CONCURRENT VALIDITY OF THE PAPER AND ELECTRONIC VERSIONS OF THE MOTOR-FREE VISUAL PERCEPTION TEST 3RD EDITION (MVPT-3) FOR SCHOOL-AGED CHILDREN

Lauren Armstrong

November, 2014

Director of Thesis: Dr. Leonard Trujillo

Major Department: Occupational Therapy

This study examined the concurrent validity of the electronic version of the Motor Free Visual Perception Test Third Edition (MVPT-3). The purpose of the study was to determine whether the electronic MVPT-3 was valid for use with school-aged children. A counter-balanced correlational design was used and the subjects were 33 school aged children (4-10 years old) recruited from 4 daycare centers and after school programs within eastern North Carolina. The data were analyzed using SPSS to calculate a single tailed Pearson product-moment correlation coefficient to compare the score from the first administration of the test to the second score. A high correlation was expected between the electronic version and the paper version of the MCPT-3. The electronic version of the MVPT-3 was found to possess clinically acceptable concurrent validity with a correlation coefficient of r =.69 and thus could be an appropriate screening tool to be used by professionals working with children in a variety of settings. During data analysis, learning effects were revealed for certain items on the MVPT-3 which along with its low reliability in the current paper version, supports that the MVPT-3should not be used for diagnostic purposes or to demonstrate change over time and it is recommend that it be used a screening tool only.

CONCURRENT VALIDITY OF THE PAPER AND ELECTRONIC VERSIONS OF THE MOTOR-FREE VISUAL PERCEPTION TEST 3RD EDITION (MVPT-3) FOR SCHOOL-AGED CHILDREN

A Thesis

Presented To the Faculty of the Department of Occupational Therapy

East Carolina University

In Partial Fulfillment of the Requirements for the Degree

Masters of Science in Occupational Therapy

by

Lauren Armstrong

November, 2014

CONCURRENT VALIDITY OF THE PAPER AND ELECTRONIC VERSIONS OF THE MOTOR-FREE VISUAL PERCEPTION TEST 3RD EDITION (MVPT-3) FOR SCHOOL-AGED CHILDREN

by

Lauren Armstrong

APPROVED BY:

DIRECTOR OF
THESIS: _____
(Dr. Leonard Trujillo, PhD)

COMMITTEE MEMBER: _____
(Dr. Denise Donica, DHS)

COMMITTEE MEMBER: _____
(Dr. Carol Lust, Ed.D,)

CHAIR OF THE DEPARTMENT
OF (Occupational Therapy): _____
(Dr. Leonard Trujillo, PhD)

DEAN OF THE
GRADUATE SCHOOL: _____
Paul J. Gemperline, PhD

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I: INTRODUCTION

Since the establishment of Public Law 94-142 the Education of All Handicapped Children Act in 1975, occupational therapists have been charged with the responsibility to provide assessment, screening, and quality care of students in public schools (Bazyk & Case-Smith, 2010). This law has since been revised and is now known as the Individuals with Disabilities Education Act (IDEA, 2004) which ensures that students are provided with free appropriate public education (FAPE) in the least restrictive environment (LRE) (Bazyk & Case-Smith, 2010). Occupational therapy is categorized as a related service under IDEA and delivered to students if the provision of services will benefit their education (Bazyk & Case-Smith, 2010). One of the many responsibilities of occupational therapists under IDEA is to screen and assess problems when students are referred to their services. Visual perception is one aspect of academic performance that occupational therapists routinely address to help students engage in their educational experience.

Visual perception is described as "a highly complex, integrative activity which involves the understanding of what is seen" (Koppitz, 1970, p. 431) and can be thought of as a hierarchy of skill levels that when integrated together allow visual information to be processed (Warren, 1993). Visual perception involves the integration of higher cognitive functions, sensory information, and previous experience to organize, understand, and experience visual input from the environment (Scheiman, 1997). Occupational therapists must possess an understanding of visual perception because the ability for people to interact with and engage in their environment through occupations depends upon their ability to perceive objects in real world settings (Colarusso & Hammill, 2003). The Motor Free Visual Perception Test Third Edition (MVPT-3) is a standardized assessment tool used by occupational therapists to screen for visual perception

problems. It provides an overall visual perception score and perceptual age of the individual (Colarusso & Hammill 2003). Colarusso and Hammill (2003) describe the visual perception areas measured by the MVPT-3 as follows:

> spatial relationships are the abilities to orient one's body in space and perceive positions of objects, visual discrimination is the ability to perceive dominant features of an object such as shape, form, and color, figure-ground is the ability to distinguish an object from the surrounding background, visual-closure is the ability to see an object when only fragments of it are presented, and visual memory is the ability to remember and recognize an object after a short period of time (p. 9).

Learning is a major occupation of school-aged children and occupational therapists support children's function and participation in the classroom and other school settings by helping them to perform their daily activities (Cantu, 2003). Occupational therapists' role in the school setting has increased with the passing of the Individuals with Disabilities Improvement Act (IDEA) and the No Child Left Behind Act (Reeder, Arnold, Jeffries, & McEwen, 2011). The responsibilities of occupational therapists include assessing students with screening tools, collaborating with and educating teachers and school staff, providing intervention and resources for students, and referring students to special education or other services when necessary (Reeder, et al., 2011). Additionally, occupational therapists can assist students in assuming the student role, aid students in self-care tasks, help to improve posture and mobility, help students express what they have learned either verbally or through some other means, and educate other professionals to help them gain a better understanding of students with special needs and how to implement strategies that will best serve this population of students (Bundy, 1995). Occupational therapists are responsible for treating a full spectrum of students with disabilities, as defined by

IDEA, including students who have intellectual disabilities; hearing impairments including deafness; speech or language impairments; visual impairments including blindness; emotional disturbances; orthopedic impairment; autism spectrum disorders; traumatic brain injury; other health impairment; specific learning disability; deaf-blindness; or multiple disabilities (IDEA, 2004; Cantu, 2003). Valid and reliable assessment tools are necessary for occupational therapists to use as a guide for intervention planning and to determine what will be the best strategy to improve students' performance and help them meet their goals (Bundy, 1995).

Use of technology in classroom instruction has grown over the past several decades, but assessments of students continue to be through traditional paper and pencil tests (Clarke-Midura & Dede, 2010). Paper-based assessments can be problematic for determining whether a student has actually mastered a complex concept as they force students to select from predetermined answer choices (Clarke-Midura & Dede, 2010). In a study conducted by Shavelson, Baxter, and Pine (1991), the researchers used hands-on science experiments, traditional paper and pencil tests, and computer simulations of hands-on science experiments to assess students' learning. They found that each of the three assessments seemed to be measuring different aspects of learning because students performed differently when presented with the same material in the three different assessment styles (Shavelson, Baxter, & Pine, 1991). Russell and Haney (2000) found that students were more successful when responding to short answer and essay prompts on the computer than when they were assessed using a paper-based assessment.

With almost instantaneous access to the internet on a wide variety of multimedia devices and the abundant use of technology throughout everyday life, the impact of technology on learning and assessments must be considered. The mismatch between the use of technology in schools and in daily life and how students are assessed seems to indicate that there is a need for

valid digital assessments to give a clearer picture of students' performance and abilities. Additionally, digital assessments may provide ease of use, increase productivity through saving time, and may be preferred by professionals who use them when working with students (Reid & Jutai 1997).

Statement of the Problem

The use of technology and computer or video based systems has become ubiquitous in everyday life and in the educational atmosphere students encounter at school. Despite the fact that technology is becoming so pervasive, there is a lack of standardized digital assessments of visual perception for use with school-aged children. The current study focused on researching the electronic version of the MVPT-3 to determine whether it possesses concurrent validity and therefore should be made available for assessing children. This assessment tool could be used by occupational therapists when conducting visual perception screenings on children in schools. To determine the concurrent validity of the electronic version of the MVPT-3, this study used a counter-balanced correlational design. The scores from administrations of both the electronic version and the paper version of the MVPT-3 were compared to determine whether there was a correlation between the two scores in order to establish concurrent validity. Previous research supports the use of correlational designs to determine concurrent validity among newly developed assessment instruments (Brown, Mullins, & Stagnitti, 2009; Obler, & Avi-Itzhak, 2011; McCrimmon, Altomare, Matchullis, & Jitlina, 2012).

Purpose of the Study

This study examined the concurrent validity of the electronic version of the MVPT-3 as compared to the paper version to determine its validity for use with school-aged children in

Eastern North Carolina. The MVPT-3 is a screening tool commonly used by various professionals including occupational therapists to examine a student's visual perception skill level. If found to be valid, the electronic version could be an option for occupational therapists to use as a quick screening tool for assessing student's visual perception skills.

Research Question

Does the electronic version of the Motor Free Visual Perception Test Third edition (MVPT-3) demonstrate concurrent validity when compared to the paper version of the MVPT-3 when used with school-aged children?

Operational Definitions

For the purpose of this study, we defined "school aged" children as those between 4 and 10 years of age. This age bracket was selected because the MVPT-3 was normed on children within this age group (Colarusso & Hammill 2003).

Summary

The current study examined the concurrent validity of the electronic version of the MVPT-3 in order to establish its concurrent validity with the paper version. Determining that the electronic version of the MVPT-3 is valid for use with school aged children is significant because the electronic version can be made available for use with various professionals working with children. The electronic MVPT-3 can be used as a quick vision screening tool that may be preferred by both clinicians and students alike for its simplicity and ease of use as well as the current generation of students' innate capability and comfort with technology. Occupational therapists often have a limited amount of time to devote to assessing the children they work with

and the electronic version speeds up the process by providing immediate scoring and the ability to quickly interpret results.

CHAPTER II: LITERATURE REVIEW

The Technology Shift in the Classroom

To meet the demands of today's society and prepare students to enter the workforce as technologically competent individuals, there is a push for classrooms to be "high-access, technology-rich learning environments" (Duffey & Fox, 2012, p.17). This definition of a classroom includes internet access, online curricular resources, software, and variety of technological devices. The State Educational Technology Directors Association (SETDA) published a report on technology trends in classrooms across the nation and encouraged teachers to embed technology within their curricula and classrooms to meet the needs of today's learners (Duffey & Fox, 2012). Technologies like interactive whiteboards are becoming more common in classrooms from preschools to higher education (Wong, 2013).

With the drive to intertwine technology use with instructional practices, comes the need to revise assessment practices and implement new digital assessments. Digital assessments are being developed and implemented to align with the Common Core standards (Center for K-12 Assessment & Performance Management at ETS, 2012). The new end of year assessments will be delivered on the computer and have been developed to match how children learn in the classroom (Center for K-12 Assessment & Performance Management at ETS, 2012). The aim of these digital assessments is to provide better evidence of college and future career readiness skills in students (Center for K-12 Assessment & Performance Management at ETS, 2012).

Technology Use and Children

Individuals born between 1990 and 2010 are members of what is known as generation Z (Raymond, 2012). For these individuals, technology is second nature as they never lived in a world without internet, cell phones, personal computers, etc. (Raymond, 2012). The U.S.

Department of Education analyzed computer and internet use of American children enrolled in preschool programs through 12th grade in their report, *Computer and Internet Use by Students in 2003,* and determined several key findings: a majority of children ages 3 and up use computers and the internet, computer use begins at early ages, public and private school students show differing patterns of computer and internet usage, computer and internet usage differs among socioeconomic and demographic lines, and schools help to bridge this socioeconomic and demographic divide (DeBell & Chapman, 2006). The data regarding computer and internet use showed that 91 percent of children age 3 and above use computers and 59 percent use the internet and this use begins at an early age; two thirds of children in nursery school and 80 percent of kindergarteners use computers (DeBell & Chapman, 2006). Computer and internet use continues to rise as children get older and progress in grades; 23 percent of children in nursery school use the internet but this percentage increases to 50 percent in 3rd grade and to 79 percent by grades 9-12 (DeBell & Chapman, 2006). The report also showed differing trends in computer and internet use amongst public and private school students. Public school students are more likely to access computers and internet in schools, but private school students are more likely to have access to computers within their homes (DeBell & Chapman, 2006). The U.S. Department of Education's data makes it easy to see that a majority of children 3 and up access computers and the internet and that this use begins at an early age (DeBell & Chapman, 2006). The subjects of the current study were born in the tail end of generation Z. This population was chosen because of their inherent comfort with and exposure to technology essentially from birth.

Education and Assessments in a Digital Society

Technology pervades our everyday lives and affects how we interact, learn, and engage with our world. The use of technology and availability of educational options outside of traditional

schools has transformed the way society conceives of education and traditional schooling (Collins & Halverson 2010). Collins and Halverson (2010) referred to this phenomenon as a "second revolution" in which education is being reorganized and reevaluated based on the availability of digital technologies such as computers, mobile devices, digital media creation and distribution, and social networking. The rise of digital learning environments through online high school and college courses challenges society's view of traditional schooling (Maeroff, 2003). Traditional schools must adapt to the influx of available digital technologies and learn to integrate them within their curricula. One of the main advantages of digital technology is the ease of customization to students' abilities in order to create an individualized learning environment in which students can thrive (Baker & Mayer, 1999). "Computers can respond to the particular interests and difficulties that learners have and provide content on any topic of interest" (Collins & Halverson, 2010, p. 19).

Computer usage is becoming increasingly widespread throughout school and home environments; however state assessments to determine passing of courses and grade advancement, are conducted through paper-based medium (Zandvliet & Farragher, 1997). A study by Russell and Haney (2000) found that for students who are accustomed to using computers and more comfortable composing their writing in word processing programs, paper-based assessments present a challenge and a subsequent dearth in performance. Other researchers have found that tests administered via paper significantly underestimated students' capabilities when compared to the same questions administered via computers, particularly for open-ended prompts such as essays or short answer questions (Vansickle & Kapes, 1993; Carlbring et al., 2007; Russell & Haney 2000). However the benefits of taking tests via computer versus paper decrease for students who have very low level keyboarding speed (Russell & Haney, 2000). This

discrepancy between how students learn and are instructed in the classroom, and how they are assessed is of critical importance to examine when determining how best to assess students' learning and determine their capabilities. Russell and Haney (2000) wrote "the situation is analogous to testing the accounting skills of modern accountants, but restricting them to the use of an abacus for calculations" (p. 2).

In addition to the findings that paper-based assessments may be significantly underestimating student performance, a study by Salend (2009) found that using technology-based testing may be advantageous over traditional assessment methods because it can minimize test-taking errors, increase student motivation, and provide test items that are easily understood by students. Computer based testing also provides a two way interface that adjusts to the test taker and so that the level of the test matches the test taker's ability (Baker and Mayer 1999). Another benefit of online testing formats is that they offer students immediate feedback about their performance, decrease the workload on teachers for generating and grading assessments, and provide a standardized testing environment that minimizes bias and errors in administration (Liu et al., 2001; Salend 2009; Zandvliet & Farragher, 1997). Test-taking error can be minimized or eliminated using computer-based testing formats because teachers can create tests that ensure that students have responded to every item before progressing to the next item and by highlighting responses students wish to review again (Salend 2009). In addition to providing immediate feedback that serves as a motivator for students, in a case study conducted by Özden, Ertürk, and Sanli (2004), the researchers found that students preferred computer-based assessments to paper-based assessments because of the speed and simplicity of testing and their own comfort with technology which reduced testing anxiety. Other research has shown that students prefer to learn information from the computer as well as be tested using an electronic

format instead of a paper administration (Pinsoneault 1996; Hansen et al., 1997; Vispoel, 2000; Hallfors et al., 2000)

Salend (2009) determined that computer-based test-taking also had the advantage of preparing students for future online evaluations in the workplace. Technology use appears to continue to increase in classrooms, workplaces, and society at large, but the question remains as to whether the gap between what technologies are utilized at home and in the classroom and how students are assessed can be closed. Occupational therapists need to understand how technology affects students' learning and performance on standardized evaluations in order to determine the most appropriate and valid tools for assessment of today's technologically proficient students.

Need for Standard Assessments of Visual Perception

For successful participation within the classroom, students must be able to use the following visual perception skills to perceive, observe, and make sense of visual stimuli: focusing on stimuli, scanning the environment for the big picture or detailed information, following stimuli to enable interpretation, and applying these components for problem-solving (Vlok, Smit, & Bester 2011). Occupational therapists assess and treat a wide variety of diagnoses when working within the school system. One common deficit that occupational therapists frequently evaluate is that of visual perception skills. Research by Vlok et al., (2011) found that incorporating an integrated visual perception program into intervention that addresses practicing basic eye movements, visual perceptual skills, and cognitive strategies will strengthen the students' visual perception skills as well as improve academic performance, particularly performance in math and reading and in students' confidence levels.

Assessment tools that are reliable and valid for screening students with visual perception skill deficits are necessary for occupational therapists to utilize to determine if there is a need for

intervention (Brown, Rodger, & Davis, 2003). With this knowledge, occupational therapists can begin to determine the best approach to intervention that will improve students' visual perception skills and ultimately enhance their educational experience. A recently developed cognitive assessment, The Standardized Touchscreen Assessment of Cognition (STAC), indicates that digitals assessments are the next advancement to provide quality care (Cognitive Innovations, 2013). The STAC is a cognitive assessment developed by an occupational therapist and speech pathologist that improves clinician efficiency, offers consistency of tests administration, and provides ease of use (Cognitive Innovations, 2013).

In a pilot study of the perceived clinical usefulness of a computerized visual perception assessment, the Componential Assessment of Visual Perception (CAVP), developed by Reid and Jutai (1997), found that the clinicians surveyed in their study showed interest in using the computerized CAVP and believed it to be a useful assessment tool for their clients. According to Reid and Jutai (1997), the computerized CAVP possesses the following advantages over paper-based assessments:

> (1) precise control over visual stimulus and response environments; (2) objective recording of fine-grained variations in dependent measures; (3) greater access afforded through the use of interface technologies for persons with physical disabilities; and (4) greater opportunity for concurrent measurement of psychophysiological and context variables (eg. eye movements, fatigue, and motivation). (p. 85).

The findings from this study indicate that there is appeal in computerized assessment tools and that clinicians perceive them as useful which support the development and use of electronic assessment tools in occupational therapy practice.

Motor-free Visual Perception Test

Occupational therapists use a variety of assessment tools to evaluate students' visual perception skills as they pertain to students' successful participation in the classroom learning environment. One measure that is available to occupational therapists is the Motor-Free Visual Perception Test 3rd Edition (MVPT-3). The MVPT was first published in 1972. It has since been revised in 1996 as the MVPT-R and in 2003 to the current edition, the MVPT-3 (Colarusso & Hammill 2003). The instructional manual of the MVPT-3 published by Colarusso and Hammill (2003) states that the following visual perception processes are assessed to provide an overall visual perception raw score: spatial relationships, visual discrimination, figure-ground, visual closure, and visual memory. The test includes black and white drawings for the stimulus and response items which are presented in a multiple choice format; subjects indicate their answer choice by verbally expressing their selection or pointing to indicate their response (Colarusso & Hammill 2003). Using the raw score combined with the examinee's age, one can determine standard scores, percentile ranks, and age equivalents (Colarusso & Hammill 2003). The MVPT-R was revised as the MVPT-3 to include more challenging items for valid use with adults; the MVPT-3 is identical to previous editions of the test for use with children ages 4 through 10 (McCane 2006; Colarusso & Hammill 2003). The original MVPT displays the answer choices horizontally and was normed on children ages 4 to 10; the most recent version, the MVPT-3, has been normed for ages 4 to 94+ in response to the clinical need for the assessment to be validly used with adults (Colarusso & Hammill 2003). Burtner, Qualls, Ortega, Morris, and Scott (2002b) conducted a study to assess the test-retest reliability of the MVPT-R for children with and without disabilities. Their study included 38 children with identified disabilities and 37 control children all between the ages of seven and ten years old. The children were assessed

twice during a period of two and a half weeks. Burtner et al. (2002b) found that the MVPT-R had moderate test-retest reliability with combined correlation coefficients of both groups being .77-.83. The control group of children had lower correlation coefficients than the group of children with learning disabilities which Burtner et al. (2002b) thought may have been a result of using memory of answers on the original assessment to guide performance on the second evaluation. This effect occurred in both groups but was more prominent in the control group of children. The implications of this study need to be considered when using the MVPT-3 as an assessment tool and interpreting change in scores because learning effects may occur.

Reliability. An instrument possesses reliability when it provides the same information across different circumstances (Kielhofner & Fossey, 2006). The MVPT-R has been widely tested and found to have moderate test-retest reliability, and research findings support using the MVPT-R as a measurement to identify visual perception deficits in children with and without disabilities (Burtner, Qualls, Ortega, Morris, & Scott, 2002b)**.** Colarusso and Hammill (2003) tested 103 subjects with an average of 34 days between test administrations to determine the test-retest reliability of the MVPT-3; they found the test-retest coefficients for each age group to be .87 for the 4-10 age group and .92 for the 11-84+ age group. The MVPT-R is a frequently used assessment because of its ease of administration and scoring. It is a short evaluation that requires little time for assessment. Brown, Bourane, Sutton, Wigg, Burgess, and Glass (2010) evaluated the test-retest reliability of three different visual perception tests, including the MVPT-3, with adult participants and found that the MVPT-3 had moderate test-retest reliability. The test-retest reliability was not found to be as high as Colarusso and Hammill (2003) reported in the MVPT-3 testing manual, but this was perhaps because Brown et al. (2010) retested participants within a much shorter time frame and this could indicate practicing effects.

Validity. Validity of an instrument is whether the instrument measures what it is supposed to measure (Kielhofner & Fossey, 2006). In a study of the validity of the MVPT-R, Burtner, Ortega, Morris, Scott, and Qualls (2002a) found that there was a significant difference in raw scores as well as perceptual age scores for children with and without learning disabilities. Their research supports the use of the MVPT-R as a valid measure to determine visual perception deficits in typically developing children as well as children with learning disabilities.

Advantages of Technology

Technological advancements continue to shape our society through the ways in which we interact, learn, access and dispel information, and are evaluated either in school settings or by employers. Research has shown that computer-based assessments have the advantage of immediate feedback and ease of testing and are preferable to many of today's students because of their comfort with technology (Salend, 2009; Özden, Ertürk, & Sanli, 2004; Russell & Haney, 2000). In a study of handwriting of elementary students, Poon, Li-Tsang, Weiss, and Rosenblum (2010) found that children who received a computerized visual perception and visual-motor integration training program showed a significant improvement in their visual perception scores assessed by the MVPT and in their handwriting time. The computerized visual perception and visual-motor training program used by Poon et al. (2010) did not focus on handwriting directly and instead used entertaining games to teach visual perception skills. It is possible that the success of their program could be attributed to the use of a computerized program which students found motivating and interesting. Based on the findings from Poon et al. (2010) and research on the advantages of computer based assessments (Salend, 2009; Özden, Ertürk, & Sanli, 2004; Russell & Haney, 2000), the concurrent validity of the electronic version of the MVPT-3 will be assessed to determine whether it should be utilized by occupational therapists to assess students'

visual perception skills. The current study is further supported by research by Reid and Jutai (1997) that showed clinicians felt they could benefit from use of an electronic assessment and were interested in potentially investing in computerized assessments. The recently developed electronic version of the MVPT-3 has not been examined for its validity and the focus of this study will be to determine concurrent validity of the electronic version of the MVPT-3 as compared to the paper version.

Summary

Current paper-based assessments may not provide an accurate portrayal of students' abilities and are often not the preferred method of evaluation by students. Comfort with the use of technology and its motivating factors seem to indicate that technology should be incorporated into educational curriculum and assessments whenever possible. Occupational therapists' role in educational settings, including assessment and intervention of children, continues to grow and valid assessment tools are necessary for occupational therapists to determine students who need intervention. As society increasingly progresses toward a digital world, occupational therapists need to understand how this technology boom affects students' learning processes and select assessment tools that are appropriate for today's learners. Assessment of visual perception skills is one area that occupational therapists commonly conduct screening because visual perception skills are necessary for functioning successfully within a classroom setting. The electronic version of the Motor-Free Visual Perception Test (MVPT-3) is one assessment tool of visual perception skills that has not been researched to determine its validity. Given the shift in education from paper-based learning to electronic assessments, the focus of this study will be to explore the viability of the computerized version of the MVPT-3 as a measure of visual processing skills as compared to the paper version of the MVPT-3.

CHAPTER III: METHODOLOGY

Design

This study used a counterbalanced correlational design to examine whether the electronic version of the MVPT-3 is valid as compared to the paper version. Brown, Unsworth, and Lyons (2009) conducted a correlational study to examine the concurrent validity of four visual-motor integration assessments using Pearson's *r* calculations to determine whether each visual-motor integration assessment was significantly correlated with one another. Obler and Avi-Itzhak (2011) used a correlational design to determine the concurrent validity of the Wide Range Assessment of Visual Motor Abilities compared to the Beery-Buktenica Developmental Test of visual-Motor Integration and found weak correlations between the two tests suggesting that the Wide Range Assessment of visual Motor Abilities does not have concurrent validity and cannot be used as an alternative to the Beery-Buktenica Developmental Test of visual-Motor Integration. The current study used a similar correlational design to determine whether the electronic and paper versions of the MVPT-3 are significantly correlated. All participants were assessed using both the electronic and the paper versions of the MVPT-3. Using a counterbalanced design, half of the participants took the electronic version first and then received the paper version, and the other half took the paper version first and then received the electronic version. The order of the test was randomly alternated to achieve this. The counterbalanced design, similar to that of the study completed by Brown, Unsworth, and Lyons (2009), was used to eliminate the potential for test order effects.

Population

This study used convenience sampling to obtain an end sample of 33 subjects. The researcher sought a larger sample size, however after contacting multiple daycares and sending

home parental consent forms several times, it was determined that the population had been fully saturated, and 33 subjects was the final sample size. The subjects of this study included school-aged children (4 to 10 years old) from daycare facilities and afterschool programs in eastern North Carolina. This age group was selected because Colarusso and Hammill (2003) divided children into a 4 to 10 years old group and an 11 years old and older age group when determining test-retest reliability of the MVPT-3. The inclusion criteria for this study were that participants had to be between 4 and 10 years old, were proficient in English, were able to hear and follow verbal instructions, and had normal vision or corrective lenses. The exclusion criteria for this study were if the student was not proficient in English, was unable to follow instructions, had uncorrected vision impairments, or exhibited test anxiety.

Instrumentation

MVPT-3 Paper Version. The paper version of the MVPT-3 is the current edition of the original MVPT which is a well-established visual perception screening tool for use with people ages 4 to 94+ in various settings including schools and rehabilitation centers (Colarusso & Hammill 2003). The MVPT-3 uses simple black and white templates for its test and response items. Additionally, it does not require that respondents have any motor skills as respondents can verbally select their answer, point to their answer of choice, or indicate their answer through some other means. The MVPT-3 includes 65 test items, the first 40 of which are identical to the MVPT-R, and is arranged so that items with similar instructions are sequentially grouped together (Colarusso & Hammill 2003). Colarusso and Hammill (2003) examined the test-retest reliability of the MVPT-3 using 103 participants split into a 4 to 10 year old age group and an 11 year old and up age group. They found that the test-retest correlations for the two age groups were .87 and .92 respectively which provides evidence that the MVPT-3 has sufficient test-rest

reliability. Colarusso and Hammill (2003) found that the MVPT-3 had acceptable concurrent validity with significant correlations ranging from .27 to .82 with a median of .65, when compared to other assessments measuring visual perception. The MVPT-3 can be administered and scored within 30 to 40 minutes thus making it an efficient screening tool for occupational therapists (Colarusso & Hammill 2003).

MVPT-3 Electronic Version. The electronic version of the MVPT-3 was developed by Dr. Leonard Trujillo, associate professor at Eastern Carolina University, in 2007. The electronic version displays the same templates as the paper version of the MVPT-3 on a computer screen and uses the same instructional protocol as the paper version of the MVPT-3. Examinees can verbally select their answer choice or point to the screen to indicate their answer. A Toshiba laptop computer was used for testing of the electronic version of the MVPT-3 in this study, and all students were tested following the MVPT-3 manual's protocol (Colarusso & Hammill, 2003). As stated in the literature review, no studies exist that test the validity or reliability of the electronic version of the MVPT-3. This study examined the concurrent validity of the electronic version of the MVPT-3 as compared to the paper version.

Procedure

Prior to beginning the study, Institutional Review Board (IRB) approval was obtained through East Carolina University's IRB panel. The directors from each of the daycare centers and afterschool programs gave their written consent to participate in the study. Once these approvals were established, an explanation of the purpose of the study and the MVPT-3 evaluation procedure was sent to parents for their approval. If parental consent was not provided, students were not enrolled in the study. The researcher kept a record of which students had been given parental consent using an Excel spreadsheet to check off whether permission had been

granted. Also, the researcher asked that the classroom teacher or daycare provider retained the returned permission forms so that these could be kept for the researcher's records. Once parental permission was granted, the study was explained in age-appropriate terms to the students and they were asked for their verbal assent (Appendix A). If this was not obtained, they were removed from the study sample. Students were randomly alternated to either the electronic or paper version of the MVPT-3 for initial testing. Half of the participants were tested using the paper version and the other half received the electronic version to ensure a counterbalanced design. Students were assigned a number to identify them which was recorded in an Excel spreadsheet. Demographic information was recorded into the Excel spreadsheet with the student identification number. Students were tested one at a time during typical school hours with scheduling beginning at 9:00 am or students were tested one at time during the afterschool program beginning at 4:30 pm. Testing took place in a quiet area away from the classroom setting in each individual daycare center or afterschool program. Consistency of room environment for lighting and test placement was followed to the fullest extent possible. All students were tested following the MVPT-3 manual's protocol regardless of which version they were being tested under (Colarusso & Hammill, 2003). Students either verbally selected their answer choice or pointed to the computer screen for the electronic version or flipchart for the paper version of the MVPT-3. Students were retested under the same conditions within a 2 to 4 week time period using the opposite version of the MVPT-3 to which they were originally assigned. This 2 to 4 week testing window was followed as per the manual of the MVPT-3 to minimize maturity or learning effects (Colarusso & Hammill, 2003). If a student was absent on a testing day, the researcher came back the next week to obtain his/her score. After several attempts to retest the absent students, if this was not possible, that student was dropped from the

study and his/her data was not included in analysis. If students ceased to attend daycare or the afterschool program or become otherwise unavailable for assessment, their data was not included in the study. Raw scores were recorded for each evaluation. All students were assessed by the researcher. If parents requested information about their child's score on the MVPT-3, a letter was sent to that child's parents explaining the scoring and some options for how they may wish to address any concerns they have about their child's visual perception (Appendix B & C).

Data Analysis

The data collected in this study consisted of demographic information and raw scores from both the paper version and the electronic version of the MVPT-3. The raw score was calculated by subtracting the number of errors from the number of the last item administered, excluding scores from example items (Colarusso & Hammill, 2003). In the case of the age group that was examined in this study, the total number of items was 40 and raw scores were determined by subtracting errors from this number (Colarusso & Hammill, 2003). The data from the raw scores was analyzed using SPSS to calculate a single tailed Pearson product-moment correlation coefficient to compare scoring from the first evaluation to the second evaluation. Participant gender was recorded however this study was not looking at gender during data analysis because the MVPT-3 is designed to be used by all demographic groups and gender is not intended as a factor in assessment and scoring.

Table1: Participant Data

Participant Number	Participant Age	Daycare Center	Gender	Raw Score 1	Raw Score 2
1	4 yr 5 mos	Childtime	M	17	20
2	4 yr 11 mos	Childtime	F	19	22
3	4 yr 5 mos	Childtime	F	23	21
4	4 yr 6 mos	Childtime	M	14	23
5	5 yr 3 mos	Childtime	M	32	35
6	4 yr 5 mos	Childtime	F	19	21
7	4 yr 9 mos	Childtime	M	23	20
8	4 yr 5 mos	A Child's Place	M	12	19
9	5 yr 1 mos	A Child's Place	M	15	19
10	4 yr 4 mos	A Child's Place	M	19	16
11	4 yr 6 mos	A Child's Place	M	18	22
12	4 yr 10 mos	A Child's Place	F	27	29
13	4 yr 2 mos	A Child's Place	F	13	19
14	4 yr 11 mos	A Child's Place	F	14	17
15	4 yr 4 mos	A Child's Place	F	23	22
16	4 yr 2 mos	Childtime Firetower	M	11	12
17	5 yr 0 mos	Childtime Firetower	M	16	20
18	4 yr 8 mos	Childtime Firetower	M	19	20
19	5 yr 2 mos	A Child's Place	M	13	16
20	4 yr 4 mos	Childtime	M	23	20
21	4 yr 9 mos	Childtime Firetower	F	27	25
22	4 yr 3 mos	Childtime Firetower	M	17	15
23	4 yr 11 mos	Childtime Firetower	M	20	28
24	4 yr 3 mos	Children's World	F	17	25
25	4 yr 0 mos	Children's World	F	15	20
26	4 yr 9 mos	Children's World	M	13	14
27	5 yr 1 mos	Children's World	F	20	26
28	4 yr 3 mos	Children's World	M	14	11
29	4 yr 5 mos	Children's World	M	17	27
30	4 yr 3 mos	Children's World	M	21	21
31	4 yr 6 mos	Children's World	M	11	11
32	4 yr 5 mos	Children's World	M	12	15
33	5 yr 3 mos	Children's World	F	23	19

n = 33

Ethical Issues

This study posed minimal risk to students because it was a short assessment of their visual perception skills and did not require that students possess motor capabilities (Colarusso & Hammill 2003). Any students who did not give their verbal assent to participate or were identified either by teachers or self-identified as having test anxiety were not enrolled in the study. The data did not include information that could identify individual students as all data was presented as a final aggregate. If parents were concerned about their child's visual perception and requested more information, a letter was sent home to the student's parents. This letter included the student's scores, an explanation of the MVPT-3, and offer to make follow-up contact if they felt that further evaluation of their child was necessary (Appendix B & C).

CHAPTER IV: RESULTS

Analysis of Data

Raw scores for each administration of the test were recorded in Excel. SPSS was used to analyze the raw scores from the first and second administrations of the paper and electronic versions of the MVPT-3 and these calculations were confirmed using Excel. The MVPT-3 is a screening tool of a person's overall visual perceptual ability and is not divided into subcategories with individual scores. Raw scores were used to complete the initial correlational analysis because they represented an aggregate of the total score, thus the participant's overall visual perceptual score.

Figure 1: Data for participants tested with the electronic MVPT-3 initially

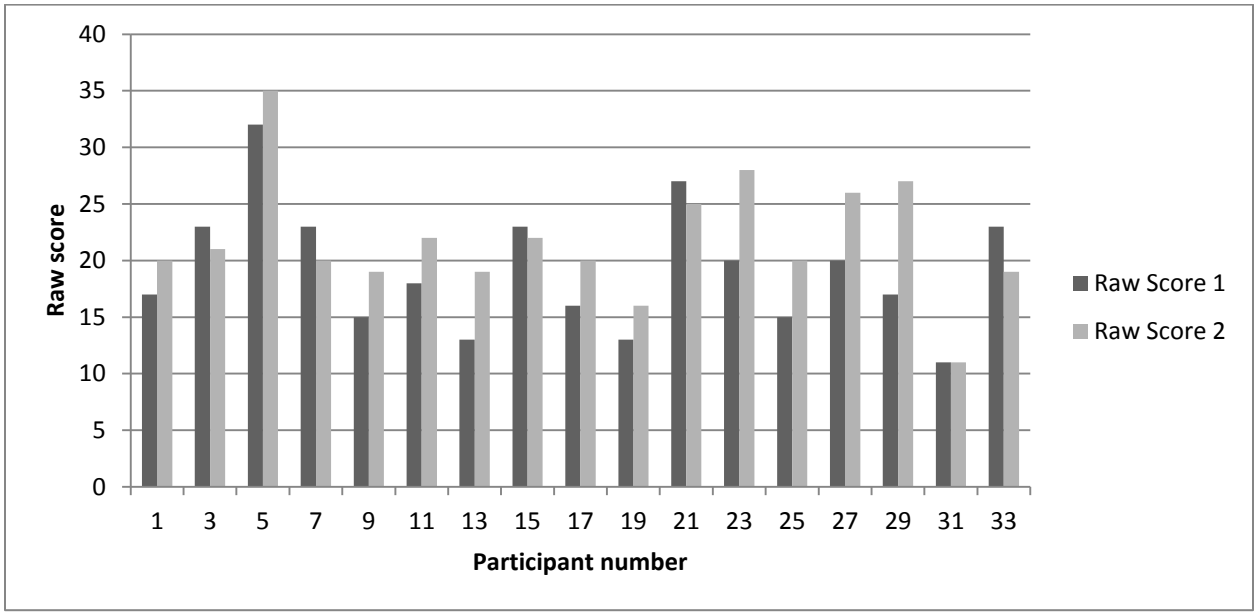
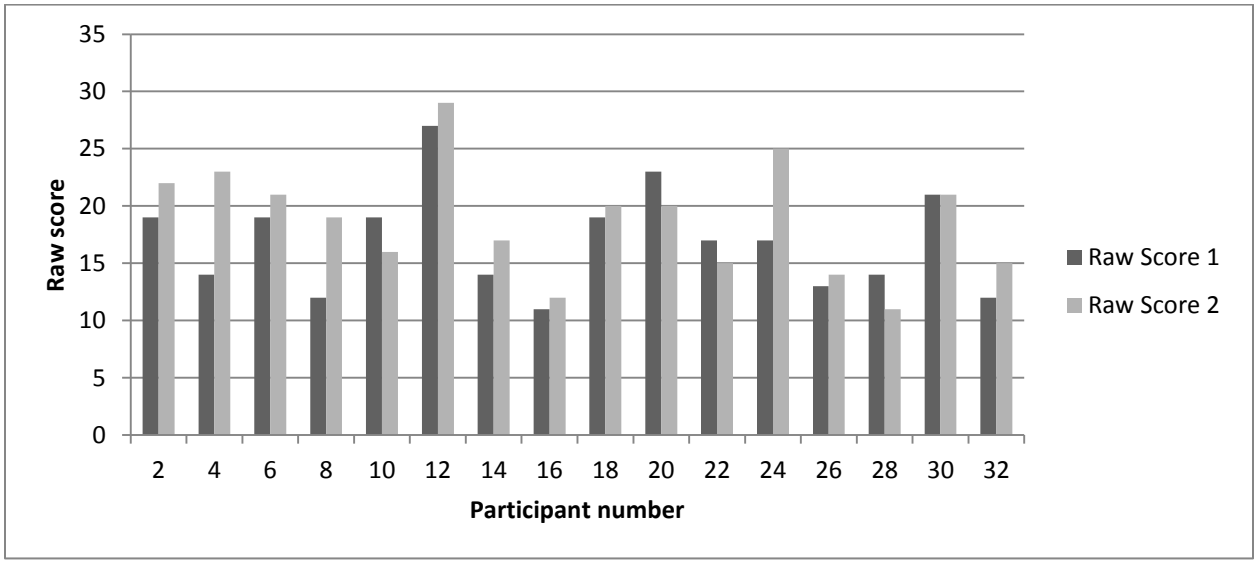


Figure 2: Data for participants tested with the paper MVPT-3 initially



Of the 33 participants tested, 22 participants' raw scores improved on the second administration, 9 participants had lower raw scores on the second administration of the MVPT-3 regardless of which version of the MVPT-3 they were tested under initially, and 2 participants had the same raw score on both administrations of the MVPT-3.

A single tailed Pearson product-moment correlation coefficient was computed to assess the relationship between the administration of the electronic version of the MVPT-3 and the administration of the paper version of the MVPT-3. The single tailed correlation was chosen because the MVPT-3 versions were being compared instead of being compared to a different assessment so there was an expectation of equivalency between the two measures. The expected outcome of the correlation was for the raw scores from each version of the test to be highly correlated.

There was a clinically significant correlation between the two variables [r =.6913, n =33]. This is a clinically acceptable correlation for concurrent validity between the electronic and paper versions of the MVPT-3. A prior study found similar moderate and clinically acceptable correlations ranging from .39 to .51 between the paper version of the MVPT-3 and other visual perception assessments (Brown, Mullins, & Stagnitti, 2009).

Although the expected outcome of the correlation between the two versions would be high, according to Colarusso and Hammill (2003), the expected median reliability coefficient for ages 4 through 10 is .80. For the four year old age group, the expected median correlation coefficient is .69 (Colarusso & Hammill, 2003). This anticipated correlation coefficient is much closer to the results of the present study. Therefore, obtaining a .6913 correlation with a probability of a 20% error range is a notable finding, particularly when the participants in this study were mostly four years of age. The present study's subjects included mostly four year olds

and the correlation coefficient was .6913 which is equitable to the .69 correlation reported by Colarusso and Hammill (2003) for the four year old age group, and makes the findings of the present study notable when considering the age group examined. This level of finding would be equitable with those correlations of the paper version, if not higher than previous studies (Brown, Bourane, Sutton, Wigg, Burgess, & Glass, 2010; Brown, Mullins, & Stagnitti, 2009; Burtner, Ortega, Morris, Scott, & Qualls, 2002a). This substantiates the reliability of the computer to paper ratio as examined in this study.

A higher correlation between the administrations of the paper version and the electronic version of the MVPT-3 was anticipated for the 4 to 10 age group. To investigate the relationship between the two assessments further, the binomial factorial expectations were explored to determine the percentage of change for the overall correlation and percentage of change for each exam question to determine if there were learning effects. The binomial review was conducted because there was an expectation that the scores and answers for individual test items would be the same regardless of which version of the MVPT-3 was administered. If the answer on an item was the same, then this assumption was "true" and the scores correlated. However, if the answers differed, the assumption of correlation was "false" because the answers for the test item did not match. As stated previously, according to Colarusso and Hammill (2003) the expected correlation coefficient for the 4 to 10 age group is .80 thus the binomial review was conducted to assess the relationship between the two versions of the MVPT-3 further. Overall, an 18.29% learning effect was found between the first administration of the MVPT-3 and the second administration, regardless of which version of the test was administered first.

These learning effects were examined because the overall learning effect could have a significant impact on the examinee's raw score and thus the interpretation of the results. For this

reason, the MVPT-3 is most appropriately used as a screening tool for visual perception deficits and not for diagnostic purposes.

In addition to the average overall 18.29% change in raw scores, some test items displayed notable changes in the number of participants who improved in that item indicating notable learning effects for those individual test items. For the purposes of this discussion, test items that had a higher than 18.29% of change in the number of participants who improved their score on the second test administration will be discussed further. This percentage was chosen because it was the overall percentage of change so any change on an individual test item that was greater than 18.29% was explored as change greater than the overall percentage was not expected. The following test items showed notable learning effects: items 1, 3, 7, 11, 15, 17, 18, 25, 26, 28, 31, 34, 35, 37, and 38 (see Appendix D for depictions of these items). This resulted in a total of 15 items out of 40 total test items that could potentially be related to a positive learning curve.

Table 2: Test Item Percent Change

Test Item Number	Percent Change
1	30.43%
3	37.50%
7	41.18%
11	83.33%
15	46.15%
17	60.00%
18	33.33%
25	38.46%
26	41.67%
28	55.56%
31	40.00%
34	50.00%
35	30.00%
37	33.33%
38	233.33%

n = 33

The percentage of change for individual test items ranged from 30.00% to as high as 233.33%. Although the MVPT-3 does not use subcategories to determine scores or make interpretations about specific features of visual perception, it is divided into sections. The test items for which there were notable learning effects, come from the following sections of the MVPT-3: visual discrimination, form constancy, visual short term memory, visual closure, and spatial orientation. Items 1, 3, and 7 are visual discrimination items. Item 11 is form constancy. Items 15, 17, and 18 are visual short term memory items. Items 25, 26, 28, 31, and 34 are visual closure items. Items 35, 37, and 38 are spatial orientation items.

Table 3: Test Items with Notable Learning Effects by Section

Test Item Number	Section
1	Visual Discrimination
3	Visual Discrimination
7	Visual Discrimination
11	Form Constancy
15	Visual Short Term Memory
17	Visual Short Term Memory
18	Visual Short Term Memory
25	Visual Closure
26	Visual Closure
28	Visual Closure
31	Visual Closure
34	Visual Closure
35	Spatial Orientation
37	Spatial Orientation
38	Spatial Orientation

The section that had the most items with notable learning effects was visual closure which includes test items 25, 26, 28, 31, and 34. Visual closure is a component of object perception which is a skill that improves dramatically as a child matures and is mostly stabilized by nine years of age (Schneck, 2010). This section may have been particularly challenging to the participants in this study because they were mostly four years old. The visual discrimination, visual short term memory, and spatial orientation sections each had three items with notable learning effects.

CHAPTER V: DISCUSSION

Summary

The purpose of this study was to examine the electronic version of the MVPT-3 to determine whether it possesses concurrent validity when compared to the paper version of the MVPT-3. School aged children were selected for this study because of their familiarity, exposure, and comfort with electronic media for learning and testing in schools. The protocols were established and followed by the researcher throughout test administration, data collection, and results analysis and were in accordance with the IRB protocols. A summary of the results was addressed in chapter 4. Briefly, a clinically significant correlation between the two versions of the MVPT-3 was found [r =.6913, n =33] with an overall 18.29% change in raw scores indicating a learning effect.

The primary research question for this study was whether the electronic version of the Motor Free Visual Perception Test Third edition (MVPT-3) demonstrates concurrent validity when compared to the paper version of the MVPT-3 when tested on school-aged children. In examining school aged children, the results of this study indicate that the electronic version does possess clinically acceptable concurrent validity when compared to the paper version of the MVPT-3 when used with school aged children. The electronic version of the MVPT-3 would be an acceptable alternative to the paper version to use with this population however clinicians should use caution interpreting results as some items on the MVPT-3 show learning effects and the test is intended to be a screening tool only.

This study examined the concurrent validity of the electronic version of the MVPT-3 compared to the paper version of the MVPT-3 when tested on school-aged children. The electronic version of the MVPT-3 has recently been developed and no studies exist that examine

its concurrent validity. School aged children (4 to 10 years old) were selected for study because of this age group's pervasive exposure to electronic medium both within schools, the community, and at home. Students are becoming increasingly comfortable with electronic learning and testing but few electronic assessments of students' abilities exist.

Initially, a high correlation was expected between the electronic version and the paper version of the MVPT-3. After using SPSS to analyze the raw scores, a single tailed Pearson product-moment correlation coefficient was calculated and found to be .6913. A single tailed correlation was used because the two versions of the MVPT-3 were being compared and there was an expected outcome of equivalency between the two assessments. It should be noted that a .6913 finding where a there is a variance of .20 and a reliability coefficient of .80 is a notable finding and a highly acceptable range to acquire. The present study's correlation coefficient of .6913 is on par with previous findings of .69 for the four year old age group (Colarusso & Hammill, 2003) and a particularly notable finding when the age group of the participants is taken into consideration. Of the 33 participants in this study, 27 participants fell within the four year old age group.

Since the correlation was lower than expected, the percentage of change between the first administration of the MVPT-3 and the second was examined for each individual test item and for the overall percentage of change. The binomial factorial expectation was that there should have been equivalency for each test item and no percentage of change, however notable learning effects were observed for 15 test items and the overall percentage of change between administrations of the MVPT-3 was 18.29%. The binomial factorial process was used as each outcome was expected to be the same for an equivalent score.

Conclusions

Although lower than anticipated, a clinically significant correlation of .6913 was found between the electronic and paper versions of the MVPT-3. The electronic version of the MVPT-3 can therefore be determined to possess concurrent validity and could be used by professionals as a quick screening tool to give a general assessment of an individual's visual perception abilities. There were notable learning effects for many test items on the MVPT-3, despite which version was administered first, that should lend caution to using the MVPT-3 as anything but a screening tool. Particularly for the 4 year old age group, the developers of the MVPT-3, Colarusso and Hammill (2003), state that "for age 4, the MVPT-3 is best used as a screening instrument (this is the expressed intent of the MVPT-3)." (p. 52). This age group is perhaps more susceptible to maturation changes because visual perception abilities mature rapidly during this stage of life as cortical areas and intracortical connections mature (Bezrukikh, & Terebova, 2009). The majority of the participants in this study fell within the 4 year old age group.

Table 4: Age Breakdown of Participants

Age	Number of Subjects
4 years 0 months – 4 years 11 months	27
5 years 0 months – 5 years 11 months	6

It is unknown why this study obtained a sample of mostly 4 year old participants. Perhaps parents of children in this age group were more interested in having their children's visual perceptual abilities assessed. Another possible explanation suggested by several of the daycare providers, is that parents of school aged children focus on permission forms and other items from their children's school and are less attentive to permission forms from their children's daycare center.

The MVPT-3 provides indicators for visual perception problems and can be used as a first step in identify visual perception deficits. The assessment cannot be used to determine specific areas of weakness related to visual perception nor should it be to assess growth over time. The MVPT-3 should not be used for diagnosing visual perception problems because there was an overall 18.29% learning effect between administrations. The electronic version of the MVPT-3 is most suitable for a brief screening of visual perception abilities as it is convenient, quick to administer, and provides automatic scoring for the test administrator.

Throughout testing it was noted that the participants seemed more engaged and excited to interact with the electronic MVPT-3 on the laptop versus being tested using the flipchart from the paper version. This anecdotal evidence gives credence to the premise of testing school aged children using the electronic version of the MVPT-3. In addition to perhaps being a more engaging testing format for children, the electronic version of the MVPT-3 offers several benefits to clinicians. It is automatically timed for more accurate and standardized test administration, it calculates raw score and age equivalency, and it determines chronological age. The electronic version can be run on a laptop or touch screen tablet and the score report can be printed or saved electronically as a PDF. These features lessen the workload of the clinician and

decrease time spent scoring and interpreting the instrument. For these reasons the electronic MVPT-3 is a valuable screening tool for a brief assessment of visual perception.

The researchers had direct contact with the vendors, Academic Therapy Publications, and this study is of interest to them as they consider production and distribution of an electronic version of the MVPT-3. The publishers recognize that developing an electronic version is an important to consideration for future testing mediums so that both clinicians and clients have a valid, reliable, and easily accessible clinical tool to use for visual perception assessment.

Impact on Occupational Therapy Practice

The purpose of this study was to examine the concurrent validity of the electronic version of the MVPT-3 as compared to the paper version. The electronic version was chosen for study due to the fact that while technology permeates all areas of life, standardized digital assessments of visual perception have not been established for use with school aged children. The current study's findings demonstrate that the electronic version of the MVPT-3 has clinically acceptable concurrent validity when compared to the paper version and could be used by occupational therapists as a more efficient and appropriate alternative option for today's students. Standardized evaluations are the future of the evaluation process in occupational therapy practice and this research is a progression in our knowledge and understanding of the effectiveness of electronic assessments as an alternative to current pencil and paper assessments.

Limitations

The limitations of this study are that it is a small study with a limited number of participants. The participants were recruited from a small geographical region and may not be representative of children outside of this area. Students who were not proficient in English were excluded from this study. Students who moved or become unavailable for assessment were not

included in analysis. Another limitation of this study is that students were tested within a short window of time as per the MVPT-3 manual (Colarusso, & Hammill, 2003), and learning effects occurred. For some of the test items, these learning effects were significant. This brief window of time was necessary however, because if a longer window of time were used, the participants may have changed due to physical and cognitive maturation. Students who were not given parental permission or did not provide their verbal assent were not included in this study which could have potentially created bias. Another limitation of the study was the testing environment. Although the researcher tried to ensure a quiet testing environment with limited distractions, testing took place at the various different daycare and afterschool program settings and thus children were tested under real world circumstances. Each daycare or afterschool program setting varied in the ambient noise, the lighting, and the set-up of the room so each testing environment was slightly different despite attempts to make them as similar as possible. Lastly, the age of the participants in the study was a limitation. Although a pool of participants aged 4 to 10 years old was sought, the vast majority of participants in the study were 4 years old, so there was almost no variation in age amongst study participants. The low correlation between the electronic and paper version of the MVPT-3 is perhaps due in part to this younger age group of participants.

Recommendations for Future Research

This study found that the electronic version of the MVPT-3 possesses clinically acceptable concurrent validity when compared to the paper version of the MVPT-3, but the electronic version is newly developed and has not been widely tested. The current study was conducted in a narrow geographic area and participants were mostly 4 years old. Future research studies could focus on gathering data from a wider geographic area and a more varied mix of age

of participants. Additionally, while this study chose to use the 4 to 10 year old participant age range because of this generation's vast exposure to electronic medium in schools and daily life, future studies could examine the concurrent validity between the electronic and paper versions when testing adult participants. The electronic version of the MVPT-3 has also not been tested for its concurrent validity when compared to other commonly used visual perception tests such as the Developmental Test of Visual Perception (DTVP-3) or Test of Visual Perceptual Skills-Third Edition (TVPS-3). Further research will help to validate the use of the electronic MVPT-3 as a screening tool for all populations to provide a screening of visual perception skills.

REFERENCES

Baker, E.L. and Mayer, R.E. (1999). Computer-based assessment of problem solving. *Computers in Human Behavior*, 15, 269–282.

Bazyk, S., & Case-Smith, J. (2010). School-based occupational therapy. In J. Case-Smith & J. O'Brien (Eds.), *Occupational therapy for children, sixth edition* (pp. 713-743). Maryland Heights, MO: Mosby Elsevier.

Bezrukikh, M. M., & Terebova, N. N. (2009). Characteristics of the development of visual perception in five- to seven-year-old children. *Human Phsyiology, 35* (6), 684-689.

Brown, G., Rodger, S., & Davis, A. (2003). Test of visual perceptual skills-revised: an overview and critique. *Scandinavian Journal Of Occupational Therapy*, *10*(1), 3-15.

Brown, T., Bourane, R., Sutton, E., Wigg, S., Burgess, D., & Glass, S. (2010). The reliability of three visual perception tests used to assess adults. *Perceptual and Motor Skills, 111*(1), 45-59.

Brown, T., Mullins, E., & Stagnitti, K. (2009). The concurrent validity of three visual perception tests used with adults. *Occupational Therapy in Health Care, 23*(2), 99-118.

Brown, T., Unsworth, C., & Lyons, S. (2009). Internal consistency and concurrent validity of four instruments used to evaluate the visual-motor integration skills of school-aged children. *Journal of Occupational Therapy, Schools, & Early Intervention, 2*(1), 35-50.

Bundy, A. (1995). Assessment and intervention in school-based practice: answering questions and minimizing discrepancies. *Physical & Occupational Therapy In Pediatrics*, *15*(2), 69-88.

Burtner, P. A., Ortega, S.G., Morris, C. G., Scott, K., & Qualls, C. (2002a). Discriminative validity of the motor-free visual perceptual test revised in children with and without learning disabilities. *OTJR, 22*(4), 161-163.

Burtner, P. A., Qualls, C., Ortega, S. G., Morris, C. G., & Scott, K. (2002b). Test-retest reliability of the motor-free visual perception test revised (MVPT-R) in children with and without learning disabilities. *Physical & Occupational Therapy in Pediatrics, 22*(3-4), 23-36. doi: 10.1080/J006v22n03_03.

Cantu, C. O. (2003). OT in public schools: A 2003 review and prospectus. *The Exceptional Parent, 33*(9), 136-140.

Carlbring, P.,et al. (2007). Internet vs. paper and pencil administration of questionnaires commonly used in panic/agoraphobia research. Computers in Human Behavior, 23, 1421–1434.

Center for K-12 Assessment & Performance Management at ETS (2012). Coming together to raise achievement. Retrieved from: http://www.k12center.org/rsc/pdf/Coming_Together_April_2012_Final.PDF.

Clarke-Midura, J., & Dede, C. (2010). Assessment, technology, and change. *Journal of Research On Technology In Education*, *42*(3), 309-328.

Cognitive Innovations (2012). Standardized touchscreen assessment of cognition. Retrieved from: http://www.cognitive-innovations.com.

Colarusso, R. P., & Hammill, D. D. (2003). *Motor-Free Visual Perception Test*. (3rd ed.). Novata, CA: Academic Therapy Publications.

Collins, A., & Halverson, R. (2010). The second educational revolution: rethinking education in the age of technology. *Journal Of Computer Assisted Learning*, *26*(1), 18-27.

DeBell, M. & Chapman, C. (2006). Computer and internet use by students in 2003 (NCES 2006-065). *US Department of Education.* Washington, DC: National Center for Education

Statistics.

Duffey, D. & Fox, C. (2012). National educational technology trends 2012: State leadership empowers education, transforms teaching and learning. Washington, DC: State Educational Technology Directors Association (SETDA).

Hallfors, D., et al. (2000). A comparison of paper vs. computer-assisted self interview for school alcohol, tobacco, and other drug surveys. Evaluation and Program Planning, 23, 149–155.

Hansen, J.-I.C., et al. (1997). Comparison of user reaction to two methods of Strong Interest Inventory administration and report feedback. Measure and Evaluation in Counseling and Development, 30, 115–127.

Kielhofner, G., & Fossey, E. (2006). The range of research. In G. Kielhofner (Ed.), *Research in occupational therapy* (pp. 20-35). Philadelphia, PA: F.A. Davis Company.

Koppitz, E. M., (1970). Brain damage, reading disability, and the bender gestalt test. *Journal of Learning Disabilities, 3*(9), 429-433.

Liu, M., Papathanasiou, E., and Hao, Y.-W. (2001). Exploring the use of multimedia examination formats in undergraduate teaching: Results from the fielding testing. *Computers in Human Behavior*, 17, 225–248.

Maeroff, G. I. (2003). A classroom of one: How online learning is changing our schools and colleges. New York: Palgrave Macmillan.

McCane, S. A., (2006). Test review: motor-free visual perception test. *Journal of Psychoeducational Assessment, 24(3), 265-272.* doi: 10.1177/0734282906286339.

McCrimmon, A. W., Altomare, A. A., Matchullis, R. L., & Jitlina, K. (2012). Test review: the beery developmental test of visual-motor integration. *Journal of Psychoeducational Assessment, 30*(6), 588-592. doi: 10.1177/0734282912438816.

Obler, D. R., & Avi-Itzhak, T. (2011). Concurrent validity of the wide range assessment of visual motor abilities in typically developing children ages 4 to 11 years. *Perceptual & Motor Skills, 113*(2), 377-385.

Oostendorp, H. (2003). *Cognition in a Digital World*. Mahwah, N.J.: Lawrence Erlbaum Associates.

Özden, M., Ertürk, I., Sanli, R. (2004). Students' perceptions of online assessment: a case study. *Journal of Distance Education, 19*(2), 77-92.

Pinsoneault, T.B. (1996). Equivalency of computer-assisted and paper-and-pencil administered versions of the Minnesota Multiphasic Personality Inventory-2. Computers in Human Behavior, 12, 291–300.

Poon, K., Li-Tsang ,C., Weiss, T., & Rosenblum, S. (2010). The effect of a computerized visual perception and visual-motor integration training program on improving Chinese handwriting of children with handwriting difficulties. *Research in Developmental Disabilities, 31*(6), 1552-1560.

Raymond, A. (2012). Here comes generation Z. *CabinetMaker+FDM, 26*(4), 20-21.

Reeder, D., Arnold, S., Jeffries, L., & McEwen, I. (2011). The role of occupational therapists and physical therapists in elementary school system early intervening services and response to intervention: a case report. *Physical & Occupational Therapy In Pediatrics, 31*(1), 44-57. doi:10.3109/01942638.2010.497180.

Reid, D., & Jutai, J. (1997). A pilot study of perceived clinical usefulness of a new computer-based tool for assessment of visual perception in occupational therapy practice. *Occupational Therapy International, 4*(2), 81-98.

Russell, M., & Haney, W. (2000). Bridging the gap between testing and technology in schools.

Education Policy Analysis Archives, 8 (19).

Salend, S. (2009). Using Technology to create and administer accessible tests. *TEACHING Exceptional Children*, *41*(3), 40-51.

Schneck, C. M. (2010). Visual perception. In J. Case-Smith & J.C. O'Brien (eds.), *Occupational therapy for children* (6th ed.) (pp. 373-403). Maryland Heights, MO: Mosby Elsevier.

Shavelson, R., Baxter, G., & Pine, J. (1991). Performance assessment in science. *Applied Measurement In Education*, *4*(4), 347.

Sheiman, M. (1997). *Understanding and managing vision deficits: A guide for occupational therapists*. Thorofare, NJ: Slack.

Vansickle, T.R. and Kapes, J.T. (1993). Comparing paper-pencil and computer-based versions of the Strong-Campbell Interest Inventory. Computers in Human Behavior, 9, 441–449.

Vispoel, W.P. (2000). Computerized versus paper-and-pencil assessment of self-concept: Score comparability and respondent preferences. Measurement and Evaluation in Counseling and Development, 33, 130–143.

Vlok, E., Smit, N., & Bester, J. (2011). A developmental approach: a framework for the development of an integrated visual perception programme. *South African Journal of Occupational Therapy, 41*(3), 25-33.

Warren, M. (1993). A hierarchical model for evaluation and treatment of visual perceptual dysfunction in adult acquired brain injury, part 1. *American Journal of Occupational Therapy, 47,* 42-53.

Wong, K., Goh, P. S., & Osman, R. (2013). Affordances of interactive whiteboards and associated pedagogical practices: Perspectives of teachers of science with children aged five to six years. *TOJET : The Turkish Online Journal of Educational Technology, 12*(1).

Zandvliet, D., & Farragher, P. (1997), A comparison of computer-administered and written tests, *Journal of Research on Computing in Education*, *29*(4), 423-438.

APPENDIX A: CHILD ASSENT FORM

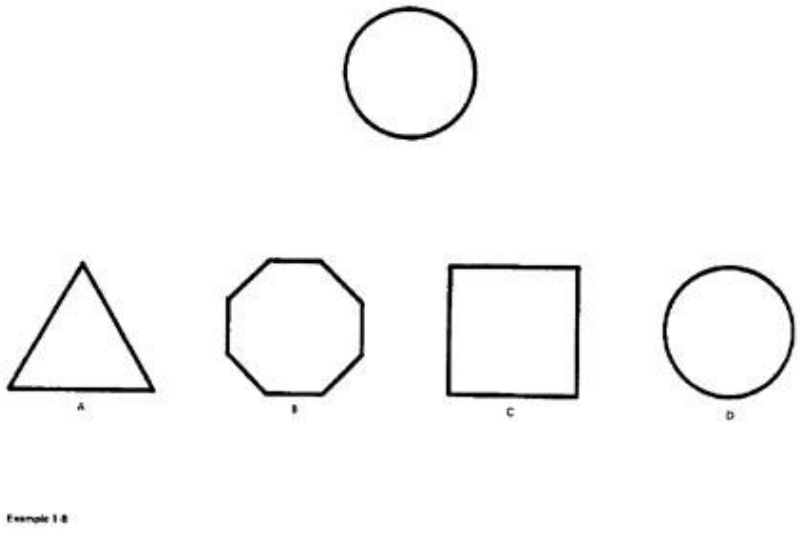
Child-appropriate explanation of the MVPT-3:

I have spoken with your mom (or the family member indicated on the consent form) and they have told me that it was OK to ask you if you would be willing to help me solve a problem. I am trying to find out if someone does something on paper and then if they do the same thing using a computer if it is going to come out the same. Would you be willing to help me with this problem?

What I want to do is first ask you to look at some pictures and choose the best answers when looking at them. Then later I will come back and do the same thing only using a computer. What do you think? Can you help me with that? It will only take a short time, less than a short video or computer game.

I have a picture of what I am talking about. Would you like to see it?

Show the following:



Which one looks the same as this one up here (point to the circle above the answer choices)? The test that I want you to do is similar to this, OK?

APPENDIX B: PARENT LETTER

Dear Parent,

I would like to thank you for allowing (Child's name) to participate in the research study that I conducted at (school name/daycare center name). This has been most helpful in allowing me to complete my work towards a Masters of Occupational Therapy. Thank you again for allowing your child to participate.

Please find that I have attached the results of your child's Motor-Free Visual Perception Test – Third Edition score and an explanation of what this test measures. The print out identifies the individual answers for each item and the perceptual age for the total score. As a parent, I am sure you are aware of the fact that children progress and reach maturation of their skills at different times than others their same age. The MVPT-3 is intended to be used as a screening tool only and your child's score should not be used for diagnostic purposes. However if you identify areas that you are concerned about in regards to your child's visual perception, you may want to further consult an occupational therapist about this matter. If you would like to discuss your child's score with an occupational therapist please contact me at armstrongla11@students.ecu.edu or my advisor, Dr. Leonard Trujillo, at trujillol@ecu.edu and we will insure one is available for your consultation. Again, thank you for assisting in me in completing this research study and allowing your child's participation in this study.

Sincerely,

Lauren Armstrong

APPENDIX C: BACKGROUND INFORMATION ON MVPT-3

Background Information on the Motor Free Visual Perception Test- 3rd Edition (MVPT-3)

The MVPT-3 is a screening test that was developed to be used with children and is designed to help estimate their visual perceptual ability. There are NO expectations or claims that the scores on this screening test also identify levels of intelligence or other associated traits. Visual perception is most often broken down to five separate areas including: Spatial Relationships; Visual Discrimination; Figure Ground; Visual Closure and Visual Memory. These can be defined in the following manner:

Spatial Relationships: This involves skills and abilities to orient one's body in space and perceive other objects and their orientation to other objects. This enables us to distinguish a row of nines and six next to each other and identify which is which.

Visual Discrimination: This visual perceptual skill allows us to distinguish the primary features of objects or shapes and identify those that are similar and those that are different. Thus we can distinguish between an oval and a circle as well as am object with flat surfaces as an octagon.

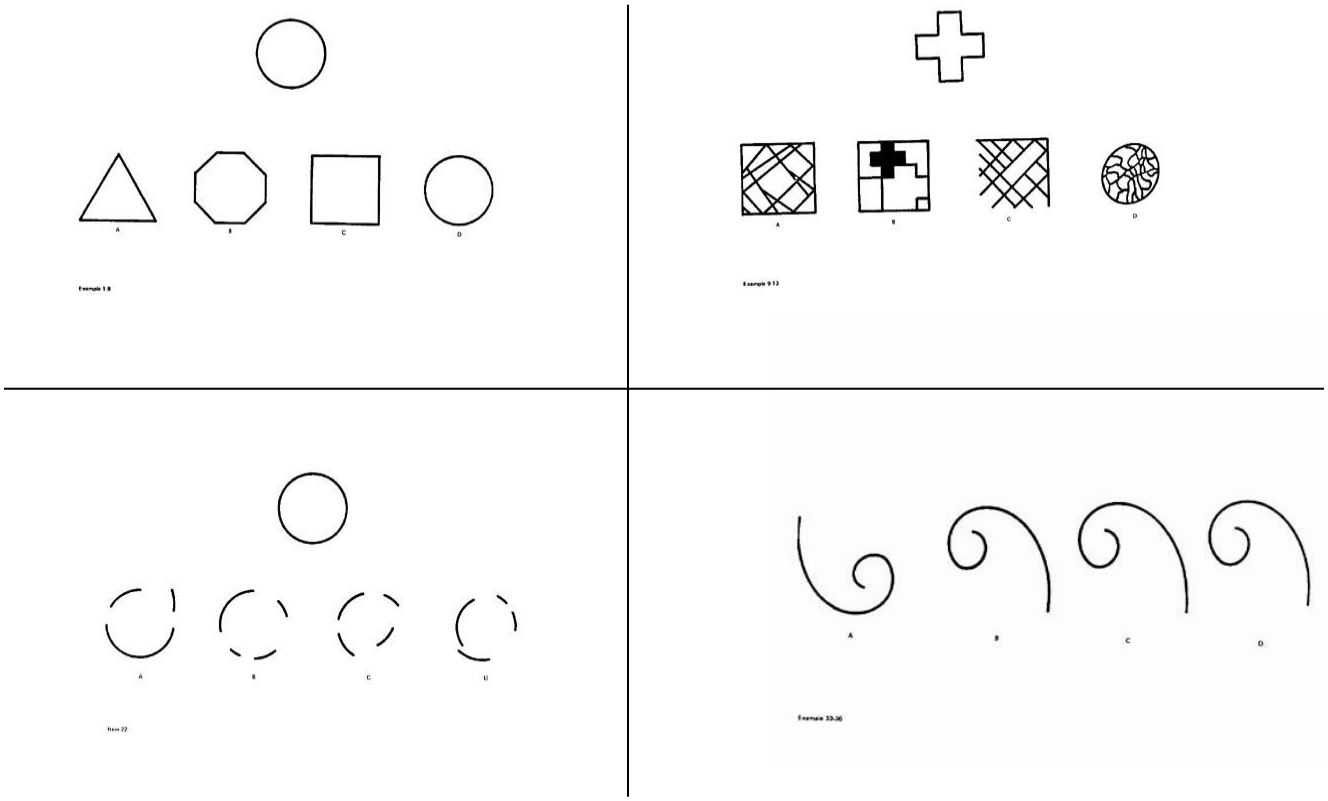
Figure Ground: The primary ability here is being able to select out an item from that of its background. It is what enables us to find things even when one's desk is cluttered.

Visual Closure: This visual perceptual skill enables us to "fill in the blanks." If you drew a circle with a pencil and then using an erasure erase certain parts of it whether random or equal segments you would still be able to recognize that the object, if connected would be a circle.

Visual Memory: This is allows us to see an object and in our mind reconstruct it without having to have it in front of us. This can be a particular object or a sequence of objects such as letters or numbers.

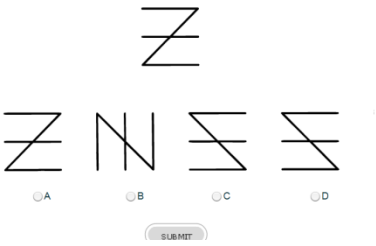
Visual Perception Skills are believed to be an important part of what allows us as humans to perform many complex cognitive and motor processes as well as to make judgments based on only having partial information. Visual Perception Skills are used in multiple areas of our lives and while an individual can go through life without them, it would be with difficulty.

The following are some examples of the templates used in conducting the test:



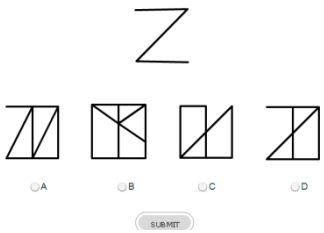
APPENDIX D: TEST ITEM TEMPLATES

Item 1:

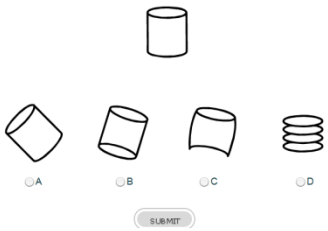


Item 3:

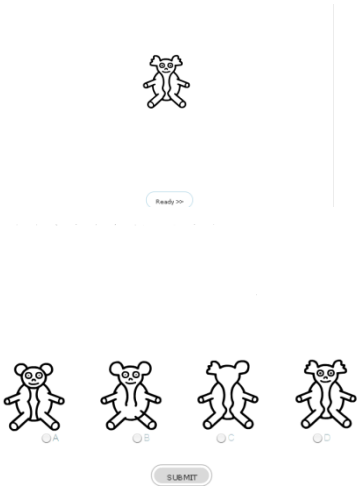
Item 7:



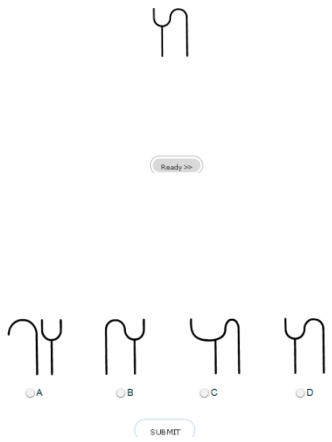
Item 11:



Item 15 a and b:

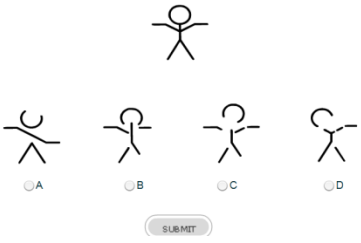


Item17 a and b:

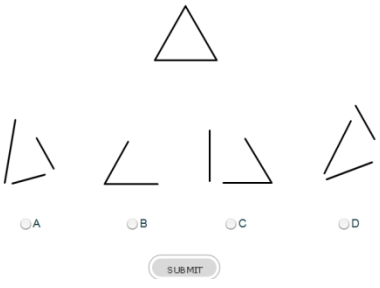


Item 18 a and b:

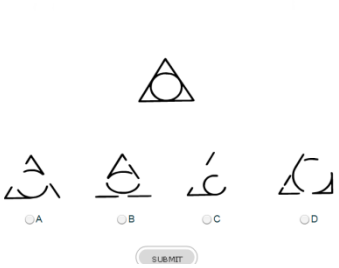
Item 25:



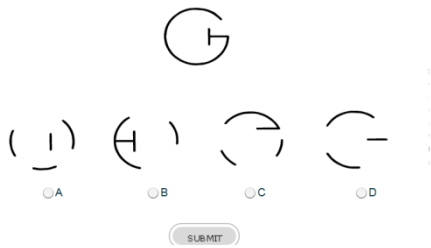
Item 26:



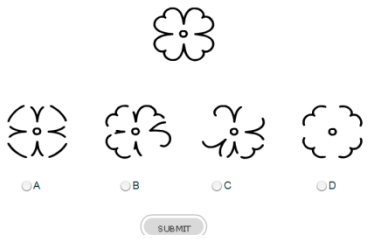
Item 28:



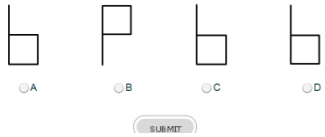
Item 31:



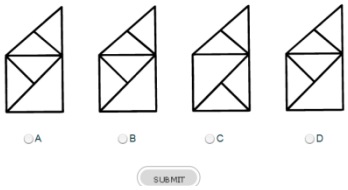
Item 34:



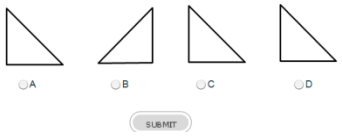
Item 35:



Item 37:



Item 38:



APPENDIX E: PARENT PERMISSION LETTER

Dear Parent/Guardian,

I'm presently working on my Masters of Occupational Therapy at East Carolina University. As part of my degree requirements, I am planning a research project that will help me to learn more about the Motor-Free Visual Perception Test 3rd Edition (MVPT-3). The fundamental goal of this research study is to determine if the electronic version of the MVPT-3 is valid and could be made available for use by occupational therapists and other professionals working with children.

As part of this research project, your child will be asked to participate in two testing periods over two to four weeks that will allow me to assess them using the paper version and the electronic version of the MVPT-3.

I am requesting permission from you to use your child's data (i.e. the raw score and derivative scores on the electronic and paper version of the MVPT-3) in my research study. Please understand that your permission is entirely voluntary.

If you have any questions or concerns, please feel free to contact me by emailing me at armstrongla11@students.ecu.edu . If you have any questions about the rights of your child as a research participant, you may contact *The University and Medical Center Institutional Review Board* at 252-744-2914.

Please detach and return the form below. Thank you for your interest in my research study.

Laurie Armstrong, OTS

Researcher/Investigator

As the parent or guardian of _____, (write your child's name)

- ☐ **I grant my permission for Mrs. Armstrong to use my child's data in her research project regarding the electronic version of the MVPT-3. I voluntarily consent to Mrs. Armstrong using any of the data gathered about my child in her study. I fully understand that the data will be kept completely confidential and will be used only for the purposes of her research study. Unless specifically requested, I understand I will not receive results of the MVPT-3.**

- ☐ **I do NOT grant my permission for Mrs. Armstrong to use my child's data in her research project regarding the electronic version of the MVPT-3.**

Signature of

Parent/Guardian:_____Date:_____

APPENDIX F: IRB APPROVAL

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834

Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Initial Approval: Expedited

From:	Social/Behavioral IRB
To:	Leonard Trujillo
CC:	
Date:	7/16/2013
Re:	UMCIRB 12-002163 Concurrent Validity of the Electronic MVPT-3

I am pleased to inform you that your Expedited Application was approved. Approval of the study and any consent form(s) is for the period of 7/14/2013 to 7/13/2014. The research study is eligible for review under expedited category #7. The Chairperson (or designee) deemed this study no more than minimal risk.

Changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must submit a continuing review/closure application to the UMCIRB prior to the date of study expiration. The Investigator must adhere to all reporting requirements for this study.

Approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Name	Description
Background information about MVPT-3	Consent Forms
Child verbal assent	Consent Forms
MVPT-3 Procedures and Background Information.pdf	Study Protocol or Grant Application
Parent consent form	Consent Forms
Seeking Children between the ages of 4.docx	Recruitment Documents/Scripts

The Chairperson (or designee) does not have a potential for conflict of interest on this study.