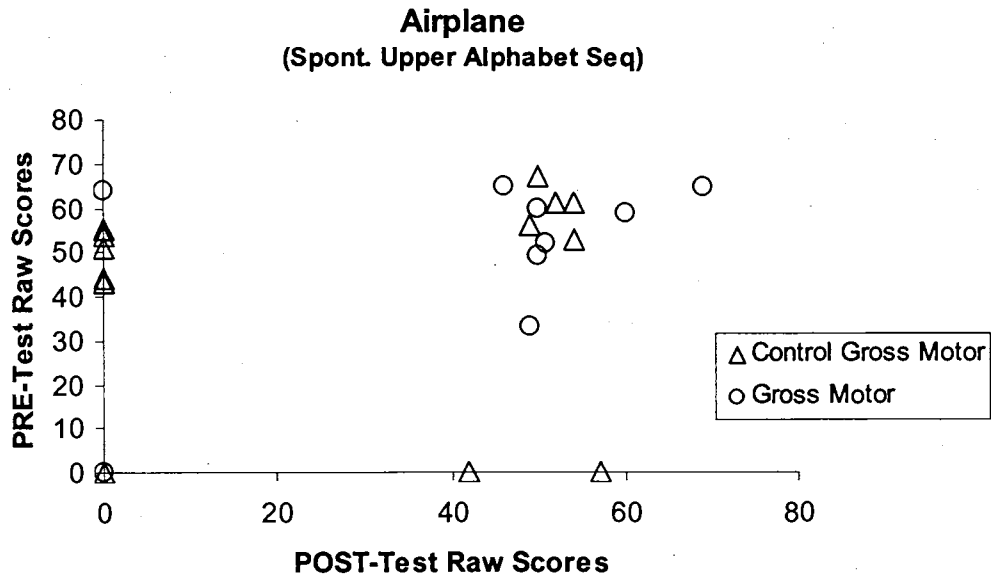


Table 5. Bus Subtest for Gross Motor Class versus Gross Motor Control Class.

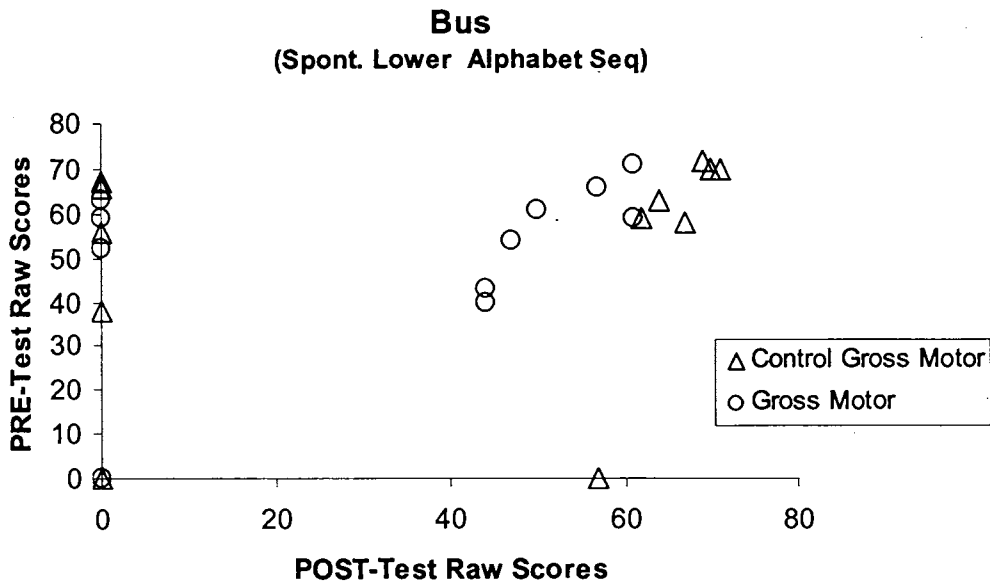


Table 6. Butterfly Subtest for Gross Motor Class versus Gross Motor Control Class.

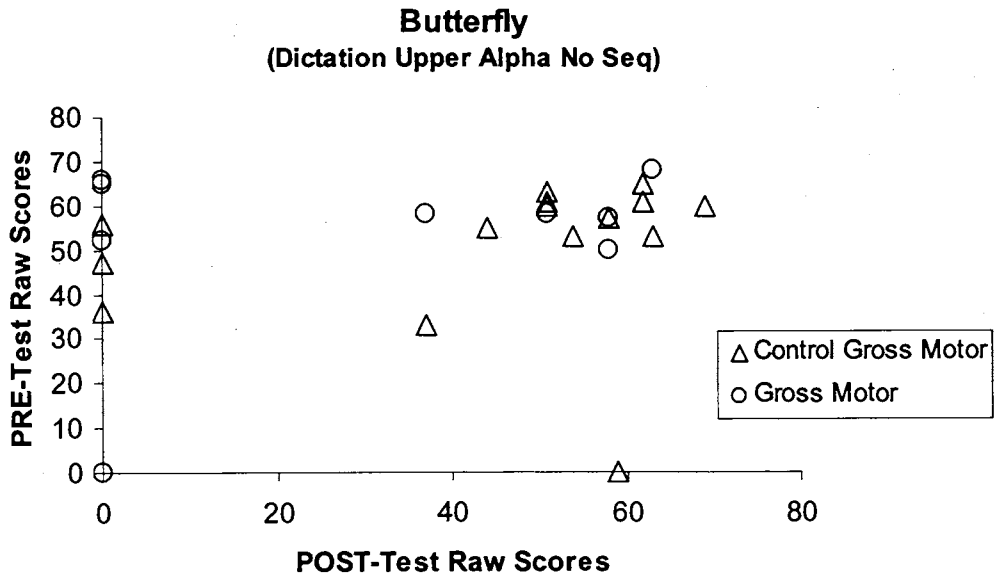


Table 7. Frog Subtest for Gross Motor Class versus Gross Motor Control Class.

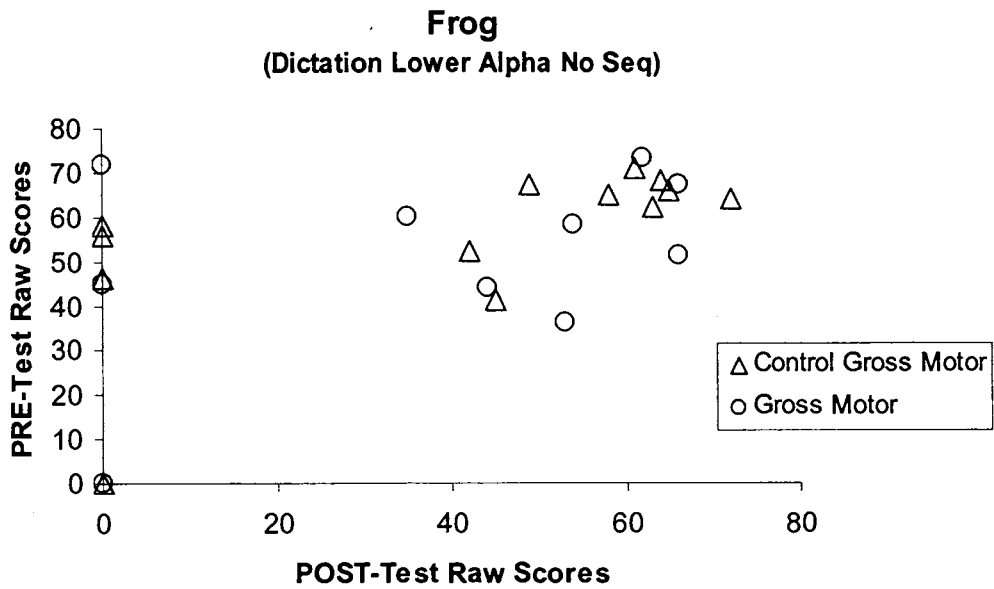


Table 8. Bicycle Subtest for Gross Motor Class versus Gross Motor Control Class.

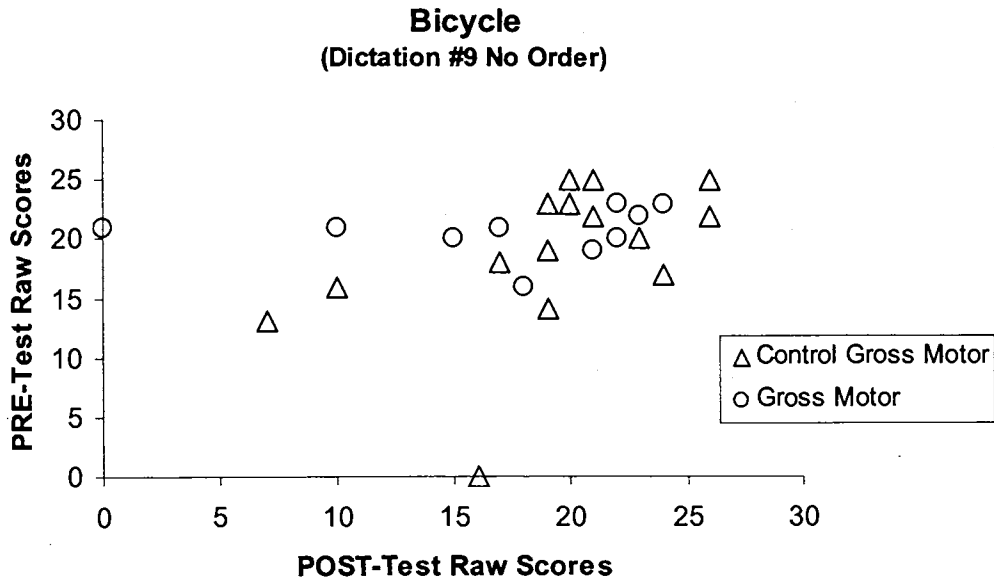


Table 9. Tree Subtest for Gross Motor Class versus Gross Motor Control Class.

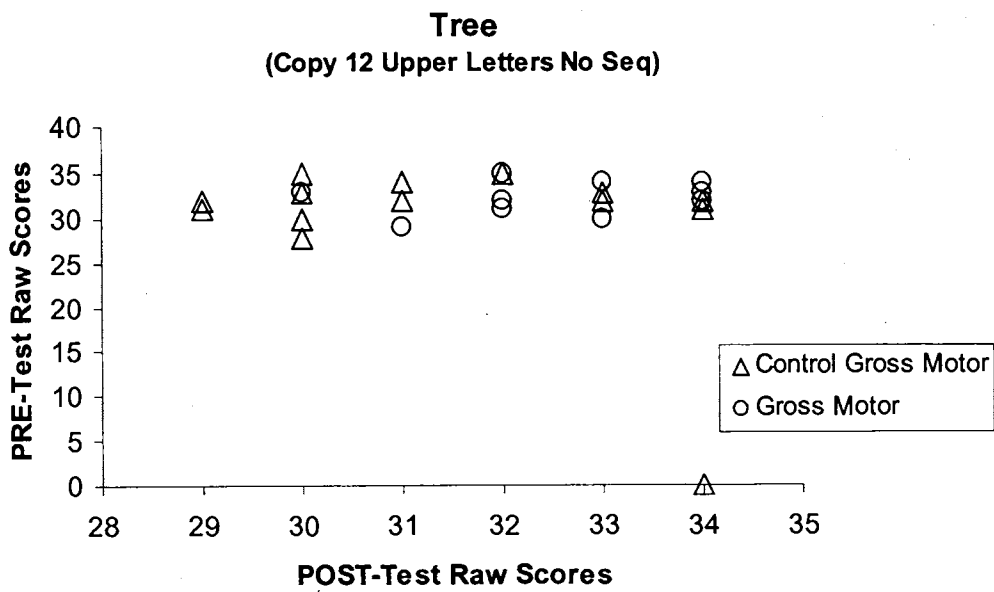


Table 10. Horse Subtest for Gross Motor Class versus Gross Motor Control Class.

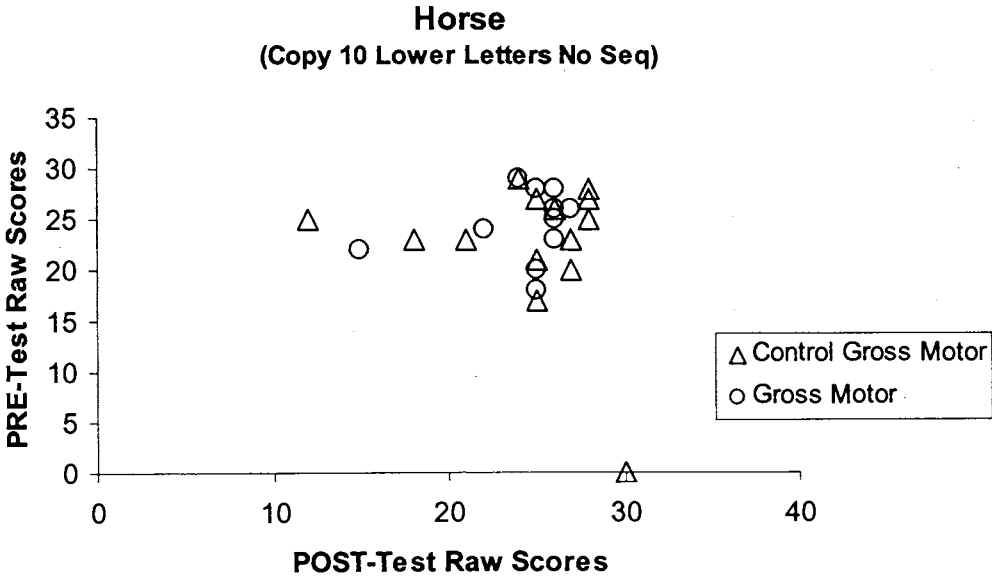


Table 11. Truck Subtest for Gross Motor Class versus Gross Motor Control Class.

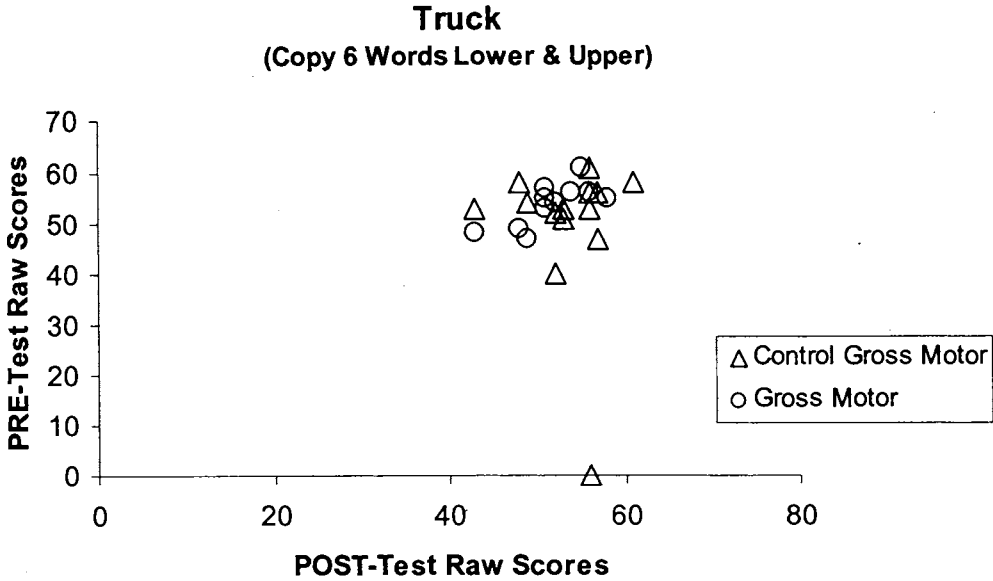


Table 12. Book Subtest for Gross Motor Class versus Gross Motor Control Class.

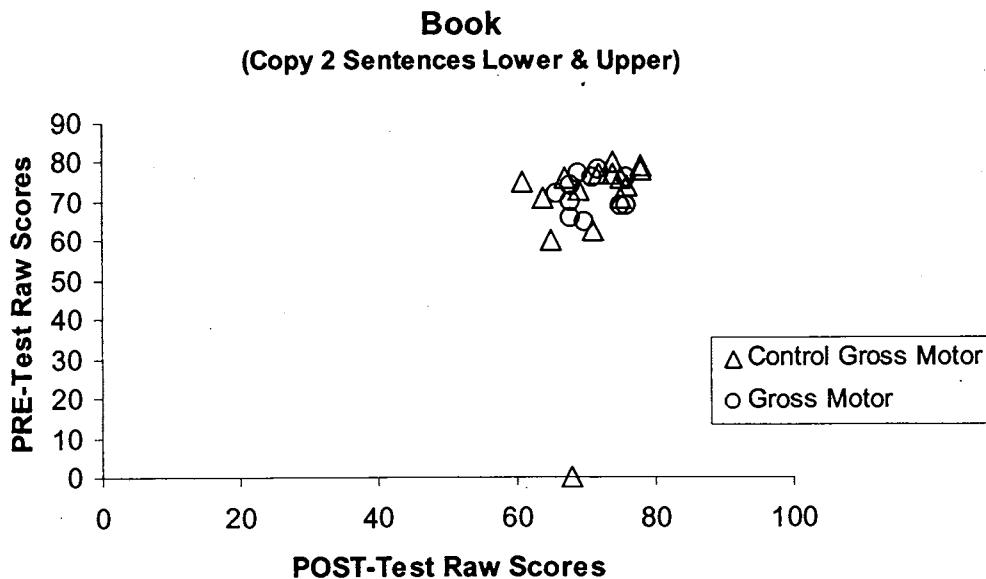
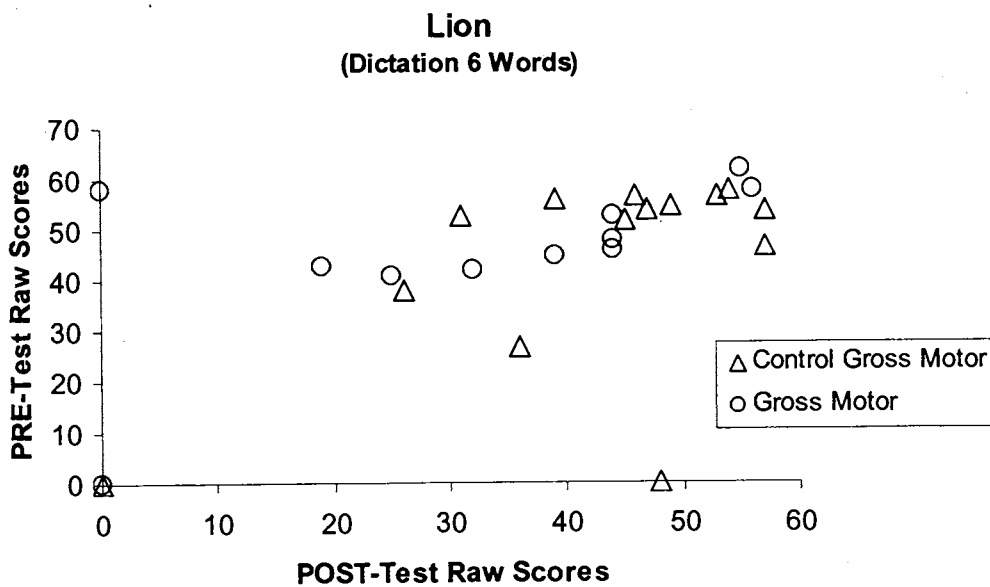


Table 13. Lion Subtest for Gross Motor Class versus Gross Motor Control Class.



in fine motor occupations or gross motor occupations is more effective for improving handwriting legibility in first-grade students.

Tables 24 - 33 display the results of the THS subtests that note the pattern of intermittent scatters of significance, which indicate that no overall effect is seen (see tables 24 - 33). Table 26 illustrates the butterfly subtest, which was the sole subtest to show the differences in effect on the scatter plot.

Gender

Table 34 gives an overview of mean scores grouped by gender variance for the ten subtests in the Test of Handwriting Skills. Females achieved higher mean scores than the males on eight out of ten subtests, however, this difference was not statistically significant (see table 34).

Table 14. Airplane Subtest for Fine Motor Class versus Fine Motor Control Class.

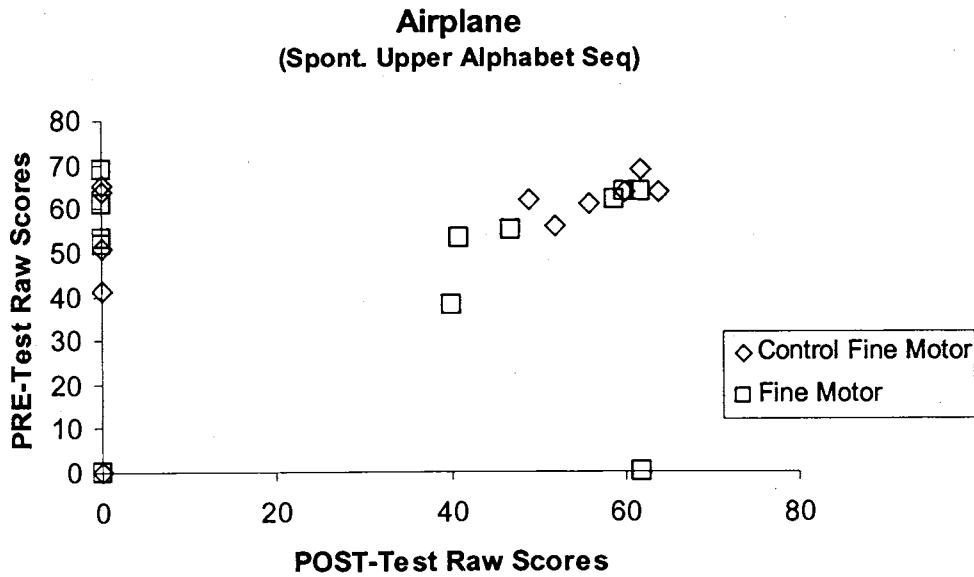


Table 15. Bus Subtest for Fine Motor Class versus Fine Motor Control Class.

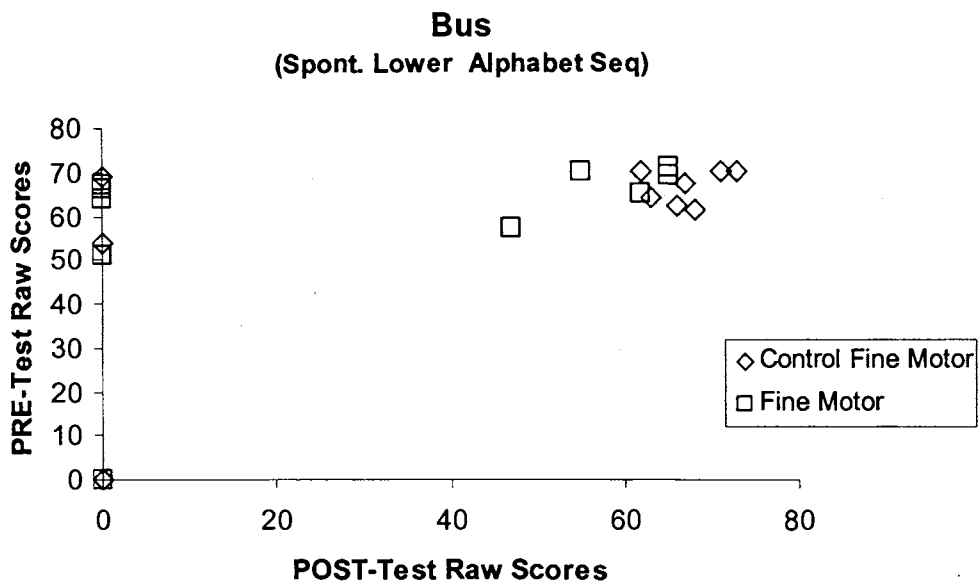


Table 16. Butterfly Subtest for Fine Motor Class versus Fine Motor Control Class.

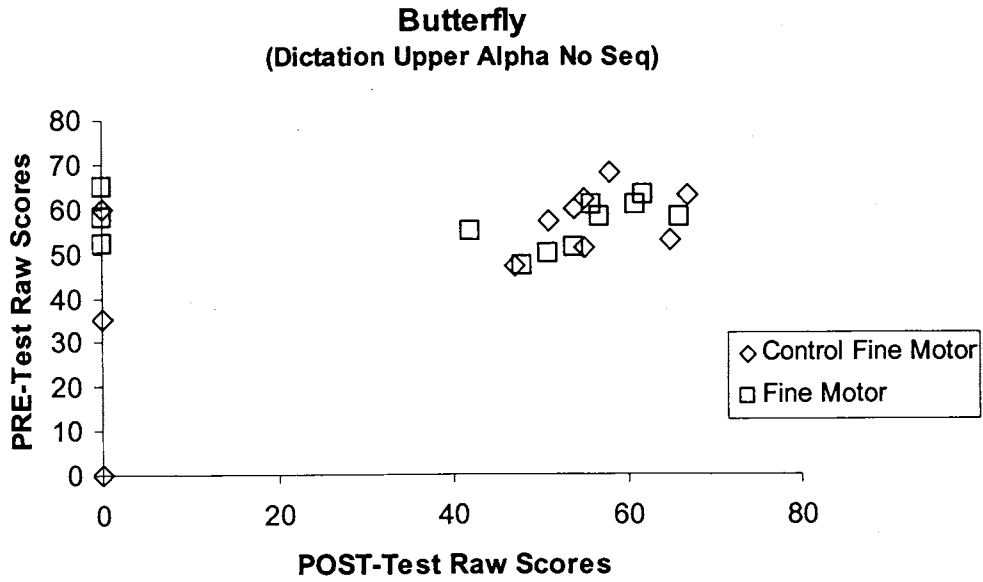


Table 17. Frog Subtest for Fine Motor Class versus Fine Motor Control Class.

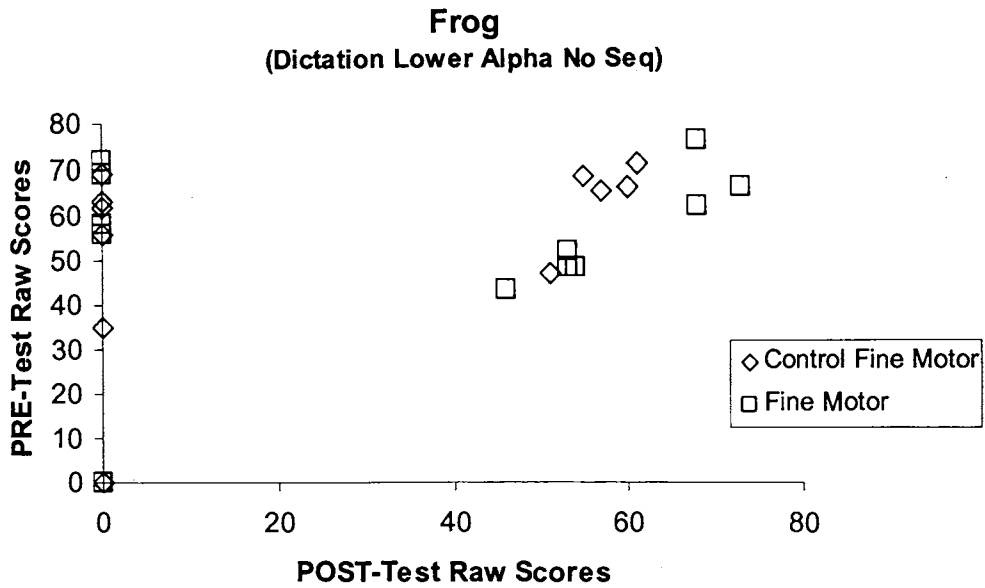


Table 18. Bicycle Subtest for Fine Motor Class versus Fine Motor Control Class.

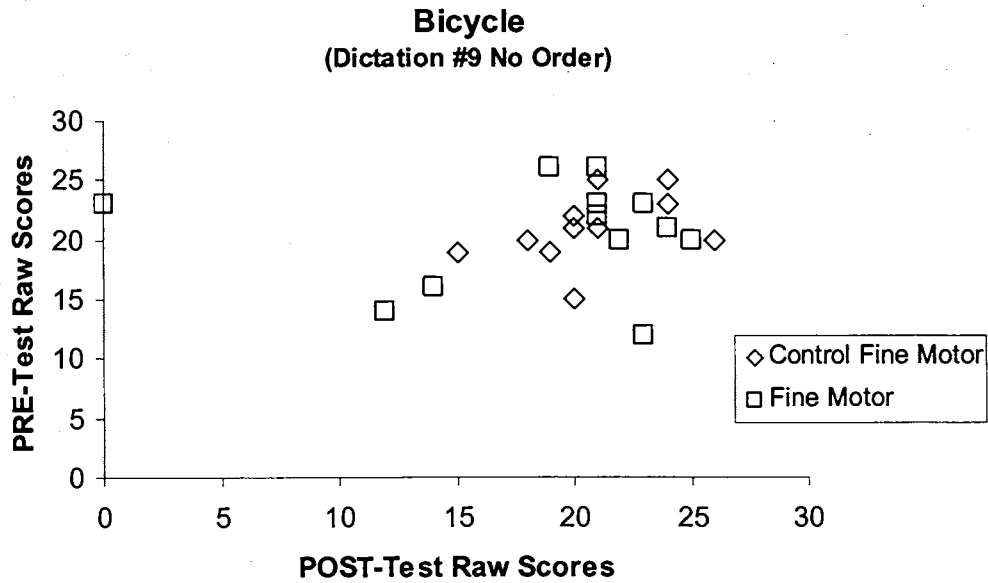


Table 19. Tree Subtest for Fine Motor Class versus Fine Motor Control Class.

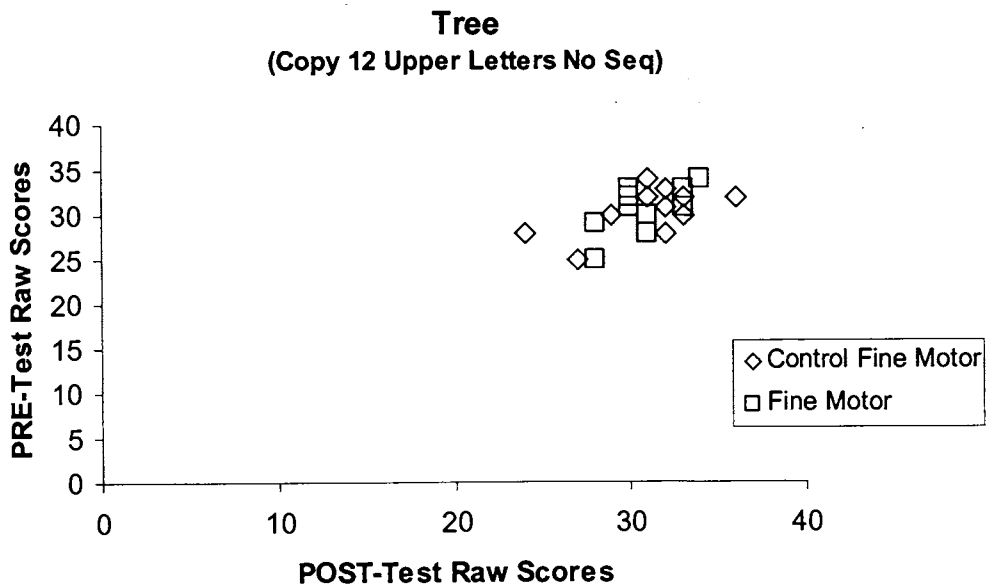


Table 20. Horse Subtest for Fine Motor Class versus Fine Motor Control Class.

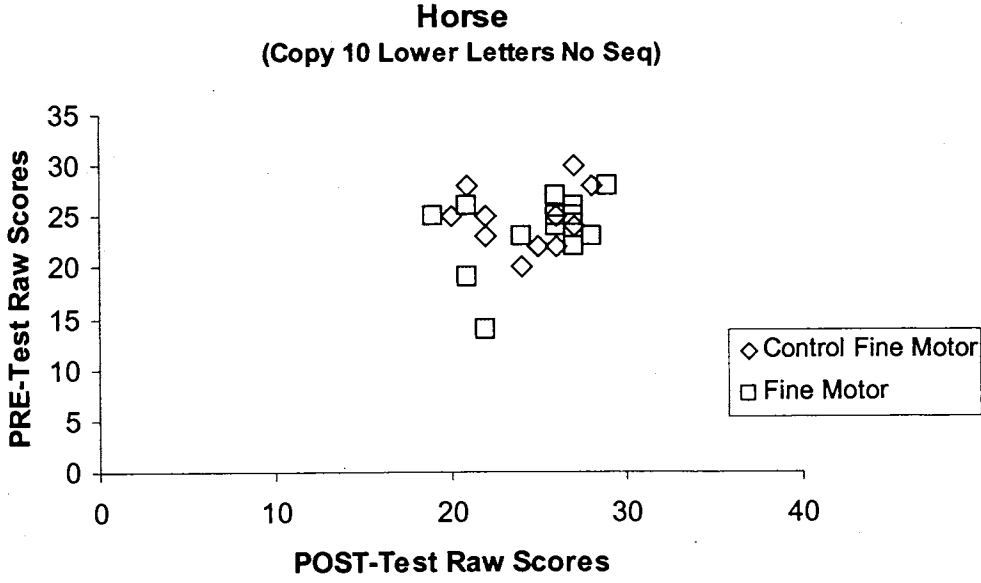


Table 21. Truck Subtest for Fine Motor Class versus Fine Motor Control Class.

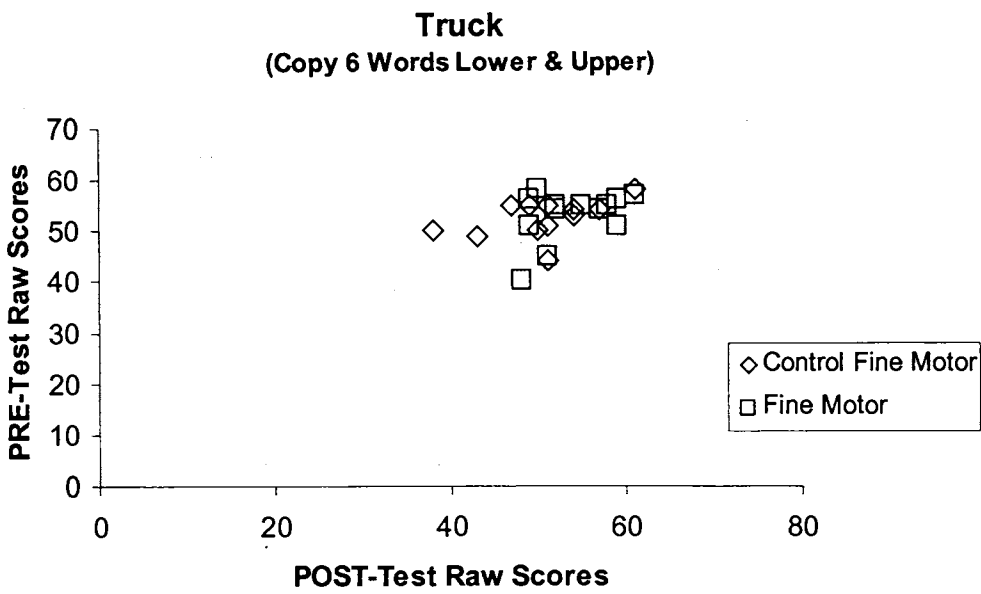


Table 22. Book Subtest for Fine Motor Class versus Fine Motor Control Class.

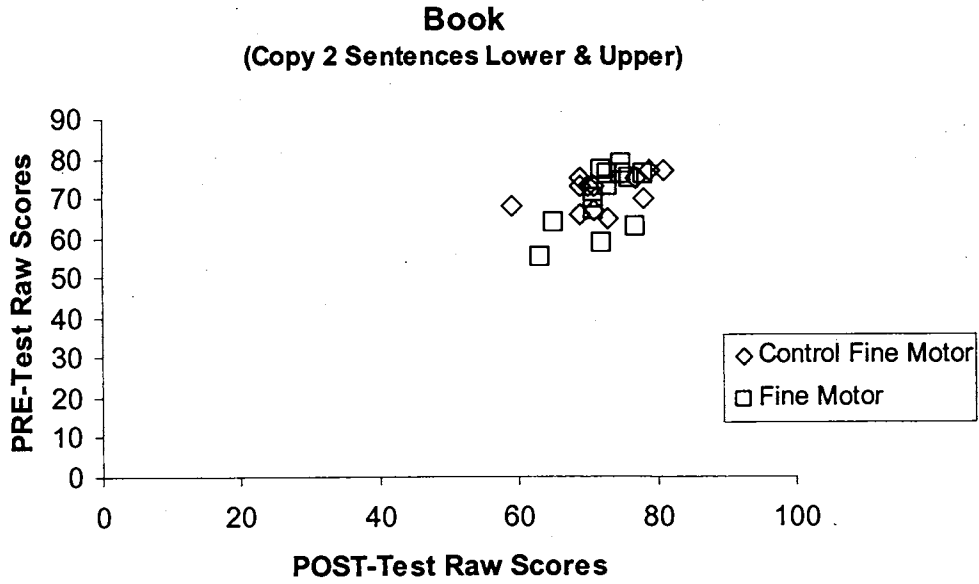


Table 23. Lion Subtest for Fine Motor Class versus Fine Motor Control Class.

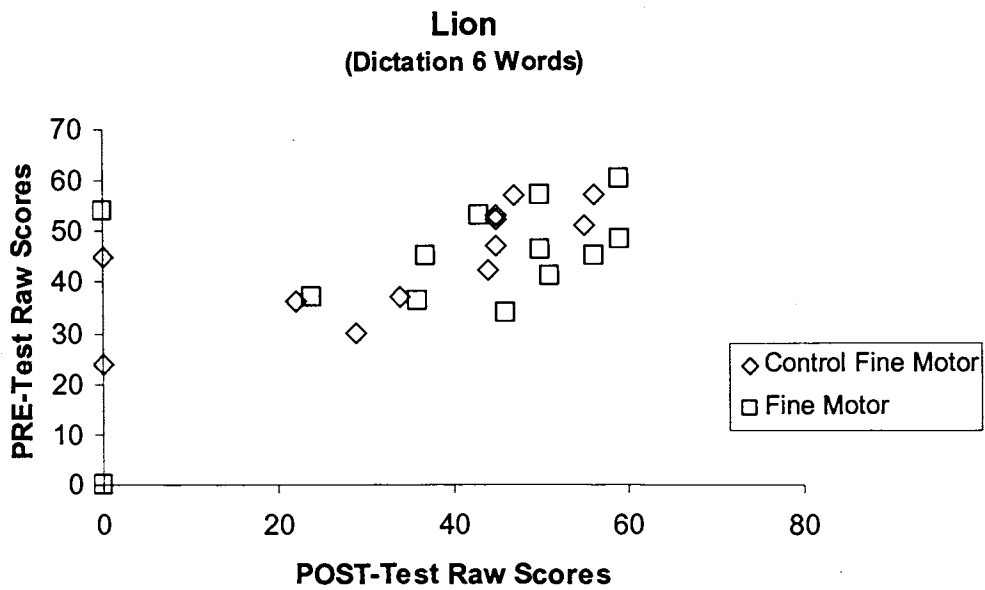


Table 24. Airplane Subtest for Fine Motor Class versus Gross Motor Class.

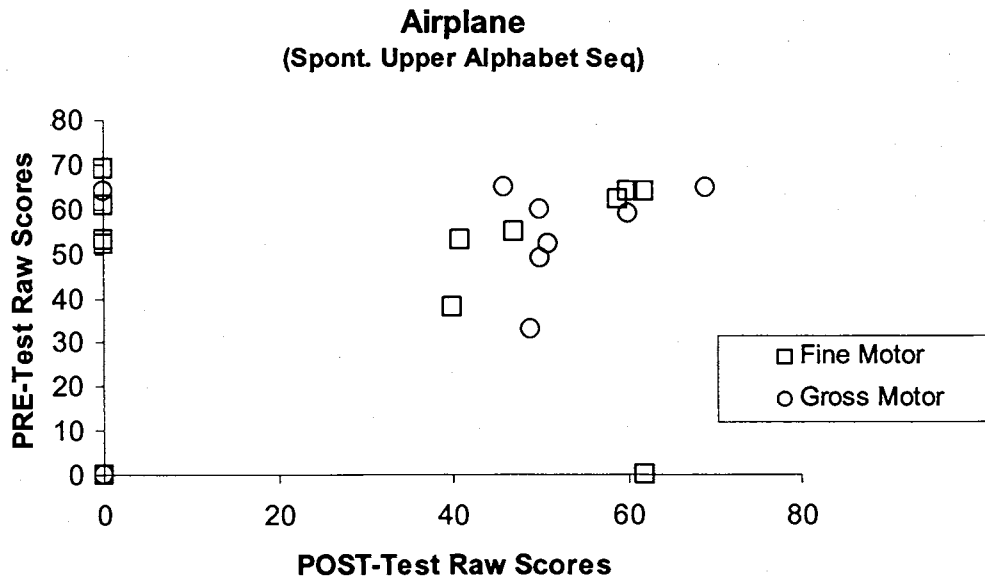


Table 25. Bus Subtest for Fine Motor Class versus Gross Motor Class.

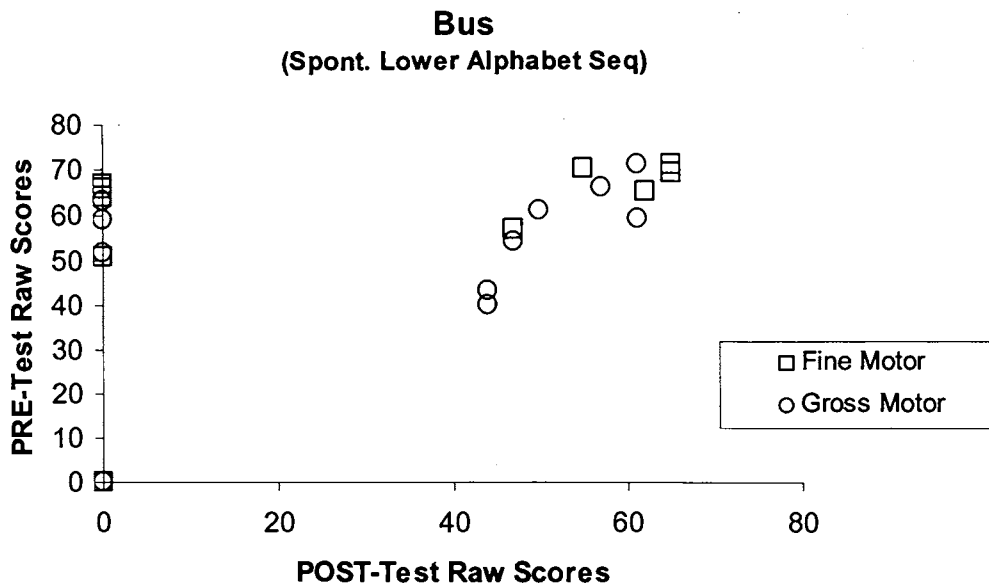


Table 26. Butterfly Subtest for Fine Motor Class versus Gross Motor Class.

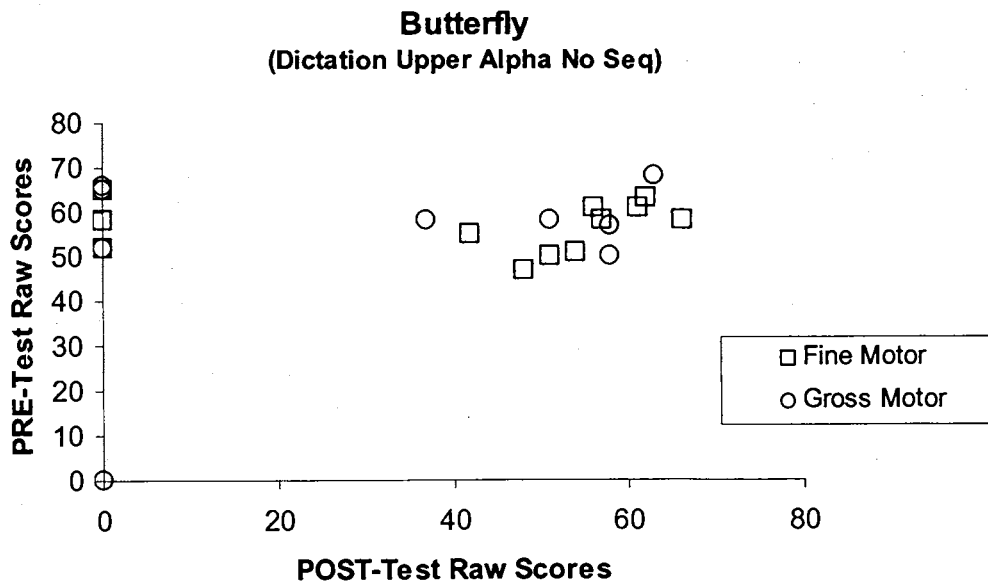


Table 27. Frog Subtest for Fine Motor Class versus Gross Motor Class.

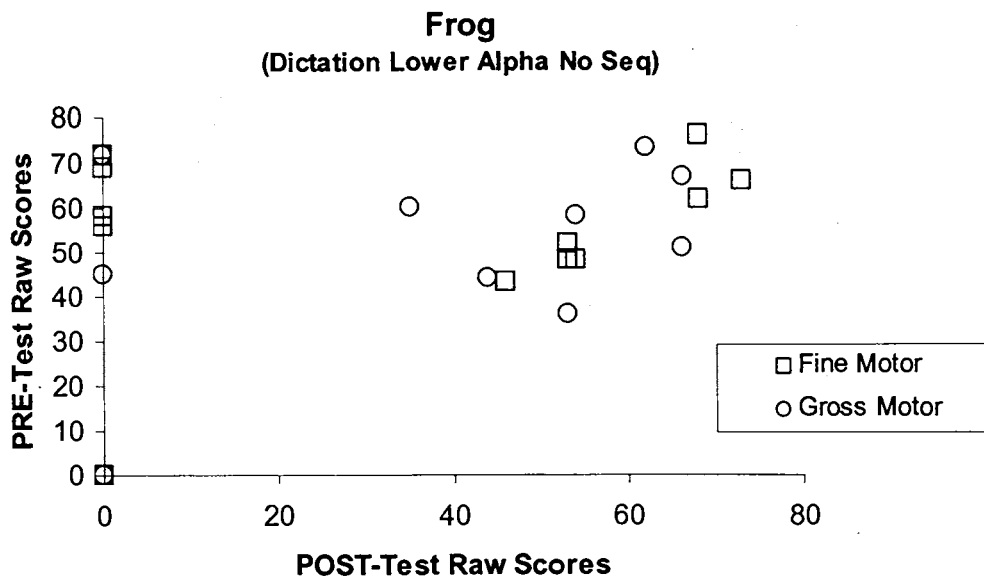


Table 28. Bicycle Subtest for Fine Motor Class versus Gross Motor Class.

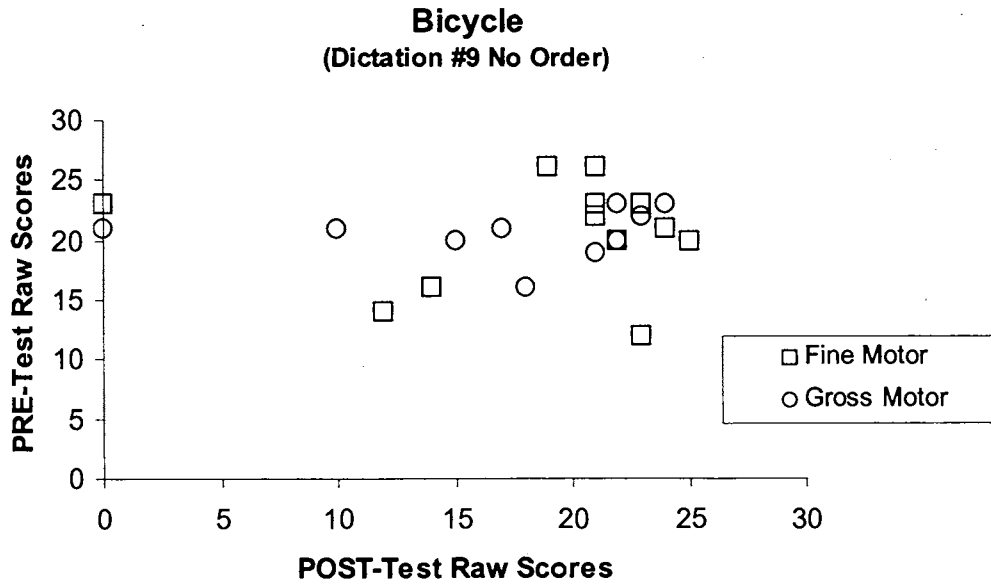


Table 29. Tree Subtest for Fine Motor Class versus Gross Motor Class.

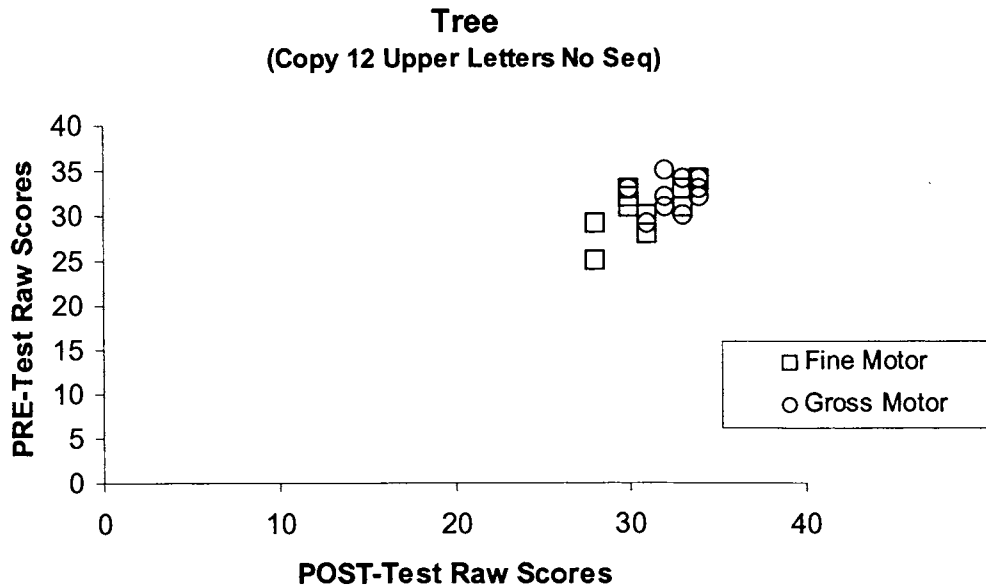


Table 30. Horse Subtest for Fine Motor Class versus Gross Motor Class.

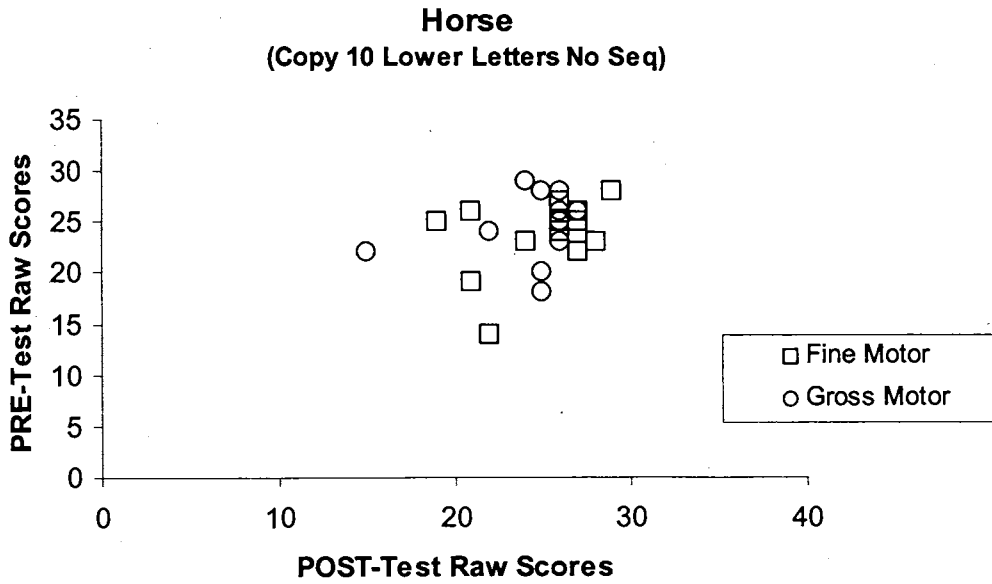


Table 31. Truck Subtest for Fine Motor Class versus Gross Motor Class.

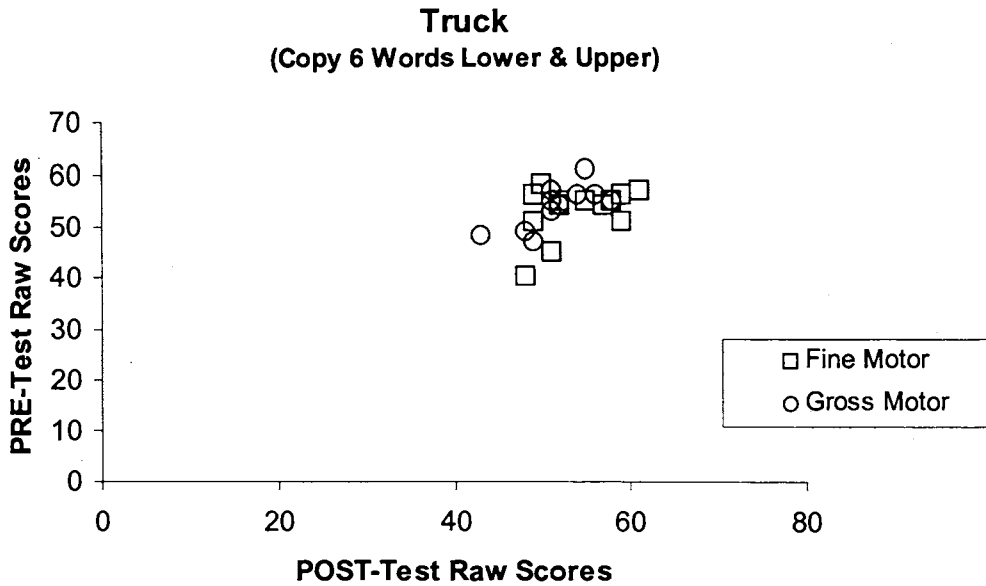


Table 32. Book Subtest for Fine Motor Class versus Gross Motor Class.

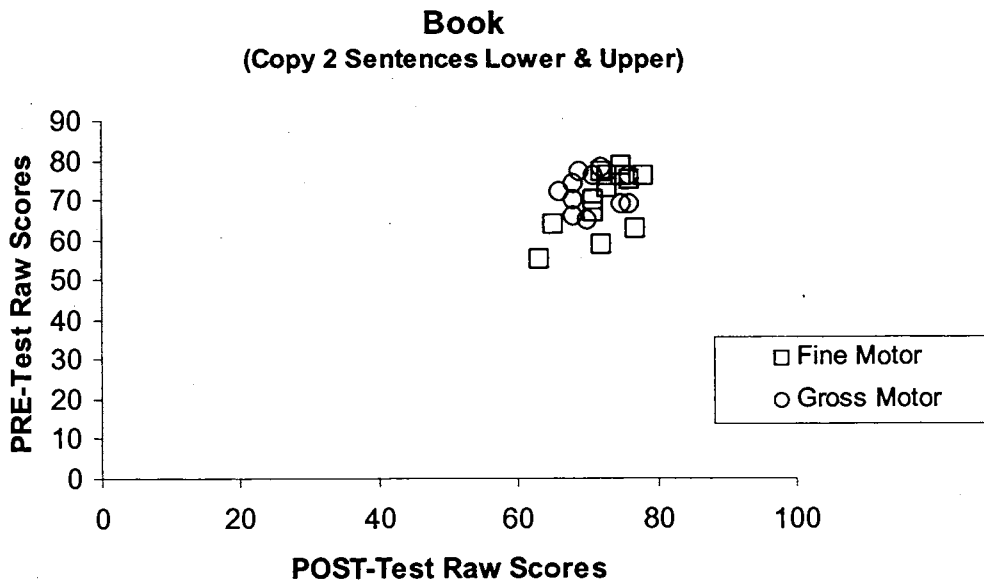


Table 33. Lion Subtest for Fine Motor Class versus Gross Motor Class.

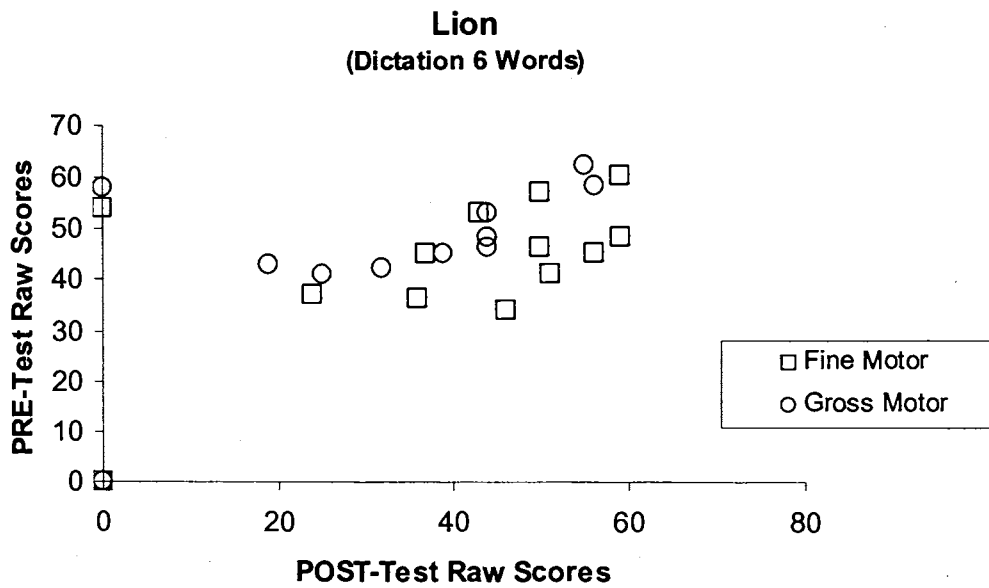
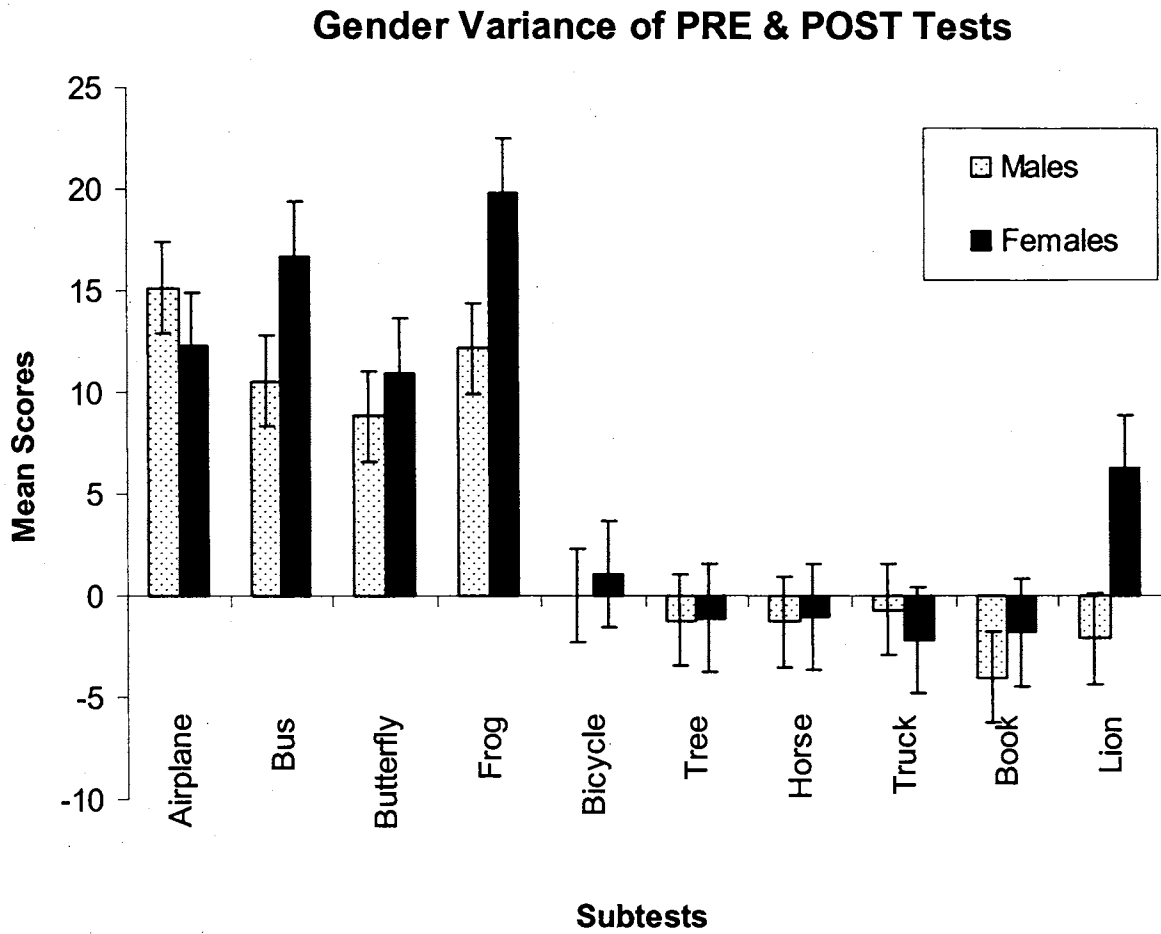


Table 34. Gender Variance by Test of Handwriting Skills Subtest Means Scores



Chapter 5: Discussion

The purpose of this study was to determine if fine or gross motor occupations incorporated into a pre-writing program improve scores in handwriting legibility as measured by the Test of Handwriting Skills.

The results of this study suggest that the addition of a motor program prior to handwriting instruction does not affect legibility in any of the conditions stated in the research questions. Improvements of handwriting legibility were found on the THS when comparing the mean scores from pre- to post-test across all four groups, however, scores were not statistically significant. Change between pre- to post-test would be expected due to maturation and the direct teaching of handwriting in the classroom for this age group. It is important to note that the teachers in all four classrooms used the Handwriting without Tears Program, which is a neurokinestically based handwriting program. The additional pre-writing motor programs may have been ineffective because the participants were already receiving similar types of input on a daily basis through the handwriting program itself. This study did not address the possibility that some effect may have occurred if the handwriting program were based on rote practice.

The lack of statistically significant change in THS scores may also be due to the measurement instrument used and the fact that all participants were typically developing. The THS may not have served as a sufficiently sensitive measure of discrete changes in a student's handwriting legibility for this age group since writing skill is still variable.

In answer to the research questions examined, analysis showed that there was no statistically significant difference in handwriting legibility as measured by the Test of Handwriting Skills in either study group as compared to the control groups. The findings

of this study are similar to those of past studies. For example, Sudsawad, et al. (2002) found that kinesthetic training did not improve handwriting legibility of first grade children tested in their study. Sudsawad, et al. (2002) measured kinesthesia and handwriting legibility before and after intervention. There was no significant improvement of handwriting legibility as measured by a standardized test in any of the groups they tested, although teachers indicated improvement of handwriting legibility in the classroom setting in all groups.

Cunningham Amundson (1992) claims that the use of a combination of techniques to improve handwriting is more effective than any one method, but it was beyond the scope of this study to examine the question of the effects of a combined gross and fine motor program on handwriting legibility. Harris and Livesey (1992) did find that kinesthetic ability is important for the performance of motor tasks such as handwriting. Children in their study who participated in kinesthetic sensitivity practice produced significant improvement in handwriting performance while handwriting practice alone did not; therefore, they suggested that rote practice alone does not produce the most effective approach for handwriting remediation. The conflicting results of various studies suggest that more research is needed in this area.

Gender Effects

Girls demonstrated more improvement overall in eight out of ten subtests, whereas boys in the groups showed more improvement in two of the ten subtests. This finding supports Gardner's (1998) conclusion that on average females tend to perform slightly better on THS items than males. Research indicates that illegible handwriting is attributed to a male more often than to a female (Sappington & Money, 2003; Spillman &

Others, 1994; Sprouse & Webb, 1994). Research also claims that at this age females are at an advantage scholastically and athletically as compared to males due to the fact that female brains grow faster (Epstein, 2004). For example, a four-year-old female has the equivalent size of a five-year-old male brain at this age. In kindergarten, there is a twenty percent difference between females and males.

The developmental difference between males and females might explain why many first grade classrooms are currently composed of seven-year-old males and six-year-old females (Dana Foundation, 2004). Dr. Martha Denckla, professor of Neurology, Pediatrics, and Psychiatry at Kennedy Krieger Institute at Johns Hopkins University, explained that around the age of six years the brain is developing at a slightly lesser rate in boys than in girls (Dana Foundation, 2004). Therefore, many schools are intermixing the ages of male students versus female students. Consequently, girls do better motorically with handwriting at this developmental age. The effect of the participants' age on handwriting legibility could not be addressed in this study, as a disproportionate majority of students were six years of age.

Hand Dominance

When viewing research on hand dominance Erhardt (1994) noted that:

“normal three year olds still show ambidexterity; alternating dominance from one hand to the other until six years of age. Between four to six years of age, dominance gradually increases and the other hand becomes more passive.

Completely integrated dominance does not always occur until eight to nine years of age” (p. 15).

Therefore, it is not unusual that some participants had not yet established hand dominance. When standardizing the THS Gardner (1998) found that right-handed students perform somewhat better on THS items than left-handed students. In this study the vast majority of students were right handed, therefore, the handedness analysis was not done and was not felt to affect the outcomes of the study.

Potential Explanation for Insignificant Findings

A number of possible explanations need to be considered when attempting to interpret the outcomes of this study.

Selection of occupations.

An interaction within or between the fine or gross motor programs may not have been discovered due to the occupations selected. Although the occupations selected are reported in the literature as commonly used (Benbow, 1995b; Levine, 1991; Woodward & Swinth, 2002), these motor occupations may not have been the best possible pre-writing motor techniques available to assist handwriting skill development. This review of motor occupations is noteworthy since they are so commonly used in practice. In addition, control groups may have completed classroom activities sufficiently similar to those in the prescribed motor programs through typical use of the Handwriting without Tears Program, thus, canceling out the potential effects of the added motor programs.

Pre-writing program time frame.

The three-week time frame for completion of the motor programs may not have been sufficient for demonstrating the attainment of improved handwriting skills. The time frame was short due to the time constraints of the study. It is possible that results may have been different if the programs were in effect for a longer time. This study was

carried out for three weeks in the classroom. Some skills of handwriting may require a longer time period before improved skill emerges and statistically significant changes are evident.

Assessment instrument administered.

The Test of Handwriting Skills assessment used to test first grade students may not have been a sufficiently sensitive measure of handwriting legibility. Given that the purpose of this study was to examine handwriting legibility in terms of how a child produces letters and numbers motorically and that the THS incorporates subtests that required use of cognitive skills by the students, the THS may not have been a sufficiently specific tool. For example, a subtest requesting one to copy letters relies on motoric skill while limiting the need for cognitive skills. There were four types of this subtest. Some subtests rely heavily on cognition by requesting one to recall the alphabet and write the letters in sequence from memory. There were six types of this subtest.

More specifically, subtests 1, 2, 3, 4, 5, and 10 require a child to use cognitive thought processes and motor components in combination to recall, sequence, and write letters from memory. Subtests 6, 7, 8, and 9 require a child to draw using simpler and predominately motor components by copying letters onto a page from a model. The purpose of this study was to examine the level of legibility related to motoric skills only. When comparing the subtests, no statistically significant difference was found. However, there was an interaction between all four groups on subtest 3 which required participants to write all letters of the alphabet in upper case from dictation out of sequence. Subtest 3 (Butterfly) was the only subtest that indicated a significant change between practice (fine or gross motor), activity (pre-writing program or control), and time (pre to post). It

appeared that many of the participants did not seem able to recall the alphabet in sequence. According to scoring criteria, if a child skips a letter, the scoring is discontinued for that subtest. Thus, a number of participants did not receive credit for this subtest.

The Test of Handwriting Skills scoring procedures also raise a pertinent issue. The THS manual explains that if a child does not know all letters and numbers, or does not know how to motorically produce all letters and numbers in Subtest 1, 2, 3, 4, 5, and 10, these subtests cannot be scored and no partial credit given (Gardner, 1998). The omission of all subtest data when an item is scored with a zero may be a significant factor related to measurement sensitivity. Therefore, the THS may not be an appropriate assessment to use as pre- and post-test criteria. It is possible that an effect from the pre-writing program may have been found if the researcher scored the pre and post tests based solely on the motor skill versus the cognitive skill of recall.

Additionally, the factor of lined classroom paper versus unlined THS paper raises a concern in this study (Lindsey & McLennan, 1983). Controversy exists regarding the use of lined versus unlined paper for handwriting instruction (Daly, et al., 2003). Woods (2001) discovered that the “use of unlined paper is a possibility in the beginning stages, but the lines quickly become useful” (p. 39). On the other hand, some researchers found that unlined paper enhances letter legibility by decreasing the demands placed upon the child (Daly, et al., 2003, p. 460). Teachers of the four classrooms reported that their students are taught handwriting through use of lined paper to help them attend visually to the formation of letters, words, and sentences. Since the student participants used lined paper in everyday classroom instruction, the use of unlined paper during test

administration may have introduced a confounding variable. It is possible that a lined pre-post test measurement may have allowed students to display a more accurate rating of handwriting. However, all students were equally disadvantaged by the unlined paper.

Handwriting curriculum utilized in participants' school district.

The handwriting curriculum utilized in the first grade classrooms of this school district may have negated the effects of the pre-writing motor programs. Olsen's (2001) Handwriting Without Tears multi-sensory program was designed to teach students with varied learning styles, using visual, auditory, manipulative, tactile, and kinesthetic methods. According to Olsen (2001), this handwriting program may help "eliminate problems with letter formation, reversals, legibility, sentence spacing, and cursive connections" (p. 1). This program is often used by occupational therapists due to its multisensory nature and its ability to be used with children of all ability levels. There may have been sufficient gross and fine motor components to the handwriting program itself so that the 10-minute program was insufficiently novel or additive.

Further research comparing Handwriting Without Tears and other writing programs is needed to determine if the Handwriting Without Tears program is indeed superior.

Typically Developing Children

Another possibility is the typically developing nature of the participants themselves. Since the vast majority of students learn to handwrite adequately when taught through a variety of methods, it may simply be that any program to accelerate learning is redundant. When taking into consideration all explanations of the results, the

researcher concluded that the final outcome might have been a result of an interaction between all variables listed.

Assumptions and other Considerations

The following assumptions were made as part of the investigation: a) the nature of the handwriting assessment will be accurate and will gather the data aimed intended for the purpose of the study, b) the population of first grade students is a representative sample of the population of interest, and c) teachers would conduct the intervention program accurately.

The use of group administration of the assessment should be taken into consideration when reviewing this study. Although group administration of the assessment is described in the THS manual, the teachers felt that many of the students rushed to keep pace with their classmates. It was also noted that some children looked to their peers for correct answers or models of writing despite the efforts of the examiner and teachers to discourage such behavior. Classroom teachers reported feeling their students were capable of higher performance if the tests had been given individually and in more appropriate seating. The tables and chairs used for testing did not provide for the most favorable seating for the children. Smith-Zuzovsky & Exner (2004) would support the teachers' feedback since their study found that the size comparison between the furniture and the child might have a considerable effect on a student's object manipulation skills. "Test administrators should strive to test young children in the most optimal seated position possible, particularly when the test involves complex hand skills" (Smith-Zuzovsky & Exner, 2004, p. 380).

The results of this study must be considered within the study limitations. It should be noted that results could only be generalized to children who have similar characteristics to those who participated in this study. Participants used for this study were homogeneous, generally from a rural area, and had no identified disabilities. These characteristics may have resulted in less variability in scores, less representation of first grade students as a whole, and may limit generalizability of the results to children of varying abilities. The effect of fine or gross motor occupations on handwriting legibility may be different in other groups of children.

Since classroom assignment to group conditions was based on teacher interest in participating it could be assumed that someone interested is more likely to follow through. Therefore, the distribution method could bias results. A final concern is that all four classes were taught handwriting by a different teacher, and for different amounts of time. The time these teachers spent on handwriting per week ranged from ten to twenty minutes 3 days per week or daily when possible. It is also unknown if the teachers had a different focus in class regarding the critical components of handwriting (i.e. spacing, letter size, etc) which may have effected the results. Additionally, teachers in the classrooms that were used as control groups conducted class according to their typical school day schedule. The amount of physical activity in the control classrooms prior to handwriting instruction was not tracked.

Summary of Discussion

This study used teacher-led, group sessions with first grade students of typical development, and in no way determined which occupational motor program is most effective. The ANOVA analyses and comparisons of means between experimental and

control groups were not found to be statistically significant. Regardless of classroom programs, there was an overall gain in participants' handwriting legibility. The findings suggest that the handwriting program provided by teachers was sufficient to effect gains in skills with or without additional input. The findings also support the idea that further research needs to be conducted to examine if an eclectic approach that emphasizes the importance of developing writing skills through a variety of methods is effective. The results also suggest a productive direction for research, for example, replication of the study with larger sample size. Scores from pre- to post-test did change, however, this may be due to a maturational effect. As a result of this study, no evidence was provided for the theory that fine or gross motor occupations alone promote better handwriting legibility in first-grade students.

Critique

This study is a master's thesis that included a sample of convenience and limited timeframe for completion that may have led to a lack of statistically significant results. If the sample had been randomized and confounding variables been further controlled, there may have been an increase in statistically significant effects and results. Despite these boundaries, this study has potential for being replicated in the future. This study also raises awareness about the various models that may be utilized during school based occupational therapy practice.

Application to Occupational Therapy Practice

Educators and therapists are concerned about a student's readiness for handwriting instruction. This study provides information that may be used by occupational therapists when working with children who are referred for handwriting remediation in the school

setting. The impact of this study is that occupational therapists may be providing unnecessary pre-writing programs if teachers are using the Handwriting without Tears program. This study adds to the literature that reports that the neurokinesthetic pre-writing programs are not effective. There was no effect from pre-writing programs for typical children who are being taught to write using the Handwriting Without Tears program. The researcher does not know if this generalization would be true if participants were struggling to acquire handwriting skills. The researcher also can not determine if results and conclusions would be the same if the teachers were instructing handwriting using a rote practice method. Further research on this topic is needed to provide evidence for appropriate methods to utilize in occupational therapy practice.

Chapter 6: Summary

It was determined that this research provided no evidence for the prescribed neurokinesthetic pre-writing program incorporating either gross or fine motor occupations to promote better handwriting legibility. Scores from pre- to post-test did improve, however, this may be due to a multitude of variables previously described. Based on these results, insufficient evidence was obtained for the use of the pre-writing motor programs as a single strategy to utilize in school classrooms for the purpose of handwriting remediation for students with similar characteristics to those who participated in this study.

More effectiveness-based research is needed in order to supplement the findings of this study and to provide more data for therapist's decision making during treatment planning.

Future Research and Recommendations

The present study examined typically developing children and described the importance of developing handwriting skills for the first grade student. Examining the effect between pre-writing motor programs and handwriting legibility within populations at risk for handwriting problems would be of value. If the effectiveness is stronger with children in need of services, the most appropriate and effective handwriting approaches may be identified and possibly incorporated into the student's day while at school.

Future research should examine the effectiveness of a prescribed pre-writing program over a longer period of time. A controlled study spanning an entire school year would show results based on the writing program as opposed to maturity. A long-term study would also examine the carryover of this program from year to year and from pre-

writing readiness to development of printing to development of cursive. Additionally, the effects of a long term pre-writing program as compared to a short-term pre-writing program is also suggested for future research.

Future research is needed to determine the relative effectiveness of various handwriting approaches (i.e. sensory motor, motor control, neurodevelopmental, etc.) in comparison to one another. Additional research would help to determine the most effective strategies for various populations of students learning to write. It is possible that a combination of strategies may be more effective than any of the strategies used separately. Effectiveness studies on this topic would enhance the clarity of what is truly the most effective treatment for remediation of handwriting difficulties.

Studies of this nature using an alternative testing instrument would be of benefit to the field of occupational therapy. Duplication of this study using a selection of different occupations for the pre-writing motor programs could help add to the evidence.

This study can be viewed as a catalyst for future research as it raises several interesting questions about the handwriting process. It is hoped that with this and future studies in this area, occupational therapists can learn effective methods for enhancing handwriting skills and academic performance. Future research on the validity/reliability of the Test of Handwriting Skills would also be valuable, as it is important to continually monitor assessment procedures to ensure accuracy in testing.

If given the opportunity to perform a similar study with additional resources, some adjustments and recommendations would be implemented. For example, sampling a school district that is not utilizing the Handwriting without Tears Curriculum would provide evidence specific to the prescribed pre-writing programs. Recruiting a larger

sample size for participation in the study would allow for results to be generalized to various pediatric populations. Administering an assessment that only focuses on the motoric handwriting component of legibility, instead of speed, size, and letter formation to target the specific handwriting skill, would be informative.

This study led the researcher to conclude that there is a great demand for research examining issues of therapeutic practice in the school based setting. Numerous professionals working in the educational field and related services show impressive enthusiasm and interest in advancing the knowledge base so that they can better meet the needs of their students. The field of occupational therapy and education would greatly benefit from continued research in the area of handwriting.

Appendix A

ALL-COLLEGE REVIEW BOARD
FOR
HUMAN SUBJECTS RESEARCH

COVER PAGE

Investigators: Patricia A. Cole, Graduate Occupational Therapy Student, Diane Long, MS, OTR/L, BCP & Kathleen Schlough, DSc, PT, PCS

Department: Occupational Therapy Department

Telephone: (607) 274-3093 (campus) (607) 272-6532 (home)

Project Title: The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility of First Grade Students

Abstract:

The purpose of this study is to evaluate whether participation in gross motor activities or fine motor activities, prior to handwriting lessons, will affect first grade students' handwriting legibility as assessed by the Test of Handwriting Skills by Morrison F Gardner. Approximately 60-80 students between the ages of five to seven will be assessed for the purpose of the study. The participants will engage in a structured gross or fine motor program prior to their typical handwriting program. In addition, the participants will complete the Test of Handwriting Skills to collect pre- and post- data. It is hoped that this research will result in both presentations and publications which may generate further discussion and research on determining the best occupational therapy treatment approach to remediation of students' handwriting difficulty.

There is limited evidence examining the value of handwriting remediation techniques in controlled experiments (Peterson & Nelson, 2003). More research needs to be conducted to determine the effects that motor activities, such as hopping, push-ups, finger exercises, etc., have on first grade students' handwriting skills. Research is required to discover if gross motor activity or fine motor activity incorporated into a student's class day will improve his or her handwriting legibility.

Proposed Date of Implementation: Fall Semester, 2004

Patricia Cole, Principal Investigator, Diane Long, Faculty Advisor, & Kathleen Schlough, Committee Advisor

Print/Type Name of Principal Investigator, Faculty Advisor and Committee Advisor

Signature (use blue ink) of Principal Investigator, Faculty Advisor & Committee Advisor

**ALL-COLLEGE REVIEW BOARD
FOR
HU&MAN SUBJECTS RESEARCH**

CHECKLIST

Project Title: The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility of First Grade Students

Investigator(s): Patricia A. Cole, Graduate Occupational Therapy Student, Diane Long, MS, OTR/L, BCP & Kathleen Schlough, DSc, PT, PCS

<u>Investigator Use</u>	<u>HSR Use Only</u>	<u>Items for Checklist</u>
<u>X</u>	<u> </u>	1. General Information
<u>X</u>	<u> </u>	2. Related Experience of Investigator(s)
<u>X</u>	<u> </u>	3. Benefits of the Study
<u>X</u>	<u> </u>	4. Description of Subjects
<u>X</u>	<u> </u>	5. Description of Subject Participation
<u>X</u>	<u> </u>	6. Description of Ethical Issues/Risks of Participation
<u>X</u>	<u> </u>	7. Descriptions of Recruitment of Subjects
<u>X</u>	<u> </u>	8. Description of How Anonymity/Confidentiality will be Maintained
<u>X</u>	<u> </u>	9. Debriefing Statement
<u>X</u>	<u> </u>	10. Compensatory Follow-up
<u>X</u>	<u> </u>	11. Appendix A – Recruitment Statement
<u>X</u>	<u> </u>	12. Appendix B – Informed Consent Form
<u>N/A</u>	<u> </u>	13. Appendix C – Debriefing Statement
<u>N/A</u>	<u> </u>	14. Appendix D – Survey Instruments
<u>N/A</u>	<u> </u>	15. Appendix E – Glossary to Questionnaires, etc.
<u>N/A</u>	<u> </u>	16. Appendix F – Protocol Template and Sample Tear-Off Cover Page (Delegated Review only)

Items 1-8, 11, and 12 must be addressed and included in the proposal. Items 9, 10, and 13-15 should also be checked if they are appropriate – indicated “N/A” if not appropriate. This should be the second page of the proposal.

HUMAN SUBJECTS PROPOSAL

1. General Information about the Study:

- a. Sources of funding, if any: There are no external sources of funding for this project. A request for funds from the Graduate Occupational Therapy Department budget will be made to cover the cost of test materials, and copying. Any expense not covered will be the responsibility of the principal investigator.
- b. Where will study be conducted: This study will be conducted in the elementary school that the participants attend.
- c. When do you plan to begin the study, and when will it be complete: It is anticipated that this study will begin in the Fall Semester 2004 and will conclude in the Spring Semester 2005.
- d. What are the expected outcomes: It is anticipated that the results will be shared with the participating school systems and may be presented at a professional conference and/or published in a professional journal.
- e. Related experience of the researcher(s): As the principal investigator, *Patricia Cole* has earned a Bachelor of Science in Occupational Science at Ithaca College and is currently an Ithaca College graduate occupational therapy student. In preparation for this study she has completed biostatistics, research methods in occupational therapy, medical ethics, occupational therapy in pediatrics and practicum in pediatric occupational therapy courses. She has also completed a Dana Internship for the occupational therapy department where an in-depth review and coding of existing client records was performed.

Diane Long, faculty advisor, has been an occupational therapist for 25 years with experience and Specialty Certification in Pediatrics. She has been involved in several research projects including program evaluation of occupational therapy consultation in kindergarten programs, use of constraint-induced movement therapy and summer programming for kindergarteners at risk of developmental delay. She is an associate professor in the occupational therapy office. She has supervised four graduate students in these projects and has been the primary instructor of group research projects where data has been collected, analyzed, and reported. She has taught research methods in the OT graduate program.

Kathleen Schlough, thesis committee advisor, has practiced as a pediatric physical therapist for thirty years and as an assistant professor for eight years. She has conducted numerous student research projects with both physical and occupational therapy students.

2. Benefits of the Study:

It would be to the benefit of occupational therapists, educators, parents, and children to carry out this study and gain more insight into what is an effective treatment approach for the remediation of students' handwriting difficulties. Parents and teachers will gain standardized information about the children's handwriting abilities. This study will provide another source of research that will

help to show the effects of gross motor versus fine motor activity on handwriting legibility of first grade students.

3. Description of Subjects:

- a. *How many & Salient Characteristics:* Approximately 60-80 typically developing first grade students from four classrooms will be recruited for the purpose of this study. Both females and males, ranging in age from five to seven years old, will be included. The cut-off age of eight years will be used due to the achievement of different developmental milestones associated with the age range. All students included in the study are required to have parent consent prior to data collection. Subjects are excluded from this study if they are receiving occupational therapy services for handwriting remediation or if they have diagnosed conditions that impede their handwriting ability. Students whose parents do not give consent for participation will also be excluded.

4. Description of Subject Participation (explanation in detail):

- a. *Exactly what the subjects will be doing in the study and what will be done to them:* As part of the study, all students in the four classrooms will complete the Test of Handwriting Skills, Manuscript version (Appendix E) as a pre--test prior to implementation of either a gross (large) motor program, a fine (small) motor program, or one of two controlled groups held within the classroom. However, only student participants whose parent(s)/legal guardian(s) gave consent will have their data scored and analyzed. A consultative approach with teachers of each classroom will be utilized for instruction for the motor activity program. Teachers will direct either a prescribed gross or fine motor group activity or no pre-writing activities, every day before handwriting class for three consecutive weeks. At the end of the three week timeframe, the Test of Handwriting Skills will be readministered.
- *Pre-Test:* All students in the four classrooms will complete the Test of Handwriting Skills, Manuscript version (Appendix E).
 - *Gross Motor Program:* One of the four first grade classrooms will participate in a gross motor program. Students in this program will complete a five to ten minute warm up activity involving hopping, jumping as high as they can while tracing a letter in the air, running in place, push-ups, animal walks on hands and feet, jumping right and left, hopping on one foot across a line on the floor, hopping on both feet across a line on the floor, hopping backwards across the line (Appendix F). All gross motor activities will be completed in the classroom as a group activity.
 - *Fine Motor Program:* One of the four first grade classrooms will participate in a fine motor program. Students will complete a five to ten minute warm up activity involving spider on mirror hand patterns, penny flipping in an "x" shape pattern, finger tracing in the air with two fingers, tic tac toe while lying prone, and inch worm on a stick (Appendix G). All fine motor activities will be completed in the classroom as a group activity.

- *Control Group:* Two of the four first grade classrooms will participate in a control group. Students in this group will not be participating in a motor program. These students will complete classroom activities as normally scheduled by their teacher.
- *Post-Test:* All students in the four classrooms will complete the Test of Handwriting Skills, Manuscript version (Appendix E).

The researchers want to be able to review the collected data for analysis related to the study questions. Parents will be asked to complete a demographic form detailing family and student information (Appendix D).

- Amount of time subjects' participation will take:* The assessment will take approximately 15-20 minutes to complete per class. The gross or fine motor program will take 5-10 minutes to complete daily prior to the first grade handwriting curriculum taught in the classroom. The gross or fine motor program will be carried out within the first grade classroom for a period of three consecutive weeks.
- Description of apparatus or equipment used:* The forms provided in the appendices along with pennies and tic tac toe handouts will be used.

5. **Ethical Issues:**

- What are the potential physical and psychological risks to the subjects as a result of their participation in the study? Describe attempts to minimize potential risks to subjects:* Risks to the participants in this study are minimal. Some participants may become anxious, experiencing a source of mild anxiety during the assessment therefore; participants will be assured that he or she is not being graded on the assessment test. There is also a potential risk for injury during completion of the motor program; however, this risk is not higher than the risk involved in the child's normal everyday school environment. In order to minimize this risk of injury in the classroom, teachers will be made aware of the need to provide a safe environment by clearing the area of classroom furniture.
- Informed consent: Attach copy of informed consent form to be used; if one is not used, explain why one is not necessary for this type of study:* See Appendix C for informed consent form.

6. **Recruitment of Subjects:**

- How will participants be recruited? Describe procedures used to identify and recruit subjects: attach a copy of the recruiting statement, letter, or flyer to be used. Identify how confidentiality and concern for the individual are reflected in your selection of subjects:* Three elementary school principals, from the Altmar-Parish-Williamstown school district in Upstate New York, will be contacted and given a letter explaining the purpose and parameters of the study (See Appendix A). At this time the principals will be asked to sign and return the memo to principals form allowing me to conduct this study in their school (See Appendix A). Consent will be obtained from all building principals whose school is

participating in the study. All parents of the students identified as potential subjects will be sent a letter describing the study (See Appendix B) along with an informed consent form (See Appendix C) by the school principal. Student's parents will return informed consent for their child's participation in the study to the school principal who will contact the researcher when they have been compiled.

- b. Are subjects offered any inducement for their participation in the study (e.g. extra credit, money, food)? Additional concerns: (recruitment in own classes, extra credit opportunities): No inducement to participate will be provided to the students involved in the study.

7. Confidentiality and Anonymity of the Study:

- a. Describe procedures used to ensure anonymity or confidentiality of the subjects' responses: To ensure confidentiality of the students' responses the following will occur. The Test of Handwriting Skills assessment will be administered to all students in the classroom. The building principal will only give the researcher the assessments of the students whose parent(s)/guardian(s) gave consent. Participants' will write their first name and last initial on the assessment test sheet. Building principals will apply a numeric code to the test sheet prior to submission to the researcher. Therefore, the researcher will not know scores of specific children. Consent forms will be stored by the building principal until the tests are scored. The consent forms will then be given to the researcher for storage with the test forms for seven years in a locked cabinet in the occupational therapy department at Ithaca College that is designed specifically for this purpose. No individual child's score will be reported, all scores will reported as a group.

8. Debriefing:

- a. Describe what subjects will be told after their participation in the study and attach a copy of the debriefing statement, if any: Participants will not be deceived as part of this study, so there will be no structured debriefing. Participants, legal guardians of the participants and school administration will be able to ask questions of the investigators at any time during the study or after about the procedures involved. All parties involved in the study will be informed that they may contact the researcher for a copy of the results of the study. The informed consent will provide all necessary information to parent/guardian(s). There will be no hidden purposes to the study, or anything that may require debriefing. The primary researcher will be available to answer parents' questions about how the children scored on the test.

9. Compensatory Follow-up:

- a. If negative physical or psychological outcomes are foreseen due to participation, describe what type of compensatory treatment or counseling will be made available to or recommended to the subjects: No negative outcomes are foreseen

due to participation, however, participants' guardians and school administration will be instructed to contact the principal researcher with any concerns or questions that arise during the course of their participation in the study.

10. All Required Appendices and Attachments are Attached, and Include:

1. Appendix A – Recruitment Statement & Agreement Letter to Principals
2. Appendix B – Parent/Legal Guardian(s) Description of the Study
3. Appendix C – Parent/Legal Guardian(s) Informed Consent Form
4. Appendix D – Demographic Form
5. Appendix E – Test of Handwriting Skills test form, Manuscript version
6. Appendix F – Gross Motor Program
7. Appendix G – Fine Motor Program
8. Appendix H – First Grade Teacher Questionnaire

Appendix B
Recruitment Statement for Participation in the Study

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Dear Building Principal,

I am a graduate student in the occupational therapy program at Ithaca College. As part of my master's degree requirements, I am completing a research project. I am requesting the assistance, of your first grade teachers as well as yourself; with a study I am conducting which will examine the effects of gross motor or fine motor activity on handwriting legibility of first grade students.

The subject of my thesis project relates to occupational therapy service delivery for children in the school system. Specifically, I am interested in examining the effects of gross motor or fine motor activity on handwriting legibility of first grade students in their classroom. Gross (large) and fine (small) motor skills are central concepts that occupational therapists focus on when working in the school system, however there is little research regarding the influence of one type of activity over the other. By participating in this study, teachers, parents, and yourself will gain standardized information about your students' handwriting abilities.

I plan to conduct this study with four first grade classrooms in the Altmar-Parish-Williamstown School District. In collaboration with my thesis committee members Diane Long (Ithaca College professor of occupational therapy) and Kathy Schlough, (Ithaca College professor of physical therapy), I have developed and will ask teachers to implement a gross or fine motor program in two classrooms for three weeks. In the third and fourth classrooms, the teachers will conduct class as usual and be considered a control group. I will administer a short handwriting assessment before and after this three week period.

You will be asked to sign a letter of agreement stating that you have the authority to commit your school to allow my research project to be conducted within your building. I will be asking that you assist in the coding of the students' individual test forms to ensure confidentiality.

Thank you very much for your assistance with this study.

Sincerely,

Patricia Cole, BS, OTS
(formerly Patricia Poindexter)

Diane Long, MS, OTR, BCP

Kathleen Schlough, DSc, PT, PCS

Appendix C
Agreement Letter to Principals

To: Ithaca College Human Subjects Review Board

From: Building Principal

I have met with Mrs. Patricia Cole, Ithaca College occupational therapy student, and discussed the potential for conducting her research project within my school system.

I understand that:

- 1) The purpose of her study is to evaluate if participation in motor activities will affect first grade students' handwriting legibility as assessed by the Test of Handwriting Skills,
- 2) Classroom teachers will be asked to conduct a prescribed set of either gross motor or fine motor activities daily prior to classroom handwriting instruction for three consecutive weeks,
- 3) Mrs. Cole will design the pre-writing activities and educate teachers on the protocols prior to initiation of the study,
- 4) Mrs. Cole will administer a handwriting assessment to all students before beginning and after the three week period of the motor programs,
- 5) School personnel will be asked to obtain parental permission for student handwriting assessments to be used in an aggregated manner for the purposes of this study (a preliminary copy of the Consent Form is attached),
- 6) Mrs. Cole will maintain confidentiality of all student information. It will be shared with her thesis advisor and destroyed once the study is completed,
- 7) Mrs. Cole will share study results with school personnel.

By signing below, I am stating that I have the authority to commit my school to allow Mrs. Cole to conduct her research project. Once my agreement to participate has been obtained, Mrs. Cole will be allowed to contact first-grade teachers in my building to ask for their participation. If I have any questions or comments at anytime I know that I can contact: *Occupational Therapy Student, Patricia Cole* at home: (607) 272 - 6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274 -

3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu.

I, _____, have read the above and I understand its contents. I am agreeing to allow this study to be conducted within my school.

School Name

Signature, Title

Date

Appendix D
Parent/Legal Guardian(s) Description of the Study

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Dear Parent/Legal Guardian(s),

I am a graduate student in the occupational therapy program at Ithaca College. As part of my master's degree requirements, I am completing a research project. I am interested in studying first grade students' handwriting legibility. The subject of my thesis project relates to occupational therapy service delivery for children in the school system. Specifically, I am interested in examining the effects of gross motor versus fine motor activity on handwriting legibility of first grade students in their classroom. Gross (large) and fine (small) motor skills are central concepts that occupational therapists focus on when working in the school system, however there is little research regarding the influence of one type of activity over the other. Your child was selected because he/she is in the first grade level, therefore, I am writing to request your permission to include your child's handwriting test scores in my study.

I plan to conduct this study with first grade classrooms in the Altmar-Parish-Williamstown School District. In collaboration with my thesis committee members Diane Long and Kathy Schlough, I have developed and will ask teachers to implement a gross or fine motor program in two classrooms for three weeks. In the third and fourth classrooms, the teacher will conduct class as usual and be considered a control group. I will administer a short handwriting assessment before and after this three week period. Every attempt will be made to be sure this study does not interfere with your child's academic program and I will be sure to collaborate with the teachers of the classrooms to find the best time to complete this activity. Diane Long will be supervising me throughout this study which is planned to begin around October 2004 and to be completed March 2005. Please consider allowing your child to participate in this project. If you agree to allow your child to participate, please return the enclosed "Informed Consent Form" in the pre-addressed stamped envelope no later than October 11th, 2004. The study will begin after permission is received. If you would like more information at anytime about the study or if you have any questions or comments, please contact: *Occupational Therapy Student Patricia Cole* at home: (607) 272-6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274-3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu.

Thank you very much for your time and assistance with this project.

Sincerely,

Patricia Cole, BS, OTS
(formerly Patricia Poindexter)

Diane Long, MS, OTR, BCP

Kathleen Schlough, DSc, PT, PCS

Appendix E
Parent/Legal Guardian(s) Informed Consent Form

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Investigators: Patricia A. Cole, Graduate Occupational Therapy Student,
Diane Long, MS, OTR/L, BCP & Kathleen Schlough, DSc, PT, PCS

1. **Purpose of the Study:** The purpose of this study is to evaluate whether participation in gross motor activities or fine motor activities will affect your first grade child's handwriting legibility as assessed by the Test of Handwriting Skills.

2. **Benefits of the Study:** It would be to the benefit of occupational therapists, educators, your child(ren), and yourself to carry out this study and gain more insight into what is an effective treatment approach for the remediation of students' handwriting difficulties. Teachers as well as yourself will gain standardized information about your child's handwriting abilities. This study will provide another source of research that will help to show the effects of gross motor or fine motor activity on handwriting legibility of your child and other first grade students.

3. **What you will be Asked to do:** As part of the study, your child, along with all students in the class will complete the Test of Handwriting Skills, Manuscript version (Appendix E) as a pre- and post-test prior to implementation of either a gross (large) motor program, a fine (small) motor program, or a controlled group program held within the classroom. However, only student participants whose parent/legal guardian(s) gave consent will have their data scored and analyzed. A consultative approach with teachers of each classroom will be utilized for instruction for the motor activity program. Teachers will direct either a prescribed gross or fine motor group activity or a control group, every day before handwriting class for three consecutive weeks.
 - *Pre-Test:* Your child, along with all students in the class, will complete the Test of Handwriting Skills, Manuscript version (Appendix E),
 - *Gross Motor Program:* If your child's class is chosen for the gross motor program then your child will complete a five to ten minute warm up activity involving hopping, jumping as high as they can while tracing a letter in the air, running in place, push-ups, an animal walk on hands and feet, and jumping/hopping tasks (such as jumping right and left, hopping on one foot across a line on the floor, hopping on both feet across a line on the floor, hopping backwards across the line, etc.). All gross motor activities will be completed in the classroom as a group activity.
 - *Fine Motor Program:* If your child's class is chosen for the fine motor program then your child will complete a five to ten minute warm up activity involving spider on mirror hand patterns, penny flipping in an "x" shape pattern, finger tracing in the air with two fingers (using index and middle fingers together), tic tac toe while lying prone, and inch worm on a stick (holding a writing

utensil and inching the finger from top to bottom and bottom to top). All fine motor activities will be completed in the classroom as a group activity.

- *Control Group:* If your child's class is chosen for the control group then your child will not be participating in a motor program. Your child will complete classroom activities as scheduled by their teacher.
- *Post-Test:* Your child, along with all students in the class, will complete the Test of Handwriting Skills, Manuscript version (Appendix E).
- *Amount of Time Students' Participation will Take:* The assessment will take approximately 15-20 minutes to complete per classroom. The gross or fine motor program will take 5-10 minutes to complete prior to the first grade handwriting curriculum taught in the classroom. The motor program and control group will be carried out within your child's first grade classroom for a period of three consecutive weeks.

The researchers want to be able to review the collected data for analysis related to the study questions. As the first grade student's parent, you will be asked to complete a demographic form detailing family and student information (Appendix D).

4. **Potential Risks of the Study:** Risks to your child in this study are minimal. Your child may become anxious, experiencing a source of mild anxiety during the assessment therefore; your child will be assured that he or she is not being graded on the assessment test. There is also a potential risk for injury; however, this risk is not higher than the risk involved in your child's normal everyday school environment. In order to minimize this risk of injury in the classroom, teachers will be made aware of the need to provide a safe environment by clearing the area of classroom furniture.
5. **Compensation for Injury:** If your child(ren) suffers an injury that requires any treatment or hospitalization as a direct result of this study, the cost for such care will be charged to you. If you have insurance, you may bill your insurance company. You will be responsible to pay all costs not covered by your insurance. Ithaca College will not pay for any care or provide other financial compensation.
6. **If you would like more Information about the Study:** If I have any questions or comments at anytime I know that I can contact: *Occupational Therapy Student, Mrs. Patricia Cole* at home: (607) 272 - 6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274 - 3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu.
7. **Withdrawal from the Study:** The participation of your son or daughter in this study is purely voluntary, and you may withdraw him or her from the study at any time.

8. **How Data will be Maintained in Confidence:** To ensure confidentiality of your child's responses the following will occur. The Test of Handwriting Skills assessment will be administered to all students in the classroom. The building principal will only give the researcher the assessments of the students whose parent(s)/guardian(s) gave consent. Your child will write his or her first name and last initial on the assessment test sheet. Building principals will apply a numeric code to the test sheet prior to submission to the researcher. Therefore, the researcher will not know scores of specific children. Consent forms will be stored by the building principal until the tests are scored. The consent forms will then be given to the researcher for storage with the test forms for seven years in a locked cabinet in the occupational therapy department at Ithaca College that is designed specifically for this purpose. No individual child's score will be reported, all scores will reported as a group.

Parent/ Legal Guardian(s) Consent:

I have read the above and I understand its contents. I give permission for my son or daughter, _____, to participate in the study. I acknowledge that I am 18 years of age or older.

Print name of Parent/ Legal Guardian(s)

Signature of Parent/Legal Guardian(s)

Date

Appendix F
Demographic Form

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Please fill out the form below indicating your child's level of handwriting needs. If you agree to allow your child to participate in the study please fill out this form and send it in with the informed consent form using the pre-addressed stamped envelope provided. Thank you for your time and energy!

1. **Date of Birth** of child participating in the study: _____.
2. **Gender** of child participating in the study: MALE FEMALE
3. Current **grade placement** of child participating in the study: _____.
4. What age did your child **learn how to write** letters: ____? At HOME or SCHOOL?
5. Please list any **difficulty** your child may be experiencing currently **with handwriting**:

6. Has your child been identified with any difficulty with motor coordination, learning disorder, decreased attention span, or any other condition that may affect his or her handwriting ability? If yes, please list:

7. Is your child currently **receiving occupational therapy services**? YES NO
8. Is your child currently **receiving any special education services**? YES NO

If I have any questions or comments at anytime I know that I can contact:

Occupational Therapy Student, Patricia Cole at home: (607) 272 - 6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274 - 3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu. Thank you very much for your time and assistance with this project.

Sincerely,

Patricia Cole, BS, OTS (formerly Patricia Poindexter)

Diane Long, MS, OTR, BCP

Kathleen Schlough, DSc, PT, PCS

8. **How Data will be Maintained in Confidence:** To ensure confidentiality of your child's responses the following will occur. The Test of Handwriting Skills assessment will be administered to all students in the classroom. The building principal will only give the researcher the assessments of the students whose parent(s)/guardian(s) gave consent. Your child will write his or her first name and last initial on the assessment test sheet. Building principals will apply a numeric code to the test sheet prior to submission to the researcher. Therefore, the researcher will not know scores of specific children. Consent forms will be stored by the building principal until the tests are scored. The consent forms will then be given to the researcher for storage with the test forms for seven years in a locked cabinet in the occupational therapy department at Ithaca College that is designed specifically for this purpose. No individual child's score will be reported, all scores will reported as a group.

Parent/ Legal Guardian(s) Consent:

I have read the above and I understand its contents. I give permission for my son or daughter, _____, to participate in the study. I acknowledge that I am 18 years of age or older.

Print name of Parent/ Legal Guardian(s)

Signature of Parent/Legal Guardian(s)

Date

Appendix F
Demographic Form

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Please fill out the form below indicating your child's level of handwriting needs. If you agree to allow your child to participate in the study please fill out this form and send it in with the informed consent form using the pre-addressed stamped envelope provided. Thank you for your time and energy!

1. **Date of Birth** of child participating in the study: _____.
2. **Gender** of child participating in the study: MALE FEMALE
3. Current **grade placement** of child participating in the study: _____.
4. What age did your child **learn how to write** letters: ____? At HOME or SCHOOL?
5. Please list any **difficulty** your child may be experiencing currently **with handwriting**:

6. Has your child been identified with any difficulty with motor coordination, learning disorder, decreased attention span, or any other condition that may affect his or her handwriting ability? If yes, please list:

7. Is your child currently **receiving occupational therapy services**? YES NO
8. Is your child currently **receiving any special education services**? YES NO

If I have any questions or comments at anytime I know that I can contact:

Occupational Therapy Student, Patricia Cole at home: (607) 272 - 6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274 - 3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu. Thank you very much for your time and assistance with this project.

Sincerely,

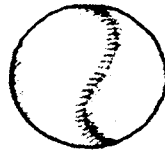
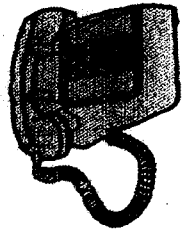
Patricia Cole, BS, OTS (formerly Patricia Poindexter)

Diane Long, MS, OTR, BCP

Kathleen Schlough, DSc, PT, PCS

Appendix G

Test of Handwriting Skills test form, Manuscript version (Gardner, 1998).







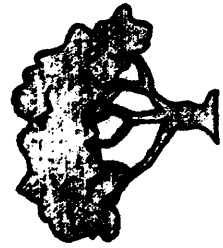






L N S V M U

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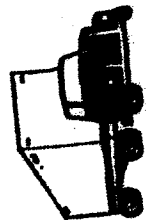


d c r b
u e m k j



wax king bed

quiz Jim star



Zebra's love jazz.

David opens gifts.





Appendix H Gross Motor Program

Students will complete a *five-ten minute* warm up activity involving:

- 1) All *gross motor* activities will be completed in the classroom as a group activity.
- 2) Participants will have their own assigned space for completing the motor activity.
- 3) Time allotted per activity is *shown below*.

Activity #1: *Jumping* right and left.

This activity involves standing with both feet together and jumping right to left over a line on the floor ten times. This jumping activity will use a fluid and constant motion with no breaks in between jumps. (*approx. 30 seconds to complete*)

Activity #2: *Hopping on both feet* across a line on the floor then ***hopping backwards*** across the line on the floor.

This activity involves standing with both feet together and hopping right to left over a line on the floor five times. This hopping activity will incorporate a break in between hops. Hopping backwards will use the same process as stated but the participant will stand with both feet together and hop forward and then backward over the line five times with a break in between each hop. (*approx. 40 seconds to complete*)

Activity #3: *Hopping on one foot* across a line on the floor.

This activity involves standing on one foot and hopping right to left over a line on the floor five times. The participant will then stand on the opposite foot and hop right to left over a line on the floor five more times. This hopping activity will incorporate a break in between hops. (*approx. 15 seconds to complete*)

Activity #4: *Animal walks* on hands and feet.

This activity involves crawling slowly on all four extremities (hand and feet) like an animal (such as a bear or a crab) ten feet forward and then ten feet backward. (*approx. 40 seconds to complete*)

Activity #5: *Push-ups*.

This activity involves the participant placing his or her hands shoulder width apart on the floor and his or her feet or knees close together on the floor. Then the participant will lower him or herself close to the floor (while bending his or her elbows) and then raise back up toward the ceiling (while straightening his or her elbows) five times. (*approx. 20 seconds to complete*)

Activity #6: *Arm activation*.

This activity involves raising one arm straight in the air next to your ear and using the other arm to hold it there for a five seconds while you breath. The student will switch and raise the opposite arm in the air repeating the process. (*approx. 15 seconds to complete*)

Activity #7: *Jumping* as high as they can while ***tracing a letter*** in the air.

This activity involves standing with both feet together and jumping as high as the participant can while creating a letter in the air using his or her dominant arm. This activity will be completed five times. (*approx. 40 seconds to complete*)

Appendix I
Fine Motor Program

Students will complete a *five-ten minute* warm up activity involving:

- 1) All *fine motor* activities will be completed in the classroom as a group activity.
- 2) *Two minutes* is allotted per activity.

Activity #1: *Spider on mirror* hand patterns.

This activity involves the student sitting at his or her own desk and lining the fingers on the left hand with the fingers on the right hand. The student will then copy the teachers hand patterns with his or her hands. Hand patterns include moving the fingers in close together, moving the fingers out as wide as they can reach, rotating the hands so that they are horizontal to one another, rotating the hands so that they are perpendicular to one another, etc.

Activity #2: *Penny flipping* in an “x” shape pattern.

This activity involves sitting at his or her own desk and flipping thirteen pennies from head to tails. The pennies will be arranged in an “X” shape pattern on a white sheet of 8 1/2” x 11” paper. This activity will be completed four times. Twice with the left hand and twice with the right hand.

Activity #3: *Tic tac toe* while lying prone.

This activity involves the student lying on his or her elbows on the floor while playing tic tac toe with another student. The students will play two games.

Activity #4: *Finger tracing* in the air with two fingers.

This activity involves using the index and middle fingers together to trace four letters in the air while sitting at his or her desk. The student will trace each letter twice. Thirty seconds is given per letter.

Activity #5: *Inch worm on a stick*.

This activity involves holding a writing utensil (pencil) and inching the thumb, index and middle fingers from top to bottom and then bottom to top. Participants will complete this activity two times.

Appendix J
First Grade Teacher Questionnaire

The Effects of Gross Motor or Fine Motor Activity on Handwriting Legibility
of First Grade Students

Dear First Grade Teacher,

Please fill out the form below specifying details about your classroom's handwriting curriculum. Thank you for your time and energy!

1. **Number** of students in your classroom: _____.
2. **Handwriting curriculum** used in your classroom: _____.
3. What **time of the day** do you teach your **handwriting curriculum** to your class:
_____.
4. Do your students **participate** in any of the classes listed below **before** your handwriting curriculum?
 - Physical Education
 - Music
 - Art
 - Lunch
 - Other: _____.
5. Please explain the **timeframe** you use to implement your **handwriting curriculum** into the school year (for example, daily throughout the year, 3 days per week, daily for 2 months):
_____.
6. Are any of your student's **receiving occupational therapy services**? YES NO

If I have any questions or comments at anytime I know that I can contact: *Occupational Therapy Student, Patricia Cole* at home: (607) 272 - 6532 or by email at: pcole1@ithaca.edu, *Professor Diane Long* at Ithaca College: (607) 274 - 3093 or by email at: dlong@ithaca.edu, or *Professor Kathleen Schlough* at Ithaca College: (607) 274 - 1385 or by email at: kschlough@ithaca.edu. Thank you very much for your time and assistance with this project!

Sincerely,

Patricia Cole, BS, OTS (formerly Patricia Poindexter)

Diane Long, MS, OTR, BCP

Kathleen Schlough, DSc, PT, PCS

Appendix K
SPSS Version 12.0 Syntax Equations
(Used with Values for Standard Deviation and Mean from THS Manual)

KEY:

If (age = #) SPSS new variable name = (((SPSS old variable name – test mean/test standard deviation) * scale standard deviation) + scale mean).

IF (age=5) preaira = (((preair-46.65)/16.17)*15)+100.
 IF (age=5) postairb = (((postair-46.65)/16.17)*15)+100.
 IF (age=6) preaira = (((preair-49.03)/14.20)*15)+100.
 IF (age=6) postairb = (((postair-49.03)/14.20)*15)+100.
 IF (age=7) preaira = (((preair-52.89)/11.01)*15)+100.
 IF (age=7) postairb = (((postair-52.89)/11.01)*15)+100.
 IF (age=8) preaira = (((preair-55.86)/8.55)*15)+100.
 IF (age=8) postairb = (((postair-55.86)/8.55)*15)+100.
 EXECUTE.

IF (age=5) prebusa = (((prebus-45.46)/18.13)*15)+100.
 IF (age=5) postbusb = (((postbus-45.46)/18.13)*15)+100.
 IF (age=6) prebusa = (((prebus-50.24)/15.46)*15)+100.
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 EXECUTE.

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 IF (age=8) postbflyb = (((postbfly-52.99)/9.68)*15)+100.
 EXECUTE.

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IF (age=8) postfrgb = (((postfrog-63.34)/7.05)*15)+100.
EXECUTE.

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EXECUTE.

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EXECUTE.

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IF (age=7) posthrsb = (((posthors-23.65)/3.69)*15)+100.
IF (age=8) prehorsa = (((prehorse-24.27)/3.29)*15)+100.
IF (age=8) posthrsb = (((posthors-24.27)/3.29)*15)+100.
EXECUTE.

IF (age=5) pretruka = (((pretruck-47.31)/6.86)*15)+100.
IF (age=5) postruk b = (((posttruk-47.31)/6.86)*15)+100.
IF (age=6) pretruka = (((pretruck-48.47)/6.65)*15)+100.
IF (age=6) postruk b = (((posttruk-48.47)/6.65)*15)+100.
IF (age=7) pretruka = (((pretruck-50.35)/6.29)*15)+100.
IF (age=7) postruk b = (((posttruk-50.35)/6.29)*15)+100.
IF (age=8) pretruka = (((pretruck-51.80)/6.02)*15)+100.
IF (age=8) postruk b = (((posttruk-51.80)/6.02)*15)+100.
EXECUTE.

IF (age=5) prebooka = (((prebook-63.84)/9.94)*15)+100.
IF (age=5) postbokb = (((postbook-63.84)/9.94)*15)+100.

IF (age=6) prebooka = (((prebook-65.21)/9.31)*15)+100.
 IF (age=6) postbokb = (((postbook-65.21)/9.31)*15)+100.
 IF (age=7) prebooka = (((prebook-67.45)/8.28)*15)+100.
 IF (age=7) postbokb = (((postbook-67.45)/8.28)*15)+100.
 IF (age=8) prebooka = (((prebook-69.17)/7.49)*15)+100.
 IF (age=8) postbokb = (((postbook-69.17)/7.49)*15)+100.
 EXECUTE.

IF (age=5) preliona = (((prelion-26.87)/17.55)*15)+100.
 IF (age=5) postlinb = (((postlion-26.87)/17.55)*15)+100.
 IF (age=6) preliona = (((prelion-33.54)/14.63)*15)+100.
 IF (age=6) postlinb = (((postlion-33.54)/14.63)*15)+100.
 IF (age=7) preliona = (((prelion-44.39)/9.88)*15)+100.
 IF (age=7) postlinb = (((postlion-44.39)/9.88)*15)+100.
 IF (age=8) preliona = (((prelion-52.74)/6.22)*15)+100.
 IF (age=8) postlinb = (((postlion-52.74)/6.22)*15)+100.
 EXECUTE.

IF (age=5) preseca = (((presec-9.72)/4.16)*15)+100.
 IF (age=5) postsecb = (((postsec-9.72)/4.16)*15)+100.
 IF (age=6) preseca = (((presec-12.85)/5.35)*15)+100.
 IF (age=6) postsecb = (((postsec-12.85)/5.35)*15)+100.
 IF (age=7) preseca = (((presec-17.95)/7.29)*15)+100.
 IF (age=7) postsecb = (((postsec-17.95)/7.29)*15)+100.
 IF (age=8) preseca = (((presec-21.87)/8.79)*15)+100.
 IF (age=8) postsecb = (((postsec-21.87)/8.79)*15)+100.
 EXECUTE.

IF (age=5) prereva = (((prerev-4.47)/4.97)*15)+100.
 IF (age=5) postrevb = (((postrev-4.47)/4.97)*15)+100.
 IF (age=6) prereva = (((prerev-3.31)/3.98)*15)+100.
 IF (age=6) postrevb = (((postrev-3.31)/3.98)*15)+100.
 IF (age=7) prereva = (((prerev-1.42)/2.35)*15)+100.
 IF (age=7) postrevb = (((postrev-1.42)/2.35)*15)+100.
 IF (age=8) prereva = (((prerev-0.00)/1.10)*15)+100.
 IF (age=8) postrevb = (((postrev-0.00)/1.10)*15)+100.
 EXECUTE.

IF (age=5) pretucha = (((pretouch-10.39)/1.98)*15)+100.
 IF (age=5) postuchb = (((posttuch-10.39)/1.98)*15)+100.
 IF (age=6) pretucha = (((pretouch-10.61)/1.87)*15)+100.
 IF (age=6) postuchb = (((posttuch-10.61)/1.87)*15)+100.
 IF (age=7) pretucha = (((pretouch-10.96)/1.70)*15)+100.
 IF (age=7) postuchb = (((posttuch-10.96)/1.70)*15)+100.
 IF (age=8) pretucha = (((pretouch-11.24)/1.56)*15)+100.

IF (age=8) postuchb = (((posttuch-11.24)/1.56)*15)+100.
EXECUTE.

IF (age=5) prelwupa = (((prelowup-6.49)/6.84)*15)+100.
IF (age=5) pstlwupb = (((postlwup-6.49)/6.84)*15)+100.
IF (age=6) prelwupa = (((prelowup-5.53)/5.99)*15)+100.
IF (age=6) pstlwupb = (((postlwup-5.53)/5.99)*15)+100.
IF (age=7) prelwupa = (((prelowup-3.98)/4.62)*15)+100.
IF (age=7) pstlwupb = (((postlwup-3.98)/4.62)*15)+100.
IF (age=8) prelwupa = (((prelowup-2.79)/3.57)*15)+100.
IF (age=8) pstlwupb = (((postlwup-2.79)/3.57)*15)+100.
EXECUTE.

Appendix L
Non-Statistically Significant Subtest Results

	Airplane		Bus		Frog	
	F	p	F	p	F	p
Practice (fine/gross)	2.37	0.130	0.05	0.823	0.10	0.000
Activity (treat/control)	0.02	0.877	0.04	0.835	0.00	0.975
Time (pre/post)	12.87	0.001	12.95	0.001	7.62	0.008
Practice x Activity	0.69	0.409	0.78	0.382	2.35	0.132
Practice x Time	1.93	0.171	0.62	0.435	0.08	0.778
Activity x Time	0.24	0.630	1.36	0.250	0.84	0.364
Practice x Activity x Time	0.08	0.777	0.79	0.379	0.44	0.511

	Bicycle		Tree		Horse	
	F	p	F	p	F	p
Practice (fine/gross)	8.40	0.006	2.58	0.115	7.00	0.011
Activity (treat/control)	1.52	0.223	1.18	0.282	5.52	0.023
Time (pre/post)	0.44	0.512	1.40	0.242	1.11	0.298
Practice x Activity	1.17	0.284	0.49	0.488	1.27	0.265
Practice x Time	1.60	0.213	2.04	0.160	0.51	0.480
Activity x Time	0.77	0.386	0.00	0.981	0.07	0.793
Practice x Activity x Time	0.20	0.657	0.07	0.791	0.55	0.464

	Truck		Book		Lion	
	F	p	F	p	F	p
Practice (fine/gross)	6.91	0.011	8.27	0.006	3.27	0.077
Activity (treat/control)	0.09	0.768	0.51	0.479	0.22	0.644
Time (pre/post)	0.77	0.384	1.52	0.223	4.12	0.048
Practice x Activity	1.30	0.260	1.07	0.306	0.02	0.887
Practice x Time	1.11	0.298	1.68	0.201	2.61	0.113
Activity x Time	0.69	0.412	0.04	0.849	1.58	0.215
Practice x Activity x Time	0.06	0.809	0.48	0.493	0.41	0.524

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