Visual Perception in School-Aged Children: A Psychometric Study of the Correlation between Computer-based and Paper-based Scores on the Motor-Free Visual Perception Test, 3rd Edition

by

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Visual perceptual skills are often assessed using paper-and-pencil tests such as the Motor-Free Visual Perception Test, 3rd Edition (MVPT-3). A computer-based version of this assessment was independently developed. This study aimed to establish its reliability by comparing scores of 3rd grade children at a local private school on each of the two testing mediums using a test-retest method. A strong correlation of age adjusted raw scores on the two testing mediums were anticipated, which would indicate that the computer-based version of the MVPT-3 is as reliable as the paper-based version. The current study found inconclusive results after correlational analysis, but results showed that 72.5% of participants received clinically comparable results. Clinically comparable results indicate that within the practical settings which this assessment may be utilized, the practitioner administering the assessment would offer similar recommendations. Regarding participants who did not receive clinically comparable results, assessment medium order is associated with incomparable scores. These results support the C-MVPT-III as a reliable and valid tool.

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CHAPTER 1: INTRODUCTION

In order to fully interact with the immediate environment, a person must be able to cohesively organize the many sensations which bombard the body at any given moment. The process by which this is done is collectively referred to as perception (Goldstein, 2007; Kramer & Hinjosa, 1999; Sternberg, 2006). In early years of studying perception, scholars believed it to be a distinct process which lies between sensation and cognition (Piaget, 1952; Strauss & Lehtinen, 1947). They theorized there was a cyclical pattern of how a person experiences the external world that required sensation of a stimulus which led to perception of that stimulus and ended with cognition regarding the stimulus (Piaget, 1952; Strauss & Lehtinen, 1947). However, more recent research has led most experts to believe that the perceptual process is actually reliant upon cognitive processes that "change as a function of learning, labeling, and experience" (Mussen, Conger, & Kage, 1969, as cited in Kramer & Hinjosa, 1999, p. 205-206). This inter-related view of perception discredits the idea of a distinct perceptual process and suggests instead that perception is complex by nature (Hudgins, 1977). This current view indicates that our perception evolves and is in many ways shaped by experience and cognition; contrarily, it also indicates that as our experiences and thought patterns change, our perception of the same stimuli may be altered as well. Thus, perception itself is an ever-changing, individual experience of our own bodies and the world around us (Goldstein, 2007). As such, perceptual deficits may impact an individual's ability to engage in activities, particularly regarding their ability to interact appropriately with their environment (Ludt & Goodrich, 2002; Murray, Cermak, & O'Brien, 1989; O'Brien, Cermak, & Murray, 1988). For this reason, careful evaluation of these perceptual

processes is vital to occupational therapists in understanding deficits in the functional levels of clients.

Visual perception is commonly referred to as the most dominant or influential distal sense in humans due to the ability to convey a large amount of information within just a sweeping glance (Bouska, Kauffman, & Marcus, 1990; Hellerstein & Fishman, 1999; Nolte, 1988). This type of perception generally refers to a set of sub-skills which "interface with one another to integrate visual information efficiently" (Warren, 1993, p. 51). This visual information which the brain uses to process into a singular perception of our environment may include which objects are available in the room, spatial relationships of the objects, the people or animals in the same environment and their perceived intentions to act upon the environment (Ludt & Goodrich, 2002). All of this information is essential to helping the individual interact appropriately and accurately with his or her environment (Lesch, Chang & Chang, 2008). However, when this perceptual process is hindered in some way, the deficits begin to impede safe, efficient environmental interactions, ultimately resulting in decreased occupational engagement, success and independence.

Effective and accurate assessment of visual perception is, therefore, an essential tool for the occupational therapist working to correct impoverished occupational engagement. As the many theories regarding visual perception have developed over time, so have the assessments. Functionally, the expectation of intact visual perceptual skills includes using these skills to act upon the stimulus appropriately. Thus, the vast majority of visual perception assessments include visual-motor activities such as drawing a copy of a visual stimulus (Colarusso & Hammill, 2003). However, research

has found that visual perception and motor output are part of two very different neuronal systems (Bortner & Birch, 1962; Leonard, Foxcroft & Kroukamp, 1988; Milner and Goodale, 1995; Parush, Yochman, Cohen, & Gershon, 1998). As such, assessing visual perception and motor output simultaneously may not yield accurate results or offer any real indication of where the true functional breakdown is occurring within the client. In response to the gap between what current research regarding the neurological basis of the perceptual process and the lack of perception-only assessments available, Collarusso and Hammill (1972) published the Motor-Free Visual Perception Test (MVPT) which assesses the ability of the individual to assimilate and interpret visual information, bypassing the need for motor output.

CHAPTER 2: LITERATURE REVIEW

History of the MVPT

The primary objective of the MVPT is to assess how an individual perceives objects in the real world without requiring a motoric response to measure perception (Colarusso & Hammill, 2003). The authors of the MVPT noted perception of objects in the real world requires the ability to "discern objects when seen in various orientations, to discern one object among others in close proximity, to identify an object correctly even when only part of it is seen, and to know where an object is in relation to oneself and/or other objects" (Colarusso & Hammill, 2003, p. 9). With this in mind, utilizing the visual perceptual abilities termed and described by Chalfant and Cheffelin (1969), the authors of the MVPT created test items which required the examinee to perform visual perception tasks in the areas of spatial relationships, visual discrimination, figure-ground, visual closure, and visual memory.

Since its original publication, the MVPT has undergone extensive research and been updated several times in response to the current findings and new theories in the field of visual perception, as well as in response to demands of the clinical environment. In 1996, Colarusso and Hammill published a revised version (MVPT-R) which included four new test items bringing the total to forty test items as well as new age-range norms for children ages four to twelve. As much of the research indicated visual perception was essentially mature at age ten, the authors did not anticipate a need for norming the assessment tool with adults (Bender, 1938; Colarusso & Hammill, 1972; Frostig, Lefever, & Whittlesey, 1964). Instead, the authors assumed the norms could be generalized to anyone over twelve, and encouraged the clinical applications with adults

whose visual perception skills appeared to have diminished (Collarusso & Hammill, 1972).

This novel motor-free assessment was soon being used in research and clinical settings beyond the limited age range for which it was normed. In 1983, the *American Journal of Occupational Therapy* published a research article which used the MVPT to distinguish between people with and without schizophrenia (Eimon, Eimon, & Cermak). The participants were 40-to-60 years old, well outside of the normed range, and yet the article reported success in using this assessment as an identification tool. In the clinical setting, an occupational therapist, referred to as L. Mercier, used the MVPT with adults after stroke or head injury to screen for any visual perceptual deficits (Collarusso & Hammill, 2003). He noticed, however, that his clients with hemi-neglect were having difficulty completing the test successfully due to their inability to attend to all answer choices presented on their affected side as indicated by a heavy reliance upon choices within their unaffected side. He suggested the need for an alternative version in which the multiple choice answers were offered in a vertical orientation for clients with visual neglect. Following this suggestion, the MVPT-Vertical was published using the same 36 items as the original MVPT with norms for adults ages 55 and older (Mercier, Hebert, Collarusso & Hammill, 1997). This version remains the standard of visual perception assessment with clients of this select population.

While research continues to suggest the neurophysiological components responsible for visual perceptual maturity are essentially complete at age ten, the increasing trend towards generalizing the norms to adolescent and adult populations indicated a need for more comprehensive standardization. In an effort to be more

thorough than previously anticipated, Colarusso and Hammill (2003) expanded the assessment to be appropriate for clients ages four to ninety-four with updated age-adjusted norms to support the expanded age range. The norms were based on a nationally representative sample using data from 1,856 participants from 118 cities in 34 states. (Colarusso & Hammill, 2003). Also during the standardization process, several new test items were developed, administered and analyzed. The items which survived this statistical scrutiny were included in the new version. In order to handle the extended age range and increase in test items, the creators of the assessment developed two protocols based on the age of the examinee (Colarusso & Hammill, 2003). This version, known as the MVPT-III, has since become the standard of visual perceptual assessments across a variety of settings with clients of all ages.

Societal Changes Affecting Visual Perception

Pre-Historic Communication

Methods of communicating ideas, stories, beliefs and events have drastically changed since primitive man, with each step forward revolutionizing how younger generations learn, process, and interpret information. Before recorded history, communities relied upon oral tradition to pass down stories, wisdom and the communal understanding of the local people to future generations (Rappaport, 2000). While no research on the oral tradition within this time frame was possible, research has since been conducted and assumed to be translatable to the pre-written era (Opie & Opie, 1959). Through this process, researchers have concluded there are profound differences between oral communication and written communication (Foley, 1993; Lord, 1993; Olrik, 1992). One central difference mentioned in the literature is the sense of

communal authorship related to oral tradition (Dodwell, 2008; Rappaport, 2000; Zipes, 2005). The process of oral tradition, as re-created in a modern world, is understood to produce within the individual a sense of tradition via "learn[ing], often by rote, what our traditions are and come to know ourselves through mass-mediated and manipulated stories" (Zipes, 2005, p. 7). Oral traditions continue to persist in our modern culture prior to literacy in the form of lullabyes and childhood rhymes (Opie & Opie, 1959). While this form of communication is often assumed to require only auditory skills as an audience member, scholars suggests oral tradition is communally-defined, therefore while one may be contributing the bulk of the story, audience members are collaborating to offer a more complete picture of the unfolding storyline (Dodwell, 2008; Rappaport, 2000).

Another pre-historic form of communication includes rock art, more commonly referred to as cave drawings. This art form was common among pre-historic societies, as they have been found in a variety of places around the globe (Ouzman, 2008). Scholars believe this form of communication existed to mark territory, often using images representing the oral traditions of the native people (Bahn, Lewis-Williams, Chippindale, Nordbladh, Schaafsma & Frankel, 1996). Wade (2005, p. 5) notes this art form "reflected the nonverbal records of perception". The location of many drawings deep within relatively inaccessible caverns indicate an unlikely physical presence of an artistic subject, suggesting many drawings were completed using visual memory accurate enough in detail so as to be vastly recognizable by modern archaeologists (Wade, 2005).

Written Communication

While oral communication allows for communal authorship, written communication indicates a higher level of authority, inducing a greater degree of trust from readers than if the message were merely spoken (Dodwell, 2008). The origin of written word marked the beginning of history as we know it since "printing links the present with forever" (Postman, 1982, p 21). The written word is believed to have originated in several cultures independently, but scholars believe the oldest surviving written artifacts to have originated in Sumeria over 5000 years ago (Carr, 1986; Gaur, 1984). While the advent of writing allows for communication, recording history, documenting scientific discovery, and a means of capturing great ideas and other cognitively stimulating activities, historians believe the earliest written records served a more basic purpose—an inventory of goods (Wade, 2005).

Notably, while the written word was being utilized to document historical events, scientific discoveries, theories and ideas over time, the literacy among the average person varied over the course of history. During the Middle Ages, the commoner "acquire[d] knowledge mainly by ear, through public sermons, mystery plays, and the recital of narrative poems, ballads, and tales" (Tuchman, 1978, p. 12). As Houston (2003, para. 4) notes, "the chances of being educated and of acquiring literacy [during the Enlightenment] depended on many factors: wealth, sex, inheritance laws, protected job opportunities, employment for children, and even the language a person spoke in everyday life". However, this method of acquiring knowledge auditorily changed drastically for commoners in the eighteenth century beginning in the Reformation and

Renaissance eras when literacy trended away from restricted to upper class or scholars to mass literacy regardless of social status (Houston, 2003).

The invention of the printing press by Johannes Gutenberg in the early 1400s offered a faster method of producing and distributing the written word as well as a uniform reference for knowledge as each print was identical to all other prints (Donnachie, 2009). This technology "contributed fundamentally to scientific communication and the preservation of knowledge during the Scientific Revolution" (Lowood, 2003, para. 1). However, it did not gain immediate popularity as Boyer (2001) notes printing and publishing have only been popular in American culture since 1640, approximately 200 years after being invented, due to the popular hymnal *Bay Psalm Book* being published in Cambridge, Massachusetts.

Distance Communication

Before a formal postal service was in place, distance communication was achieved by reliance on friends and family, merchant ships, and hired couriers (Willis, 2004; Purcell, 1998). There were privatized postal systems in place for government officials in many societies prior to an available public system (Purcell, 1998). Public access to postal services varied by society, most not receiving access until hundreds of years after initial privatized systems had been put into place (Purcell, 1998; Heslip, 2007). In the United States, a public postal service was established in 1775, when members of the Second Continental Congress agreed to appoint a postmaster (Porter, 2007).

The first telegraph was designed by brothers Claude and Ignance Chappe in France in 1794 (Feldman, 2003). The design of the telegraph was updated and

changed several times during its popularity, but the communication remained limited to daylight hours with clear skies (Feldman, 2003). The United States opened the first telegraph lines to the public during the mid-1840s (Israel, 2001). The telegraph expanded near the same time as the national railroad system, heralding much quicker routes of communication than ever before (Feldman, 2003). During this time, there were several companies competing to provide long-distance services to American customers (Israel, 2001). Also invented during this time was a "speaking telegraph", also known as a telephone, by Alexander Graham Bell in 1876 (Kragh, 2003). This rapid expansion of long-distance communications allowed for increased communication over a wider distance, allowing information distribution to become "uncontrollable… the first communication medium to allow the speed of a message to exceed the speed of the human body… [it] eliminated in one stroke both time and space as dimensions of human communication and therefore disembodied information to an extent that far surpassed both the written and printed word" (Postman, 1982, p 70).

Wireless Communication

The radio is heralded as the basis of the 20th Century communications revolution (Johnson, 2001). Following a trend of scientific discoveries proving radio technology was plausible, an Italian physicist named Guglielmo Marconi received credit for inventing the first radio system in 1901 which transmitted Morse code from England to Newfoundland wirelessly (Johnson, 2001). Radio technology was used primarily for military purposes during World War I, before broadcast programs began in many countries in the early 1920s (Allen, 2009; Bartlet, 2010; Johnson, 2001). Even after broadcast programs to the public began airing in many countries across the globe,

radio's primary use was "propaganda and regimentation", with a secondary utility supporting "education and entertainment" (Sarnoff, 1937, p.2).

The step towards a global community which was initiated by the printing press and the telegraph gained momentum with the invention of the radio (Allen, 2009; Bartlet, 2010). To provide monetary support to the station without incurring costs to the end user, AT&T's New York station, WEAF set the precedent by selling airtime to advertisers (Sterling, 2001). The radio stations became a portal of information and entertainment which received news and advertisements from all over the country (Bartlet, 2010; Sterling, 2001). These advertisements and entertainment media contributed to the development of a consumeristic society by the 1950s (Lavin, 1995). Historians designate the 1930s, at the peak of the Great Depression, as the beginning of a national trend towards consumer culture as indicated by increasingly popular phrases such as the "American Dream" (Susman, 1984).

In the wake of the popularization of radio, Hadley Cantril (1937) sought to explore how the task of listening differs when interacting in face-to-face communication versus listening to the radio. His research revealed listening to the radio creates within the human mind increased susceptibility to prestige suggestion, decreased analytical thought patterns, as well as decreased enthusiasm demonstrated via body language than when engaged in face-to-face communication. Additionally, Cantril (1937) concluded the popularity of radio is due to the sense of belonging to a larger social participation, of the ability to listen in on concurrent information and entertainment which would be otherwise inaccessible due to distance and cost associated with traveling.

While the radio maintained popularity, the television, which consists of radio waves transmitting wireless visual images, gained popularity, slowly superseding its auditory predecessor. The first television receivers were available for sale in 1939, but sales lagged until 1948 (Baughman, 2001). However, by 1962, 90 percent of homes had a television set (Baughman, 2001). This trend appeared to have occurred across the country regardless of socio-economic status as "television, compared to movie-going, was cost-efficient entertainment; parents and children could be entertained at home, without traveling to a theater or buying tickets" (Baughman, 2001, para. 1).

This multi-modal entertainment piped directly into homes all over the country was a source of hope and concern for many scholars, as they recognized "the new art of television has similar potentialities to build up or tear down social values" (Sarnoff, 1937, p.2). Idealists dreamed television would put "a stadium, amusement park, theater, university and charm school into every home" (Johnston, 1946, p.1). Contrarily, realists understood the persuasive nature of sound and vision and feared the social impacts of broadcast media redefining 'normalcy' (Sarnoff, 1937).

Regardless of the positive or negative impact television was to have on social constructs, the American public embraced television as a new addition to the home. Interior designers began to plan for the television to become the center of living room décor (Johnston, 1946). Over the years, many spaces throughout the home became increasingly appropriate for the placement of a television (Bryant & Bryant, 2000). Since then, Shannahan & Morgan (1999) noted television "has permeated every corner of public and private space, shaping consciousness, defining our 'reality', drawing us

together, and pulling us apart, in ways that uniquely enshrine this historical period as The Age of Television".

Scholars have since noted the overwhelmingly remarkable contribution television has offered to the understanding and identification of popular culture through the years (Kompare, 2002). Prior to the visual stimulus provided by television, the common man had to rely upon written or oral descriptions, or perhaps the occasional impersonation by theater actors and orators, for an idea of character personality, looks, quirks, details of place and events; whereas the television allows today's generation to see for themselves the stars of the past, the fashions, the culture, etc., generating not only a globalization of culture, but a means of capturing culture for future generations to study and experience (Kompare, 2002).

As radio is considered the instigator of consumerism within the American ethos, television's multi-media presentation of sound with video allowed for a higher degree of persuasive advertisements (Cashmore, 1994; Dyer, 1982). Dyer (1982, p. 2) suggests television advertisement "operates in the same way as myths in primitive societies, providing people with simple stories and explanations in which values and ideals are conveyed and through which people can organize their thoughts and experiences and come to make sense of the world they live in."

Television, particularly for entertainment value, has been scrutinized not only for contributing to the development of a consumeristic society, but also, as predicted, a means of establishing an altered sense of normalcy among the general public as the family unit portrayed in various programming "suggests that certain versions of family life are normal and others are deviant, strange, or (by exclusion) nonexistent" (Taylor,

1989, p. 19). With such mixed reviews of the impact of television technology on society, there have been many concerns regarding the impact of television on children. Research on this relationship is also varied, however most sources indicate potential benefits of multi-modal processing with age-appropriate material and, conversely, the dangers of excessive use and inappropriate content is also heavily documented (Van Evra, 2004).

In relation to education, wireless technology has increased availability to isolated areas where teachers are often scarce, such as in the Australian Outback where satellite two-way exchange continues to be used as a means of communication between students and teachers (Wallace & Boylan, 2000).

Digital Communications

However, in most of these forms of communication, the average person was a consumer, re-teller, or perhaps localized communicator; however with the creation and increased accessibility and applications of the internet, the average person has the opportunity, 24 hours a day, to communicate with a global audience, interact with friends, consume media in various forms and offer feedback to the author or review it for others to read (Ebersbach, Glaser, Heigl, & Dueck, 2006; Tremayne, 2007). Where people used to be isolated to cultural and religious beliefs held by the general public in the local area, now people are exposed a wide and diverse global culture and are able to make decisions about individual ideals more readily (James, 2009). The tools available online allow a person to educate themselves on an area of interest and interact with media in a way which has never been possible before (Tremayne, 2007). The interactivity of the internet allows not only multimedia processing, but also allows

multi-tasking of multimedia processing and offers opportunities for motor output via keyboard and mouse controls (Boston & Kauka, 2010; James, 2009).

As a result, our society has changed drastically since the 1970's when the MVPT was originally published as a paper-based assessment tool. During this time, it is possible visual perception itself has evolved as an adaptive response to the changing technological environment (Wade, 2005). With the global shift towards a more technologically focused society, it is essential to consider the steadily increasing gap between how often people are using their visual perceptual skills to interpret images on screens via computers, smartphones, mp3s, and other screen-based technologies, and how visual perceptual skills may be assessed within a clinical setting. The younger generation is growing up in a world with different opportunities, different expectations, and certainly different experiences than prior generations (James, 2009; Tremayne, 2007). These changes have affected every facet of life, but this paper will consider three pertinent areas of change affecting visual perception: 1) their lifestyle changes as a result of societal technology evolution, 2) the possible neurological reorganization as a result of their overexposure to media, and 3) how the classroom is undergoing a transformation as a result.

Revolutionized Lifestyles

Perhaps one of the largest societal changes in upcoming generations is the increased hours of media usage, both for productive and entertainment purposes. A recent nationally representative study conducted by the Kaiser Family Foundation demonstrated this trend by studying the multimedia habits of today's student population (Boston & Kauka, 2010). They followed over 2,000 third through twelfth grade students

for seven months from October 2008 to May 2009. During this time, the participants kept a media use diary which was used to calculate multitasking proportions. Participants spent an average of 7 hours and 38 minutes a day using entertainment media, but with the compounded impact of multitasking, they managed to fit in 10 hours and 45 minutes worth of media content. These numbers have steadily increased from the previous reports conducted in 1999 and 2004 (Boston & Kauka, 2010).

In previous generations, a faster paced lifestyle of media-based multi-tasking was affiliated with metropolitan areas such as New York City or Los Angeles. In fact, more rural areas of the country have struggled to obtain access to the internet. Even now broadband is not available in all parts of the country, but that is expected to change in the coming years. In April 2009, the U.S. Congress challenged the Federal Communications Commission (FCC) to create a plan for ensuring access to broadband for the entire country. The FCC used public workshops both online and at FCC offices to brainstorm with the American public ideas that would address this issue. The FCC then streamlined this information into a cohesive National Broadband Plan which details policy changes that would encourage the expansion of broadband nation-wide (Federal Communications Commission, 2010). While this does not offer a timeline indicating when the remnants of rural America currently without broadband can be ensured accessibility, it does indicate the path of action the government intends to take in the coming years. The implications for nation-wide broadband access are extensive, ranging from increased accessibility to medical care, business opportunities, educational resources, and so much more. In addition to these benefits, however, comes a shift in lifestyle pace as rural America becomes interconnected to the same

media which has been supporting the faster, multi-tasking lifestyle associated with bigger, more populated areas.

The societal changes have also impacted the workplace in that the expectations of employers have shifted to accommodate the impact of an increasingly global economy. In the past, marketable skills included a good work ethic and a willingness to learn and take direction from supervisors. Today's job market shows is searching for a different set of marketable skills. The Partnership for 21st Century Skills (P21) is a national organization made of business, community, and education leaders and policy makers who are advocating change within the educational system which will prepare students appropriately for today's job market. They have identified six elements they consider key to learning in the 21st century. These elements are represented in the Table 1 Key elements of 21st century learning.

Table 1 Key elements of 21st century learning

Key Element	Including	
Core Subjects	Language Arts	Government
	Mathematics	Economics
	Science	Arts
	Foreign Languages	History
	Civics	Geography
21st Century Content	Global Awareness	Economic Literacy
	Financial, Economic, Business and Entrepreneurial Literacy	Health and Wellness Awareness
Learning and Thinking Skills	Critical Thinking and Problem-Solving	Collaboration
	Communication	Contextual Learning
	Creativity/ Innovation	Information and Media Literacy
Information and Communication Technology (ICT) Literacy	Ability to use technology to develop 21st century content knowledge and skills in context of learning core subjects	
Life Skills	Leadership	Personal Responsibility
	Ethics/ Accountability	People Skills
	Adaptability	Self-Direction
	Personal Productivity	

(As adapted from Vockley, 2006, p 22)

By advocating the enhancement of this increasingly interactive and creative mindset, the organization hopes to encourage several student outcomes including life and career skills, learning and innovation skills as well as information, media and technology skills (Vockley, 2006, pg. 10). Organizations such as P21 represent the current and future job market which will be holding the future generation to a different standard than generations past. As a result of these changing expectations of the market and advocacy of emerging business leaders, the classroom itself is being transformed in an effort to prepare students who experience daily doses of media overload for the workforce of tomorrow.

The Evolved Student Population

In addition to the media transforming our lifestyles, an increasing amount of research suggests that the Information Age may in fact be perpetuating a step in the evolutionary process of mankind. Around the turn of the century, educators began to recognize differences in the students of today's classroom. Marc Prensky, a noted educational software designer who has been advocating for an educational revolution to engage today's students, called attention to these differences by coining the terms "digital natives" and "digital immigrants" (Prensky, 2001, pt 1). Digital natives are today's students who have been immersed in the electronic media culture, accepted it, and have begun to rely heavily upon it. Digital immigrants, however, refer to people who grew up before the internet was so widely available. He explains that natives consider media and internet resources first, whereas immigrants may not consider it until they have visited the library, called a friend, or used some other "old" method of acquiring knowledge. Prensky contends that not only do these students act differently, their brains and their bodies process information differently on a neurological level as a result of their vastly different environment (Prensky, 2001, pt 2).

In regards to contemporary neurological studies pertaining to the effect of technology use on brain functioning, the results are mixed. Some research suggests that overuse of technology, such as the typical digital native experiences daily, leads to information overload which has health related symptoms such as insomnia, decreased attention span, decreased ability to process information, decreased ability to make informed decisions, and in some cases mental illness such as depression (Choi, Son, Park, Han, Kim, Lee & Gwak, 2009; González & Mark, 2004; Pashler, 2000; Chou,

Condron, & Belland, 2005). Conversely, research also suggests that due to the plasticity of the human brain, technology can be utilized as a tool for promoting cognitive and visual-motor skills (Actman, Green, & Bavelier, 2008; Feng, Spence, & Pratt, 2007; Small, Moody, Siddarth, & Bookheimer, 2009). Regardless of whether the experts agree on the type of impact the digital revolution is having on our brains, they all seem to agree that technology use is capable of having a major impact on the neurological functioning of humans.

21st Century Classroom

Regardless of whether the next generation of students have truly "evolved" neurologically, the classroom of the past where notes were written using paper and pencil, books smelled like mothballs, and learning was teacher-directed is nearly certain to become a relic of the past. The push for change is coming from every direction including students, parents, teachers, advocacy groups, politicians, and of course, technology-related businesses hoping to sell their gadgets and software to school systems across the country. Perhaps the largest supporter of educational transformation, though, has been the federal government which has sponsored research projects and initiatives, passed bills increasing funds for technology accessibility and use within the classroom, and supported increased media-based literacy of teachers (Dobbins-Harper & Bhat, 2007; Vericker, Macomber, Brookings, Isaacs & Kent, 2010; Wilson, Greaves & Hayes, 2009).

Project RED (Revolutionizing Education) is an example of one such federally funded project focused on identifying and researching technology-rich school environments in an effort to better understand effective strategies to foster learning

(Wilson, Greaves, & Hayes, 2009). This project encompasses researching the long-term efficacy of strategies employed at the local and state levels in an effort to utilize technology in innovative ways with students. One such methodology under review by Project RED is the 1:1 laptop initiatives which sprouted up in various areas across the country almost ten years ago which ensured students and teachers a loaner laptop for the duration of the school year. A 2010 special issue of the *Journal of Technology, Learning and Assessment,* published by Boston College's Lynch School of Education included a collection of peer-reviewed research articles tracking the impact and effectiveness of these initiatives. When reviewed as a whole, one critical point emerges as the integral piece to insuring effectiveness of the 1:1 programs – the teacher's dedication to making it relevant to the student. This is a point of contention among teachers who feel the strain of budget cuts, increased class sizes and job uncertainty, but a few have managed to make it work. For example, teachers at Forest Lake Elementary School in Columbia, South Carolina have identified ten tips for personalizing lesson plans using various modes of technology (Rubenstein, 2010).

In order to understand the local trend of availability and use of technology for educational purposes within the target population used for this study, an anonymous poll of local private schools was conducted. This poll was conducted via phone within the Pitt County area in eastern North Carolina, inquiring about computer use within the curriculum and availability of technology to students and teachers as educational resources. Out of the schools which responded, all reported students having availability to computers at varying levels of time allotted for use and amount of computers available for educational purposes within the school environment. Table 2 Computer

use trend in local private schools provides a listing of responses offered. The schools are not named because several schools refused to comment if identified and as the information is more important than the source, the schools were all ensured anonymity. Additionally, further information was gathered as available from public sources, mainly school websites.

Table 2 Computer use trend in local private schools

School	Response	Public Information
1	Computers are available in library; a computer room is currently being established	
2	-	According to their website, they have "well equipped computer and science labs"
3	Preschool through Kindergarten are taught on desktop computers; 1st through 3rd graders use laptops; 4th grade through graduation, students are required to purchase or lease laptops for 24/7 availability	On website, they refer to students as Digital Natives
4	-	According to website, they conduct North Carolina Computer Literacy Exam in 8th Grade
5	Internet is available in every classroom with at least one computer in each classroom; 2 smartboards, 1 portable and 1 permanently fixed; 3 portable laptop units.	
6	Computers are available in classrooms, but not many due to money restraints. All computers are in need of replacement and are not currently being integrated on regular basis into the curriculum	
7	Computer use is purely instructional, every teacher has a computer; computer lab is available to students in science room	

(Polling and website search conducted by author, Fall 2010)

Three other schools were called but did not respond and did not have any accessible information on their website regarding current technology use for educational purposes.

Furthermore, research suggests changes in accessibility and use of technology within the classroom are occurring regardless of local socioeconomics. A research project funded by the U.S. Department of Education in 2009 was issued to evaluate the national Enhancing Education through Technology program (EETT) which was established under the No Child Left Behind Act of 2001 to grant monies for educational technology (Bakia, Means, Gallagher, Chen & Jones, 2009). Their report indicates that despite suspicions of an economic-driven predictor, the main predictor of high speed internet access within the classroom is the grade level being taught. They found that 72% of elementary school classrooms have high speed internet access, followed by middle school (55%) and high school (49%). With innovation and solid research supporting efficacy of novel pedagogical approaches along with support from the highest levels of government, it is unlikely that the traditional classroom will survive the 21st Century.

In the past, online education was nearly a laughable course of action as it was associated with frivolous, unregulated so-called educational programs which often promised an unaccredited degree in the field of your choice. However, with the increased appeal of online education, entities such as the Sloan Consortium have arisen in an effort to increase accessibility of educational opportunities and, more importantly, ensure the quality and effectiveness of such opportunities (Moore, 2005). In an effort to monitor the results of their efforts and the need for their services, the Sloan Consortium conducted extensive ongoing research regarding the enrollment rates of online and traditional higher education institutions across the nation. In their latest report, they found online enrollment rates have been growing substantially faster than

traditional enrollment in the higher education setting (Allen & Seaman, 2009). Over 4.6 million students were taking at least one online course during the Fall 2008 semester, a 17% increase from 2007, which far exceeds the 1.2% growth rate of overall higher education enrollment rates (Allen & Seaman, 2009). They also found distinctions between online students and classroom students are increasingly blurring as more than one-in-four higher education students take at least one course online (Allen & Seaman, 2009).

Even high schools are beginning to understand the importance and use of online education. Many are offering online classes beyond the scope of what would typically be available to students due to lack of teachers within specialty fields such as a more specific foreign language like Latin or Japanese. While most continue to view online education as optional and perhaps beneficial, some schools are making online instruction a requirement for graduation. In April of 2006, Governor Jennifer Granholm signed the Michigan Merit Curriculum into state law. This has been heralded as "one of the most comprehensive sets of high school graduation requirements in the nation" and includes, among other points, completion of an online class as a prerequisite to high school graduation (Michigan Department of Education, 2006, p. 1). While other states have yet to follow suit, this piece of legislation has certainly set a precedent for future education reform.

The current economic crisis appears to be playing a significant role in the current popularity and increasing prevalence of online education. While 54% of institutions reported the economic downturn increasing demand for existing face-to-face courses, 73% of institutions reported an increasing demand for existing online courses and 66%

of institutions reported an increasing demand for new online courses (Allen & Seaman, 2009). These numbers indicate not only the state of online enrollment rates and class demands, but also, more applicably, the rate of people who are becoming increasingly comfortable learning via screen-based methods.

Considerations of Computerized Visual Perception Assessment

While computerization of clinical assessments within a society which is shifting towards reliance upon technology seems apropos, it is imperative to consider fully the implications of such a change. This paper will consider if and why such a change may be necessary or appropriate, then discuss both the potential benefits as well as concerns of transitioning to electronic assessments. Finally, considerations of the process by which computerization of appropriate assessments will follow.

Compromised Ecological Validity as Performance Contexts Shift

The American Occupational Therapy Association (AOTA) (2008) recognizes occupational engagement occurs within a variety of contexts and environments which may impact performance skills and patterns. As discussed earlier, it is becoming apparent people, particularly of the younger generation, are increasingly using their visual perception skills within a virtual context. This trend may affect the ecological validity of the paper-based versions of visual perception assessments. Ecological validity is defined as the contextual consistency between assessment circumstances and typical performance situations (Sbordone, 1996). In order to optimize ecological validity of visual skills, practitioners need to be able to perform an assessment of skill level within the context which the client utilizes those skills most frequently. Scholars in the field of education began drawing attention to a similar issue as students who are

learning electronically are often being tested on paper (Howell, 2003). Other researchers have indicated that because of this gap, testing students via paper-based methods often underestimates the abilities of the technology-literate student (Russell & Haney, 2000). Therefore, as a professional allied health field dedicated to client-centered practice, occupational therapists need to format assessments and intervention strategies appropriately to the client in an attempt to provide opportunities for optimum performance capacity.

Benefits and Pitfalls of Computerized Assessment

While the creation and implementation of computerized assessment is lagging behind technological advances, it has been in consideration for a couple of decades now. As early as 1993, researchers were already suggesting computers would ease documentation, work faster, and produce fewer errors than humans in scoring assessments (Smith, 1993). More recent studies suggest computerized testing allows for faster results and decreases the risk of human error (Hargreaves, Sharrocks-Taylor, Swinnerton, Tait & Threlfall, 2004). Additionally, it may allow the therapist to capture process-oriented variables such as time and sequence (Austin & Mahlman, 2000).

Research regarding practitioner and client views of computer-administered interviews within the field of psychology reveals several perceived pragmatic benefits (Garb, 2007). These anticipated advantages included saving time, convenience, legibility of results (as compared to hand-written responses), and a decrease in paperwork processing required by the clinician.

More importantly, however, computerized assessment also allows for the presentation of data through automated organization of raw scores into tables, charts or

graphs, which are powerful mediums of communicating results which surpasses obscure discipline-specific jargon to communicate relevant results more effectively (Smith, 1989). In a society where the interdisciplinary approach was noted as the tenth rule for re-designing the healthcare system, in order to meet the demands of the 21st century client by the Institute of Medicine (2001), the possibility of using technology to transcend jargon in an effort to support effective communication between various healthcare providers is a notable benefit of computerizing appropriate assessments.

Despite the potential benefits to transitioning towards electronic assessment, there may also be some legitimate concerns which are necessary to address before it is safe to proceed with the transition. Concerns regarding the cost of computerization, privacy of client information, and insufficient empirical support all need to be weighed.

Cost of computerization

While the long-term benefits of incorporating computerized technology into the classrooms are well established, cost remains a commonly reported barrier (McNurlen, Gikeson, & Drake, 1996). It may be surmised that this is also a practical barrier for incorporation of computerized assessments within the clinical setting as well. However, the high cost associated with technology tends to decrease as more advances are made and availability increases (Garb, 2007; McNurlen, Gikeson, & Drake, 1996). Conversely, costs of health care may be reduced in the long term with the automization of scoring, allowing the clinician to be more productive in providing skilled services while on the clock (Farrell & Muik, 1993; Garb, 2007; Spinhoven, Labbe, & Rombouts, 1993). It has also been suggested that computerization will decrease human scoring errors, resulting in more accurate recommendations which will increase appropriate

interventions, supporting higher value of care for clients (Garb, 2007). Therefore, while cost is often a barrier of transition towards computerization, the potential benefits to the client process should ultimately reduce overall costs to the facility and its clients.

Privacy of Client Information

In the wake of the Health Insurance Portability and Accountability Act (HIPAA) of 1996, privacy concerns have been a priority within the healthcare profession, especially regarding electronic documentation (U.S. Department of Health and Human Services, 1996). Simultaneously, clients are entitled to increasing degrees of portability of their medical information and the degree of interdisciplinary coordination is at an all-time high in the medical field (Boschert, 2007). This struggle for privacy and availability is difficult to monitor, but as more technology becomes available such as the ability to embed a hiding function in a portable electronic health record becomes available, the privacy concerns may be more easily managed (Huang, Chu, Lien, Hsiao, & Kao, 2010). It is important to note, however, with electronic documentation, the individual practitioner will be charged with the ethical responsibility regarding preservation of client information privacy (Page, 2010).

Empirical Support of Psychometric Properties

The traditional paper-based assessments have undergone systematic and statistical analysis regarding their psychometric properties in order to be printed and distributed by reputable publishers, whereas newer technologies have not had as much time to become established in this way. In fact, the recurrent concern that is echoed by a variety of researchers across a multitude of professional fields is the decided lack of psychometric studies on the efficacy and use of computerized assessments (Angelo &

Smith, 1993; Hargreaves et al, 2004; Garb, 2007). While it is unclear as to how and when this transition to computerized assessment will occur, it is a positive sign that most researchers are wary of new technological breakthroughs which have not yet been proven and supported through solid research methodologies.

Process of Developing Valid, Reliable Computerized Assessments

Although computerized assessment methods have not yet become the standard assessment medium, several institutions began preparing and planning for such a transition decades ago. Documents have been developed and published from various entities regarding guidelines on computer-based testing. Table 3 Published Guidelines for Computerized Assessment is a chronological list of some such documents which are highly regarded within their respective fields.

Table 3: Published Guidelines for Computerized Assessment

Year	Publisher	Title of Publication
1986	American Psychological Association	Guidelines for Computer-Based Tests and Interpretations
1999	American Educational Research Association/ American Psychological Association/ National Council on Measurement in Education	Standards for Educational and Psychological Testing
2002	British Standards Institution	A Code of Practice for the Use of Information Technology for the Delivery of Assessments
2002	Association of Test Publishers	Guidelines for Computer-Based Testing
2002	British Psychological Society	Guidelines for the Development and Use of Computer-Based Assessments
2005	International Testing Commission	International Guidelines on Computer-Based and Internet Delivered Testing

(As adapted from web article published by CTB/McGraw-Hill, 2010)

These guiding documents offer generic principles of creating and implementing computerized assessments regarding issues such as computer requirements, user

interfaces, privacy concerns, and guidelines regarding evaluation criteria for developing and reviewing computer-based assessments. As such, these guidelines may prove to be of great help in the years to come.

Scope of This Research Project

In light of the societal shift towards technology and the resulting gap in visual perceptual skill use and the assessment of such, Dr. Leonard Trujillo, OTR/L, FAOTA, developed the Computerized Motor-Free Visual Perception Test, 3rd Edition (C-MVPT-III). This new computer-based visual perception assessment is the primary subject of this research thesis.

Purpose of the Study

Before the C-MVPT-III can be published and made available to use in assessments of clients, it must be confirmed by research as a reliable assessment tool. Thus, the purpose of this study is to establish the reliability of the C-MVPT-III against that of the traditional paper-based version. Participants were assessed using both versions, a correlational analysis of their scores was conducted, as well as a clinical comparability report.

CHAPTER THREE: METHODOLOGY

Participants

This study was conducted using third grade students from St. Peter's Catholic School in Greenville, North Carolina. This venue was selected due to convenience factors of doing research in a private school facility as well as the school's acceptance of tuition on a sliding scale basis, fostering a higher degree of diversity among a wider array of children from various socio-economic backgrounds in comparison of other local private schools. Also, despite its affiliation with the Catholic Church, St. Peter's accepts children from other religious backgrounds, as well.

Third grade students were selected for a variety of reasons. First of all, the teachers of this grade were willing to allow us to interrupt their schedule in order to accomplish the goals of this research project. But, more importantly, the students at this age are strategically appropriate for researching assessment of visual perception for a wide variety of reasons. The original MVPT was designed and normed for children ages 4-11 and since then, this has been the most intensely researched population with this assessment tool, yielding some of the strongest age-based norms for the current MVPT-III (Colarusso & Hammill, 2003). Therefore, comparing the computer-based version against the paper-based version, with this same population, should yield the strongest, most reliable results to confirm or reject the C-MVPT-III as a valid visual perception tool. Furthermore, the students are old enough to be near visual perception maturity, indicating differences due to development are minimized (Collarusso & Hammill, 2003). Additionally, as the protocol for ages 4-to-11 interprets raw scores 35 and above similarly, the 3rd graders were not so close to maturity that their scores were

in danger of being so high as to render this research project inept. As such, the researchers surmised that it may be more accurate for our purposes to assess those who were slightly below the age of maturation in order to gain a more accurate picture of what the assessment results mean.

Each of the third grade students were recruited to participate in this study, with the promise of parental feedback on their performance and resources should any visual perception deficits be indicated in the assessment protocol. Inclusion criteria for participation in this study included the ability to speak English and endure sitting posture and attention for 20-25 minutes. Children with serious known visual or hearing deficits which are not easily corrected with glasses or a hearing aid, as identified through report from the teacher, parent or student, were not included in the research study.

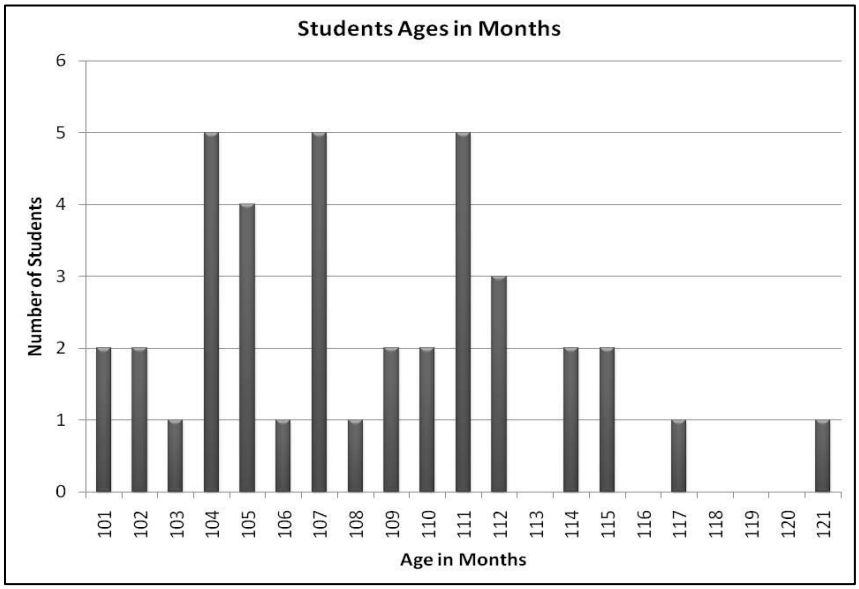
To recruit participants, a letter was sent home to parents informing them of this research opportunity. A copy of this letter can be found in Appendix B. Since this assessment is often used in the school setting without prior parental approval, the letter offered parents an opportunity to sign and return if they did NOT wish for their child to participate. If the letter was not returned and the child was identified as meeting the inclusion criteria, the researcher assumed parental consent and proceeded with assessment protocol. To ensure agreeableness of our participants, prior to assessing the child, the research purpose was explained and each participant was offered an opportunity to offer a verbal and written compliance or choose to not participate. A copy of this form is available in Appendix C.

Of the fifty-three enrolled third grade students, eight were unable to be assessed due to lack of parental consent. The remaining forty-five were assessed during the first

round of data collection. During the second round of data collection, performed three weeks later, one student could not be reassessed due to scheduling conflicts. The remaining forty-four students were reassessed. Two students' data were dropped from data analysis due to errors in data collection. Two additional students' data were dropped during analysis due to scoring below average for age on the paper-based version of the assessment, indicating a potential for deficits, which is listed as an exclusion criteria. Therefore, data from forty students assessed were used to analyze the relationship between scores on the varying test formats.

A demographical study of the participants in this study revealed that gender was evenly spread (20 males; 20 females). The average age in months was 108.325, which is 9.027 years. The ages ranged from 101 months (approximately 8.4 years) to 121 months (approximately 10.1 years). Figure 1 Participants age in months at time of first assessment offers a visualization of the students' ages in months.

Figure 1 Participants age in months at time of first assessment



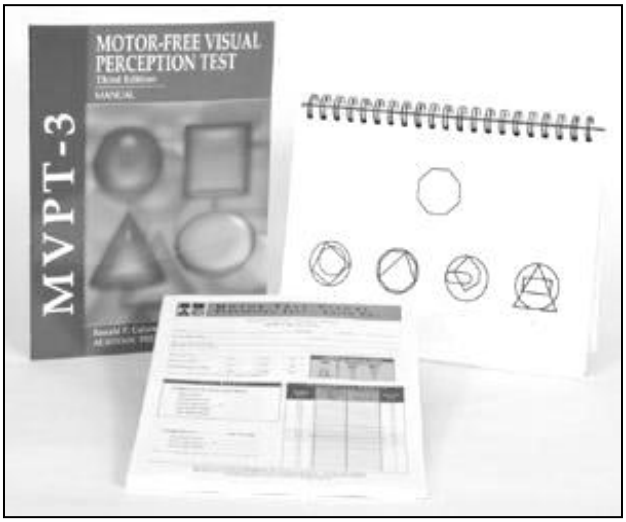
Assessment

The MVPT-III is a paper-based assessment tool which has been used by multiple professionals including psychologists, educational personnel, occupational therapists, neurologists, and others to assess visual processing abilities. The reliability has been established with a median reliability coefficient of .80 for ages 4-10 and .89 for ages 11 and up (Colorusso & Hammill, 2003). This assessment has also been demonstrated as having content validity, itemized criterion-related validity, and construct validity (Anastasi & Urbina, 1997; Colorusso & Hammill, 2003). It assumes five categories of visual perception including spatial relationships, visual closure, visual discrimination, visual memory, and figure-ground. In the accompanying manual, the creators of the assessment tool explain these five categories to be not mutually exclusive meaning that while a specific item may be designed to assess one category, it may simultaneously address more than one aspect of visual processing (Colarusso & Hammill, 2003). This is due to the dynamic and integrated nature of visual perception and cannot be avoided. As such, it is understood the scores offer a snapshot of how the individual's visual perception is functioning, not their specific abilities within each category.

The current edition, the MVPT-III, is normed for ages 4 to 94+ but is offered with two distinct administration protocols. The first protocol is for use with children ages 4 to 11 and contains the original 40 items from the MVPT-R. The protocol used with clients' ages 12+ begins with some of the items included for the younger age range but has been expanded to include more difficult items as well. Each of these protocols do not require a motoric output from the client, instead the client is urged to speak or point their answer to each question, however the client prefers to indicate an answer. The

administrator is in charge of recording answers, manipulating the easel upon which test items are presented, and explaining directions throughout the assessment. The scoring sheets, assessment manual and easel are displayed in Figure 2 Test materials for MVPT-III for reference (Collarusso & Hammill, 2003).

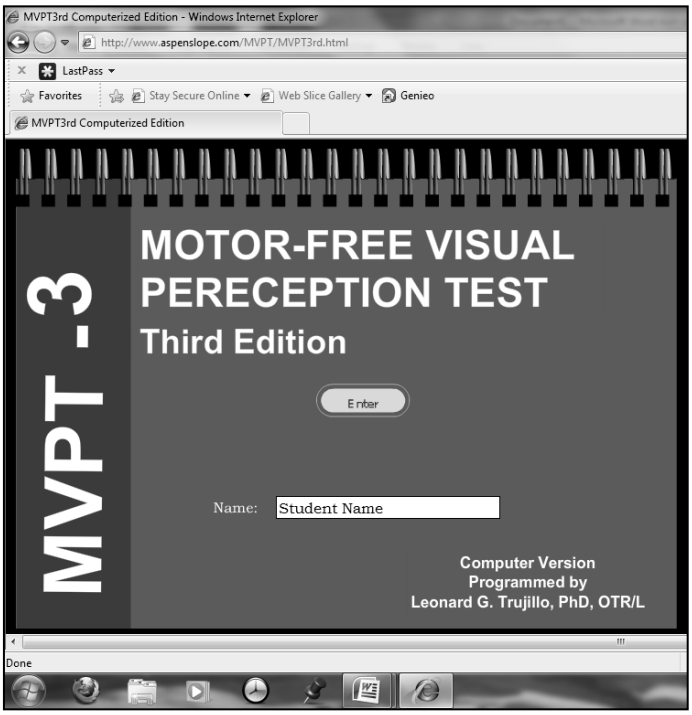
Figure 2 Test materials for MVPT-III



The independently developed Computerized Motor-Free Visual Perception Test, 3rd Edition (C-MVPT-III) is as similar as possible to the paper-based version, featuring scanned images of the same visual stimuli. Additionally a similar administration protocol is in place for the C-MVPT-III, encouraging the test administrator to be the person recording answers onto the computer to minimize motor requirement. Therefore, this new edition is not eliminating the role of the administrator by substituting in a computer, it is merely changing how the test items are viewed by the client and the method by which scores are calculated and stored. Screen print examples of how the C-MVPT-III is viewable on a computer screen are demonstrated in Figures 3-to-8.

Screen one, as shown in Figure 3 Opening page for C-MVPT-III Assessment, is an introduction to the assessment, providing the name of the assessment being performed, and offers the administrator a place to enter the client's name into the program. This allows the program to collect data and store it under the client's name. Pseudonyms or client numbers may be used if preferred by individual institutions or by the client.

Figure 3 Opening page for C-MVPT-III Assessment



Upon entering the client's name into the program, the administrator also selects the client's age range (on screen shown in Figure 4 Select age range to select appropriate assessment protocol below) which in turn determines the set of visual stimuli presented to the client according to the MVPT-III protocol.

Figure 4 Select age range to select appropriate assessment protocol

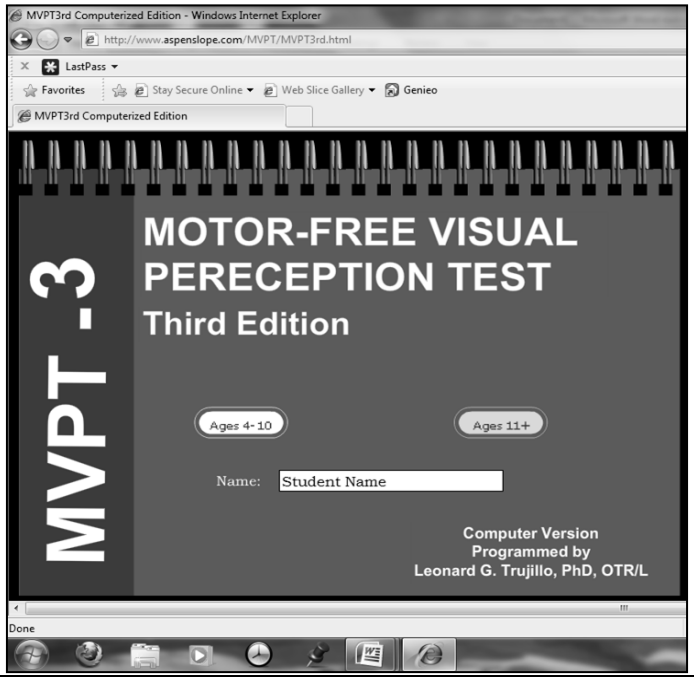
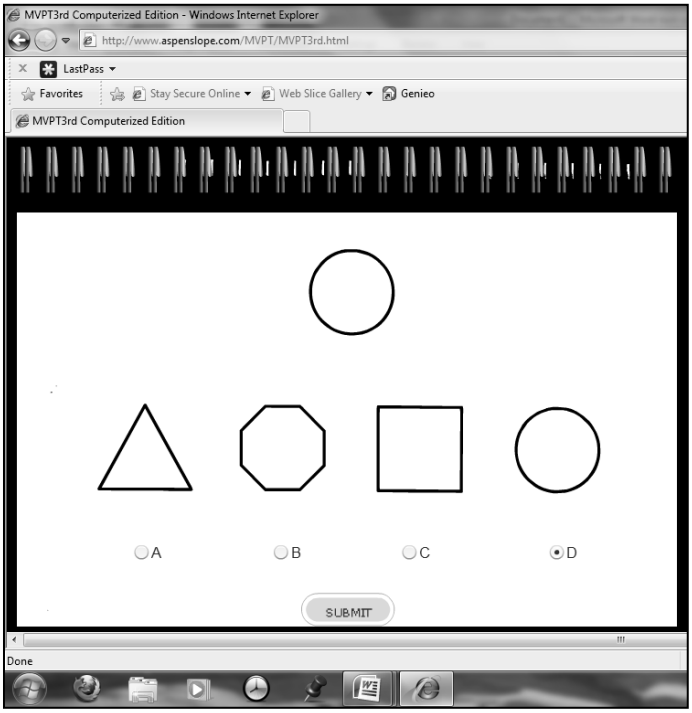


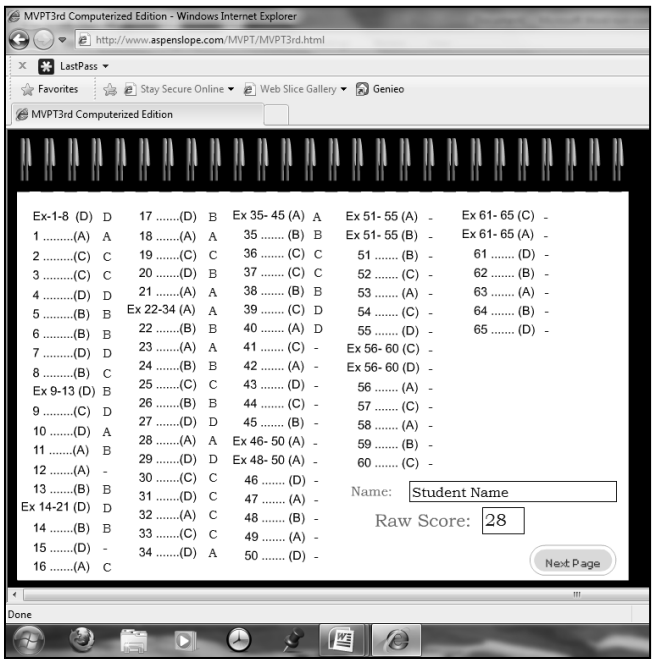
Figure 5 Sample test item offers a sample test item which is a screen print of the original MVPT-III. While the test items are being presented to the client, the administrator offers the same auditory instructions as would be offered on paper-based MVPT-III. There is a 5 second delay after the answers appear before the Select button is available to be clicked. When the client indicates an answer selection via pointing or verbalized response, the administrator selects the letter of the answer on the computer and clicks on the Submit button. If the Submit button is clicked prior to an answer being selected by the administrator, the program will move on and will not record an answer. As with the protocol of the paper version, there is no way to go back to previous test items. In this case, clinical reasoning skills are essential for accurate interpretation of scores.

Figure 5 Sample test item



When the client has completed all test items presented within age-appropriate protocol, the computer shows answers to every test item collected. This screen is simulated in Figure 6 Itemized answer report.

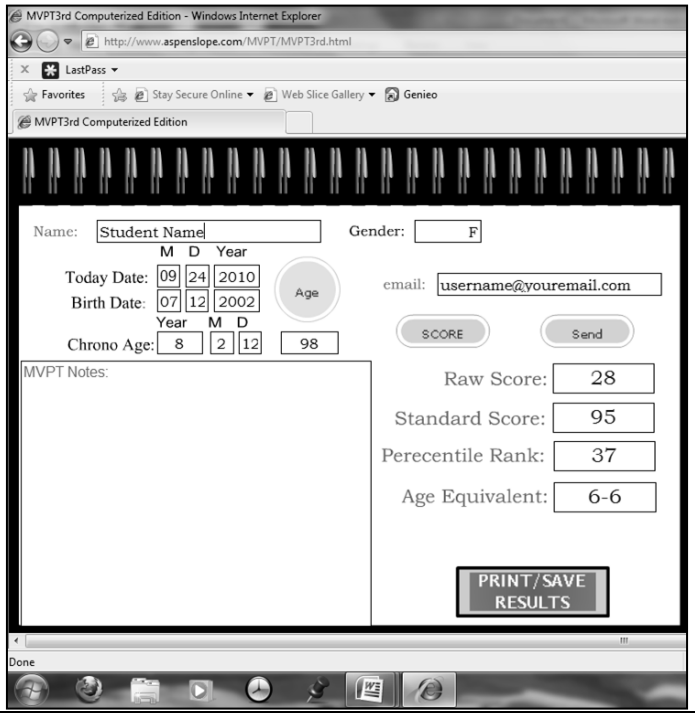
Figure 6 Itemized answer report



Notices two of the items (items 12 and 15) have a dash beside them, which indicates an answer was not selected prior to clicking the Submit button. This potential problem is another very important reason why an administrator needs to be present with the client to ensure answers are selected appropriately and all answers are collected appropriately. The intent was not to create a self-administered version of the MVPT, but one that uses a different media for presentation.

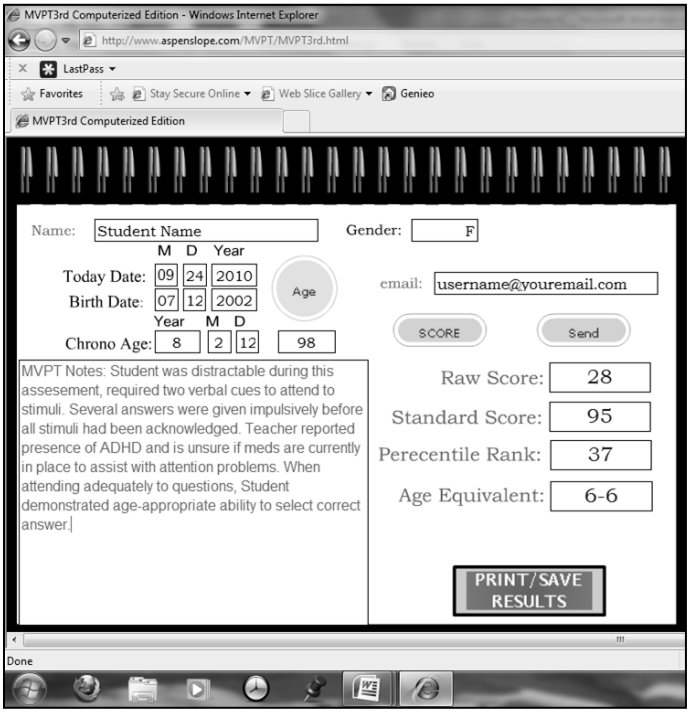
When all answers have been collected appropriately, clicking on the 'Next Page' button takes the administrator and client to a screen such as the one in Figure 7 Assessment report with automated chronological age and scoring. This screen allows the administrator to enter the date of birth and date of assessment in order to compute the client's chronological age automatically. Once this has been calculated, clicking on the 'Score' button provides the administrator with computer generated standard score, percentile rank, and age equivalency as shown below.

Figure 7 Assessment report with automated chronological age and scoring



A notes section is also available to record observations gathered during the assessment such as attention level, sitting posture, etc., as in Figure 8 Sample optional notes section.

Figure 8 Sample optional notes section



Once completed, the administrator may save to an electronic medical file or email the results to his or her own email account as an electronic record, to other colleagues as appropriate, and/or as a feedback form on visual perception abilities to the client and/or caregiver as appropriate. While it is understood improved parameters will need to be in place at a programmatic level in order to preserve HIPAA regulations, programming in the ability to do this has the potential to be very helpful in a world that is transitioning towards electronic documentation (U.S. Department of Health and Human Services, 1996).

In this study, all assessments took place in the same unused office space provided by the school. Interruptions were limited, as much as possible, by closing the door and positioning the students so as to minimize visual distractions. Each student was positioned directly in front of computer screen or assessment easel with assessor

at side to introduce stimuli and record responses. A skylight allowed for natural lighting, which was enhanced with fluorescent lighting, as needed, to minimize visual strain during the assessment periods. Students were paged from their classrooms via phone and asked to report to the office space for assessment. At the start of each session, the participant was reminded of the purpose for research project, ensured results would not be graded by their teachers, and after confirming their desire to participate, students were encouraged to simply offer their best efforts. Every reasonable accommodation was made to reduce possible stress associated with testing environment and encourage attention to stimulus items being presented.

Procedure

After receiving IRB approval (Appendix A), participants were recruited as detailed in the participants section and a timeline of scheduling assessments was established with the third grade teachers at St. Peter's Catholic School.

Each participant was assessed using both the paper-based and computer-based versions of the MVPT-III. A randomized list of participants was generated prior to data collection. Following this list, each participant was assessed alternating initial assessment mediums so that half were assessed on a computer first and half on paper first. The order of assessments was noted on each participant for reference during data collection and analysis. Additionally, the same order of participants was utilized for both rounds of assessments so that participants assessed during the beginning of the week during the first round were also assessed during the beginning of the week the second round. This precaution was in place to ensure that each participant had approximately the same amount of time between assessments as possible.

In order to allow for optimal memory deterioration, while avoiding differences due to natural maturity or development of visual perceptual skills, the second round of assessments occurred three weeks later. One of the weeks between the assessment periods was Easter Vacation for the school, which is surmised to have promoted deterioration of memory regarding test items. The second round of assessments consisted of following the same order of students as the first round, but using the opposite assessment medium. Any abnormalities which occurred during testing procedures were noted either within the electronic form of the computer-based version or by hand and attached to the score report for the paper-based version for reference during data analysis.

Once the data on each testing medium was accumulated for all participants, the raw scores were analyzed for correlational significance. Additional inquiry into the notes taken during the assessment sessions were investigated to identify any possible external features which may be impacting the results. However, it is important to note the median reliability coefficients of the current Motor-Free Visual Perceptual Test, 3rd Edition for ages 4-to-11, which was computed during the recent standardization process, is .80 (Colarusso & Hammill, 2003). Subsequent data analysis of the authors suggests that the age groups we intend to target have higher levels of reliability with coefficients ranging from .83 to .87 (Colarusso & Hammill, 2003). This may limit the extent to which our results may ultimately be generalized in order to validate the C-MVPT-III beyond the age groups being targeted.

CHAPTER FOUR: DATA ANALYSIS AND RESULTS

A complete correlational analysis was conducted on the data collected to compare the results of the paper and computer versions using correlational coefficient, Pearson's r. The purpose of this analysis was to understand the strength of the statistical relationship between the versions as evidenced by this study. More importantly, this method was utilized in order to understand the relationship of demographical information of the participants or study circumstances, such as order of versions presented, gender, etc., to the test-retest reliability of scores. In order to interpret correlational coefficients, it is important to understand what these coefficients indicate. Table 4 Interpretation guide for correlation coefficient denotes interpretation guidelines which were used in a previous test-retest study on the MVPT-R (adapted from Burtner, Qualls, Ortega, Morris, & Scott, 2002).

Table 4 Interpretation guide for correlation coefficient

Correlation Coefficient	**Interpretation**
0 - .50	Low correlation
.50 - .80	Moderate correlation
.80 - .90	High correlation
.90 – 1.0	Very high correlation

With these interpretation guidelines in mind, the chart in Table 5 Correlational Analysis of Test-Retest Results demonstrates the results of a correlational analysis conducted with the raw and standard score results from participants, including a demographical breakdown comparing first assessment medium, gender, and class association. These correlations were calculated using Excel 2007. Corelational coefficients were rounded to the nearest hundredth.

Table 5 Correlational Analysis of Test-Retest Results

Correlational Study Conducted	Raw Score	Standard Score
All Scores	.41	.41
Computer First	.62	.57
Paper First	.37	.33
Female	.78	.76
Male	.28	.26
Class #1	.79	.76
Class #2	.32	.29

These results demonstrate the correlational coefficient of scores from the test-retest study is weak at r = .41 for both raw scores and standard scores. However, it also demonstrates those who were given the computer first were more likely to have similar scores on the different testing mediums than those who were given the paper version first. Additionally, females tended to have more consistent scores than males. Students in class #1 also tended to have a higher correlation than students in class #2. There was no notable cause for the disparity of correlations between the different classes.

Below Table 6 Correlation coefficients of raw and standard scores related to age range demonstrates the effect of age in months on correlation coefficients of raw scores and standard scores.

Table 6 Correlation coefficients of raw and standard scores related to age range

Age Range (in months)	Correlation of Raw Scores	Correlation of Standard Scores
101-105	0.344163068	0.359865121
106-110	0.166335557	0.202763061
111+	0.673493163	0.729450904

These correlations indicate age may have had a significant factor on the correlational coefficients observed within this study as participants who were 111 months and up had higher correlations of scores than those younger than 111 months.

As correlation itself is known to be easily influenced by outliers, this correlational analysis was conducted more for informational purposes regarding demographics and factors affecting test-retest reliability rather than establishing the true reliability of the C-MVPT-III.

In order to establish reliability in a way that is meaningful to the clinical setting, the researchers devised a more appropriate plan of data analysis. Considering the paper-based version is the published and accepted version, this was used as the standard during analysis. The authors of the test do not expect an examinee to score the exact same raw score each time, and thus, offer confidence intervals for standard scores to aid in interpretation. The researchers, therefore, used the 90% confidence interval (the highest confidence interval offered by the authors of the test) of standard scores for each participant according to his or her score on the paper version of the test to create an expected range for the computerized version. For this age range, the 90% confidence interval is +/- 10. This information was used to create a range within which the authors of the test are 90% certain the participant to score within if the test were administered again. Table 7 Equations used to create expected range offers the equations used to create the range of expected scores on the C-MVPT-III.

Table 7 Equations used to create expected range

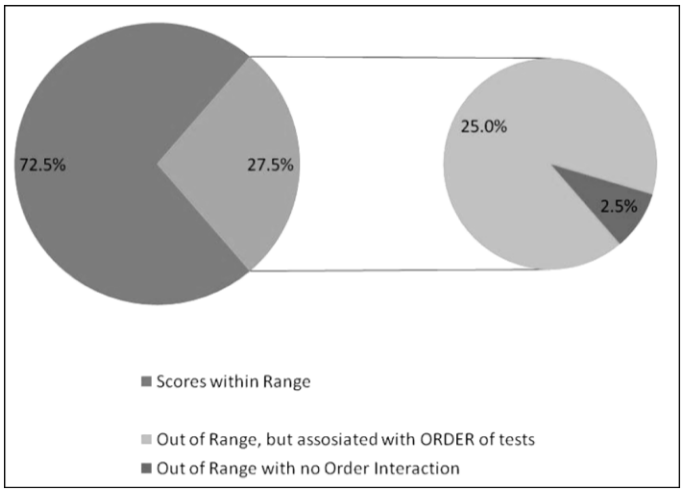
	Equation
Lower Score	=(standard score) - 10
Upper Score	=(standard score) + 10

Since the authors of the MVPT-III are 90% certain that the examinee's true visual perceptual skills falls within the confidence interval, it is a fair assumption to expect the participants to perform somewhere within that interval on another version of the same test. Thus, this acted as the expected interval for scores on the C-MVPT-III. If scores on the computer version fell within the interval, they were considered "clinically comparable". If, however, the scores on the computer version were not within the interval, it was considered "clinically incomparable". This process was used on each participant's scores in order to determine clinical reliability.

Once this process was conducted for each participant's scores, additional data analysis was run on aggregate data indicating the percent of participants' scores which were clinically comparable, and a further look into possible reasons for a lack of clinical comparability.

Using the data analysis strategy outlined above, 72.5% of all participants received computerized scores which were clinically comparable. Of the remaining participants whose scores were not clinically comparable, 90.1% of them scored significantly higher on their second assessment medium whether it was paper or computer, indicating a possible order association in this minority of participants. Only 2.5%, or 1 out of the 40 participants, scored significantly higher on the first version of the test. Figure 9 Percentages of Scores by Clinical Comparability Status demonstrates the breakdown of data by comparability status.

Figure 9 Percentages of Scores byClinical Comparability Status



Further investigation into the demographical information revealed a slight difference among genders. Of the participants with clinically comparable scores, there were 12 female and 15 males. However, of the scores which were clinically incomparable, there were 8 females and 5 males. This finding indicates females tended to be less likely to have clinically comparable scores than males. However this difference is slight and notable only for the purpose of raising questions for further research.

Additionally, as the initial correlational analysis indicated a difference varying by age group, an analysis of clinical comparability by age in months was run to investigate the relationship between age and clinical comparability in this study. Table 8 Analysis of Clinical Comparability Status by Age in Months demonstrates how comparability status differed across the age range which existed within this study.

Table 8 Analysis of Clinical Comparability Status by Age in Months

Age in Months	Number of Participants with Clinically Comparable Scores	Number of Participants with Clinically Incomparable Scores
101-105	7	7
106-110	8	4
111+	12	1

Table 8 Analysis of Clinical Comparability Status by Age in Months demonstrates within this study, there existed a trend in which younger participants (ages 101-105 months) exhibited far less consistency with scores on varying versions of the assessment than those who were older, with those who were 111 months and older (up to 121 months) demonstrating much more consistency among scores.

CHAPTER FIVE: DISCUSSION

As technology continues to evolve, changing the society in which we live, occupational therapists are expected to keep up with the developing trends affecting how people are engaging in occupation and the shifting contexts within which their occupational engagement is occurring. The American Occupational Therapy Association developed a Centennial Vision statement which details the common goals of where we as a profession should be by the year 2017 when we celebrate the 100th anniversary of the field. This statement envisions occupational therapy to become "a powerful, widely recognized, science-driven, and evidence-based profession with a globally connected and diverse workforce meeting society's occupational needs" (Clark, n.d., slide 12). In order to achieve this vision, we must embrace and utilize the technology available to us and our clients, using science and the evidence of well-designed research to support its use and further the knowledge in the field. This study has helped the profession in the pursuit of this vision by providing evidence base to support the use of the C-MVPT-III within a clinical setting, offering a method of viewing assessment reliability by clinical comparability status, and creating opportunities for further research to be conducted.

Relational research, such was used in this study, seeks to explore and establish the association between variables. Traditionally, correlation refers to the degree to which two variables are related (Elmes, Kantowitz, & Roediger, 2003; Spatz, 2005). While this type of research is typically measured using a correlation coefficient and regression, the clinical comparability status used in this study also accomplishes the same end with a higher degree of accuracy as the correlation coefficient can be easily

swayed by outliers, particularly in smaller sample sizes such as exists in this study (Elmes, Kantowitz, & Roediger, 2003; Spatz, 2005). Additionally, the methodology used in this study allowed for the comparison of clinical applications instead of the mere analysis of numbers which may or may not be significant within a clinical setting.

By exploring and establishing the association between variables, in this case, the interaction of assessment medium on scores of compatible assessments, a relationship is established which can offer insight into the validity of the unestablished medium. In this case, as the paper-based medium is published and accepted as a reliable and valid assessment tool, the degree of association to the computer-based scores affords comparable validity to the unpublished and unprecedented version.

The results of this research may indicate a weak correlational coefficient between test-retest scores on the varying assessment mediums, however, it has established its reliability as fairly strong in regards to clinical comparability. Especially when we consider visual perception assessments are not intended to be repeated within a short time frame due to carry-over of memory consolidation which was observed in this study (Colarusso & Hammil, 2003). The clinical comparability rates found in this study suggest the Computerized Motor-Free Visual Perception Test, 3rd Edition will likely yield similar interpretation of results within a clinical setting as that of the paper version.

The design for this research study was focused on a correlational study which compared the results of the same assessment administered via two different mediums with the expectation of similar results. However, the current literature presents a study published in 2002 with a similar design which established the reliability of the MVPT-R in children with and without disabilities (Burtner, Qualls, Ortega, Morris, & Scott, 2002).

Burtner and her colleagues also recognized the biased nature of correlation and relied upon t-test analysis to ensure test-retest reliability. They found all test scores to be significantly different except the perceptual quotient scores for the children with learning disabilities, but variance of scores remained constant, suggesting learning occurred between testing sessions. As their results were consistent among children with and without learning disabilities, their research supported the reliability of the assessment. Additionally, the authors recognized the important role assessment accuracy plays in the clinical decision-making process and encourage clinicians to establish a range within which the child's ability probably lies (Burtner et al, 2002). The authors of the current study used this advice to create clinical comparability status. The results gained from this study are similar to the results demonstrated by Burtner et al (2002), thus the study supports the C-MVPT-III as a reliable visual perception assessment tool.

When considering clinical comparability, it is important to consider the factors which may exist and influence assessment procedures within a typical clinical setting. Optimally, a client is assessed in a quiet room with the door closed to minimize auditory and visual distractions. However, even in an optimal environment, a client may be distracted by internal noise such as is produced by hunger or a distracted mind. A client may also be influenced by nonverbal cues he or she is receiving from the assessor. Additionally, external factors such as the weather, time of day, amount of sleep received the night prior, and other physiological factors may also play a role in assessing functional behaviors as it is only a snapshot of capacity within a very specific time, place and person.

Furthermore, there are some inherent differences between assessing a person via paper versus via computer. Perceptually, it is a different experience to perceive a physical paper versus a backlit computer screen. In many ways a computerized visual perception test supports motor-free assessment in ways that a paper version may tend to fall short. This happens because most people are not used to touching a screen because they are afraid of leaving fingerprints or damaging the computer. With the paper version, it has been observed that more people feel comfortable using a finger to trace an image, assisting with the visual perception task. Additionally, a backlit screen stands out from amongst the background of other objects within the room, attracting visual attention more so than that of externally lit paper. These differences should be explored further through research to discover if inherent differences between medium of assessment presentation supports attention and engagement for specific populations so that clinicians may be better informed on how to select an appropriate assessment medium for each client.

Additionally, further research is needed to explore the relationship of demographics, particularly age, to comparability status. The apparent trend noted by this research indicative of age influencing consistency of scores may exist across the full spectrum of ages naturally as visual perception skills and the consistency of those skills may mature with time. Alternatively, this trend may be the manifestation of how the assessment itself tends to score students at the high range of visual perceptual skills as a point difference in raw score below 35 points alters the age equivalency by six months to one year, whereas those who score above 35 points have the same age equivalency at 11+ years.

Limitations

This study is limited by not only a small sample size, but also a small population range as it was limited to private school children ages 8-10. As stated earlier, this is an appropriate selection for an initial target population as it has been the most widely researched throughout the history of the MVPT and offers some of the strongest age-based norms in the current version. However, support for the C-MVPT-III would certainly benefit from psychometric studies conducted across a wider age range, in many areas across the country in order to be as widely accepted as the MVPT-III.

Also, while the data analysis performed was appropriate for understanding reliability of this assessment within a clinical setting, it is not easily comparable to previous psychometric studies which relied more heavily upon established statistical methods to interpret data.

Furthermore, due to the essence of time limits of this research, demographic information was not obtained for analysis as it was not believed to be essential to establishing the reliability. However, with such disparity in consistency of scores among classes and across age groups, further research would benefit from understanding relationship of demographic information to clinical comparability status of scores.

Summary

This study was optimally designed for its target population, scheduled to rule out development of the child participants as a confounding factor while allowing for optimal memory loss. While the results of the study suggest that memory in some children may have been consolidated during the interim between assessments, this occurred only in a minority of participants. Beyond that, special precautions were taken to ensure a

higher level of data accuracy, such as alternation of assessment mediums, using a randomized list of participants as a standard order for both rounds of assessment, and maintaining the same testing environment for all participants.

Beyond the scope of what a researcher can prepare for includes the behavior and attitude of participants. During data collection, there were no behavior issues with any children, all of them were attentive and respectful, appearing to try very hard each time. While a few had obvious attention difficulties as evidenced by excessive talking, or more frequent glances around the room, each of them appeared to at least attempt to fully attend to each test item stimulus as it was presented, regardless of medium.

It would benefit the field of OT if this study were repeated with a much larger, more diverse population spanning the entirety of the age group the MVPT-III claims to be normed for appropriately. Once the validity of the C-MVPT-III is established, research regarding how to determine version appropriateness on a client-by-client basis would be significantly helpful to practitioners searching for an evidence-base for clinical reasoning which guides selection of assessment.

This study aimed to establish its reliability by comparing scores of 3rd grade children at a local private school on each of the two testing mediums using a test-retest method. A strong correlation of age adjusted raw scores on the two testing mediums were anticipated, which would indicate that the computer-based version of the MVPT-3 is as reliable as the paper-based version. The current study found inconclusive results after correlational analysis, but results showed that 72.5% of participants received clinically comparable results. Clinically comparable results indicate that within the practical settings which this assessment may be utilized, the practitioner administering

the assessment would offer similar recommendations. Regarding participants who did not receive clinically comparable results, assessment medium order is associated with incomparable scores. These results support the C-MVPT-III as a reliable and valid tool.

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APPENDIX A: IRB APROVAL LETTER

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
1L-09 Brody Medical Sciences Building• 600 Moye Boulevard • Greenville, NC 27834
Office 252-744-2914 • Fax 252-744-2284 • www.ecu.edu/irb

TO: Leonard Trujillo, PhD; Dept. of Occupational Therapy; School of Allied Health Sciences; ECU

FROM: UMCIRB

DATE: April 26, 2010

RE: Expedited Category Research Study

TITLE: "Visual Perception in School-Aged Children: A Psychometric Study of the Correlation between Computer-based and Paper-based Scores on the Motor-Free Visual Perception Test, 3rd Edition"

UMCIRB #10-0206

This research study has undergone review and approval using expedited review on 04/21/2010. This research study is eligible for review under expedited category number four; which includes collection of data through non-invasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be learned/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indication.). Examples: (a) physical sensors that are applied, whether to the surface of the body or at a distance, and do not involve input of significant amounts of energy into the subject or significant amounts of energy into the subject or an invasion of the subject's privacy; (b) weighing or testing sensory acuity; (c) magnetic resonance imaging; (d) electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, Doppler blood flow, and echocardiography; (e) moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

The Chairperson (or designee) deemed this **unfunded** study **no more than minimal risk** requiring a continuing review in **12 months**. 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.

The above referenced research study has been given approval for the period of **04/21/2010** to **04/20/2011**. The approval includes the following items:

- Internal Processing Form (dated 02/05/2010)
- Parental Informed Consent – Opt Out Form – (dated UMCIRB date rec'd 04/09/2010)

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

The UMCIRB applies 45 CFR 46, Subparts A-D, to all research reviewed by the UMCIRB regardless of the funding source. 21 CFR 50 and 21 CFR 56 are applied to all research studies under the Food and Drug Administration regulation. The UMCIRB follows applicable International Conference on Harmonisation Good Clinical Practice guidelines.

APPENDIX B: PARENTAL CONSENT TO PARTICIPATE IN RESEARCH

Title: Visual Perception in School-Aged Children: A Psychometric Study of the Correlation between Computer-based and Paper-based Scores on the Motor-Free Visual Perception Test, 3rd Edition

Faculty Investigator: Leonard G. Trujillo, Ph.D., OTR/L……..252-328-2755
Student Investigator: Rachel Wood, OTS……..404-310-6033

Your child is being asked to participate in a research study. As we grow up we gain certain skills and abilities. One group of these is called visual perception. Within this group there are several small groups, but essentially the skills involve being able to recognize shapes and forms. Sometimes these shapes are hidden other times they are reversed from others around them. At others times we see a shape and then are able to pick out that same shape without having it in from of us as a reminder. As early as 1972 a test was made to help therapists and others working with children to see if they were developing these skills at the same rate as other children their age. This test has been revised as is called the MVPT-3 or the Motor Free Visual Perception Test-3rd Edition. A computerized version has been created identical to the paper-based version. Once it's published, it will allow professionals who assess visual perception to do so more efficiently and allow for automated scoring, saving time and money. But, before it can be published, we need to make sure it will be a reliable tool for evaluating this set of visual perceptual skills. To do this we would like to have your child take the MVPT-3 on two different occasions, once on a computer and once on paper. We will then compare the scores to see if the test was able to consistently predict your child's visual perception capabilities.

The investigation involves almost no risk of the release of confidential information, improper release of data, and loss of privacy. Once the scores have been collected an identification number will be used instead of names. Confidentiality will be protected to the extent that is allowed by law. The MVPT-3 will be administered by the same individual and you should feel confident in their ability to administer it accurately.

If you have any questions about the research study you should ask the researchers, their phone numbers are at the top of this form.

Participation in this study is completely voluntary and you may withdraw at any time without penalty. If you have any questions, please contact the investigators at the above phone number. You will be given a copy of this dated and signed consent form to keep.

_____ _____

Signature of Participant/Guardian Date

☐ *Check here if you would like to receive a summary of the results of this study and list below the address to which this summary should be sent.*

☐ *Check here if you do not wish to receive a copy of the results of the study.*

APPENDIX C: STUDENT ASSENT TO PARTICIPATE IN RESEARCH

Title: Visual Perception in School-Aged Children: A Psychometric Study of the Correlation between Computer-based and Paper-based Scores on the Motor-Free Visual Perception Test, 3rd Edition

Faculty Investigator: Leonard G. Trujillo, Ph.D., OTR/L……..252-328-2755
Student Investigator: Rachel Wood, OTS……..404-310-6033

You are being asked to participate in a research study. As we grow up we gain certain skills and abilities. One group of these is called visual perception. Within this group there are several small groups, but essentially the skills involve being able to recognize shapes and forms. Sometimes these shapes are hidden other times they are reversed from others around them. At others times we see a shape and then are able to pick out that same shape without having it in from of us as a reminder. As early as 1972 a test was made to help therapists and others working with children to see if they were developing these skills at the same rate as other children their age. This test has been revised as is called the MVPT-3 or the Motor Free Visual Perception Test-3rd Edition. A computerized version has been created identical to the paper-based version. Once it's published, it will allow professionals who assess visual perception to do so more efficiently and allow for automated scoring, saving time and money. But, before it can be published, we need to make sure it will be a reliable tool for evaluating this set of visual perceptual skills. To do this we would like to have you take the MVPT-3 on two different occasions, once on a computer and once on paper. We will then compare the scores to see if the test was able to consistently predict your visual perception capabilities.

The investigation involves almost no risk of the release of confidential information, improper release of data, and loss of privacy. Once the scores have been collected an identification number will be used instead of names. Confidentiality will be protected to the extent that is allowed by law. The MVPT-3 will be administered by the same individual and you should feel confident in their ability to administer it accurately.

If you have any questions about the research study you should ask the researchers, their phone numbers are at the top of this form.

Participation in this study is completely voluntary and you may withdraw at any time without penalty. If you have any questions, please contact the investigators at the above phone number. You will be given a copy of this dated and signed consent form to keep.

_____ _____

Signature of Research Participant Date

The above consent form was read, discussed, and signed in my presence. In my opinion, the person signing said consent form did so freely and with full knowledge of its contents.

_____ _____

Signature of Investigator Date

☐ *Check here if you would like to receive a summary of the results of this study and list below the address to which this summary should be sent.*

☐ *Check here if you do not wish to receive a copy of the results of the study.*