5-2018

Age-Related Changes in Visual Processing Speed: A Pilot Study Using the Motor Free Visual Perception Test- 4

Amber Zadravecz
Dominican University of California

Kassidy Ha
Dominican University of California

Lauren Gollnick
Dominican University of California

Stephanie Pawek
Dominican University of California

Zoe Studer
Dominican University of California

https://doi.org/10.33015/dominican.edu/2018.OT.07

Age-Related Changes in Visual Processing Speed: A Pilot Study Using the Motor-Free Visual Perception Test- 4

By

Amber Zadravecz

Kassidy Ha

Lauren Gollnick

Stephanie Pawek

Zoe Studer

A culminating capstone project report submitted to the faculty of Dominican University of California in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy

San Rafael, California

May 2018

This project, written under the direction of the candidates' faculty advisor, Dr. Kitsum Li, and approved by the chair of the Master's program, Dr. Julia Wilbarger, has been presented to and accepted by the Faculty of the Occupational Therapy department in partial fulfillment of the requirements for the degree of Master of Science in Occupational Therapy. The content, project, and research methodologies presented in this work represent the work of the candidates alone.

Amber Zadravecz, Candidate	Date: 12/1/17
Kassidy Ha, Candidate	Date: 12/1/17
Lauren Gollnick, Candidate	Date: 12/1/17
Stephanie Pawek, Candidate	Date: 12/1/17
Zoe Studer, Candidate	Date: 12/1/17
Julia Wilbarger, PhD, OTR/L, Chair	Date: 12/1/17
Kitsum Li, OTD, OTR/L, CSRS, Advisor	Date: 12/1/17

Table of Contents

Advisors' Page ii

Copyright Page iii

Table of Contents iv

List of Tables vii

List of Figures viii

Abstract ix

Acknowledgements x

Introduction 1

Literature Review 2

Older Adults and Driving 2

Driving Assessment 4

On-the-road assessments. 5

Pre-driving assessments. 6

Visual Perception 10

Visual foundation skill 11

Assessment of Visual Perception 13

Visual Processing Speed and Response Time 15

MVPT-3 *Response Time Index* 17

Summary and Conclusions 18

Statement of Purpose 19

Definitions and Variables 20

Definitions 20

Figure ground. 20

Spatial relationship. 20

Visual closure. 20

Visual discrimination. 20

Visual memory. 20

Visual perception. 20

Older adults. 20

Younger adults. 20

Variables 21

Independent. 21

Dependent. 21

Theoretical Framework 21

Ethical and Legal Considerations 23

Methodology 25

Research Design 25

Subjects Recruitment 25

Data Collection Procedures 26

Instruments. 26

Procedures. 27

Data Analysis 28

Results 28

Discussion 33

Limitations and Recommendations 36

Conclusion 38

References.......... 39

Appendix A: IRB Approval Letter 46

Appendix B: Letter of Permission from Agency Directors 47

Appendix C: Email of Permission to Dominican Faculty 48

Appendix D: Recruitment Flyer.......... 49

Appendix E: Consent To Be a Research Subject Form 50

Appendix F: Bill of Rights.......... 52

Appendix G: Research Assistant Confidentiality Agreement 53

Appendix H: Demographic Form 54

List of Tables

Table 1. *Participant demographic data* 29

Table 2. *Results comparing younger adults' time to older adults' time to answer items* 31

List of Figures

Figure 1. *All participants' time to complete the full MVPT-4* 32

Figure 2. *Comparison of younger and older adults' average time to answer each test item* 32

Abstract

Older adults are at a significantly increased risk of being involved in motor vehicle accidents. Evidence reveals that visual processing speed decreases with age, which may impact driving. The Motor-Free Visual Perception Test- Third Edition (MVPT-3) is used as a pre-driving assessment and has an age-normed *Response Time Index* that measures visual processing speed. In 2015, a new version, the new Motor-Free Visual Perception Test- Fourth Edition (MVPT-4), was published. The new MVPT-4 does not yet demonstrate its utility in measuring visual processing speed. The purpose of this study was to explore if differences in visual processing speed between younger adults ages 20-35 years and older adults ages 70 years and older could be detected using the new MVPT-4. Results revealed a significant difference between older and younger adults' time to complete the MVPT-4 (p <.05). This pilot study demonstrated that the MVPT-4 may be able to detect age-related changes in visual processing speed and therefore, occupational therapists may be able to use the MVPT-4 as a clinical tool in pre-driving assessment.

Acknowledgements

Our team is grateful to everyone who helped make our study a success and supported the completion of our capstone paper. We would like to thank Dr. Kitsum Li, our faculty advisor, for all of her guidance and support throughout the capstone process. We would also like to thank our participants for graciously volunteering to participate and generously offering their time. Our study would not have been possible without the support from students at Dominican University of California, adults in the DUC Occupational Therapy Healthy Seniors Program, and members of the Osher Lifelong Learning Institute at DUC. We are grateful for our research assistants for the time they provided to aid in the assessment administration and data entry. Thank you to Academic Therapy Publications for their generous donation in providing testing materials. We would also like to thank the California Foundation for Occupational Therapy for partially funding our study through the Seed Money Grant. We appreciate Shad St. Louis for being our second reader, for his expertise in driving rehabilitation, and for ensuring that our work was thorough and clearly written. Lastly, we would like to thank all of our family and friends for their continuous support and encouragement throughout the occupational therapy program and our capstone study.

Introduction

Driving is an activity often associated with independence as it allows individuals to travel from one place to another without relying on others (Ball & Wahl, 2002). However, as individuals age, decreased driving safety may become a concern. Research evidence reveals that drivers 70 years and older are at a significantly increased risk of being involved in a motor vehicle accident (Tefft, 2008). One factor that may contribute to older adults' increased risk of unsafe driving performance is a decrease in visual performance (MacLeod, Satariano, & Raglan, 2014). In order to determine if an individual possesses the necessary skills required for safe driving, driving assessments are often administered by occupational therapists in clinic and community practices.

Occupational therapists use a variety of assessments to evaluate driving skills. These evaluations are completed through the use of on-the-road assessments and pre-driving assessments (Korner-Bitensky, Bitensky, Sofer, Man-Son-Hing, & Gelinas, 2006). Pre-driving assessments precede on-the-road assessments and typically assess visual performance skills, cognition, and reaction time (Dickerson, 2013). Two integral visual skills that are assessed for driving are visual perception and visual processing speed.

The Motor-Free Visual Perception Test-Third Edition ([MVPT-3]; Academic Therapy Publications: Novato, CA) was designed to measure five components of visual perception: figure ground, visual closure, spatial relationship, visual memory, and visual discrimination (Brown, 2011a). The MVPT-3 also includes a separate *Response Time Index* that measures an individual's visual processing speed (Owsley, 2013). The MVPT-3 *Response Time Index* reveals a noticeable decrease in response time after the age of 70 years old, which may contribute to older adults' increased risk of motor vehicle accidents (Martin, 2003). A new version of the

MVPT-3, the Motor-Free Visual Perception Test-Fourth Edition ([MVPT-4]; Academic Therapy Publications: Novato, CA), was released in 2015. However, this new version does not yet include a *Response Time Index* to measure visual processing speed (Colarusso & Hammill, 2015).

The purpose of this research study was to explore if differences in visual processing speed between younger adults and older adults can be detected using the new MVPT-4. If the MVPT-4 is proven to be a sensitive tool to detect changes in visual processing speed, occupational therapists may be able to use the MVPT-4 in pre-driving assessments in the future.

Literature Review

Older Adults and Driving

Driving is a means of community mobility in the area of instrumental activities of daily living (IADL), which are activities that support daily life occupations within the home and community (American Occupational Therapy Association [AOTA], 2014). Driving provides individuals with a means of community mobility through which they can attend work, social activities, religious meetings, healthcare services, and a variety of other occupations located outside of their place of residence (Ball & Wahl, 2002). Hence, the IADL of driving is highly valued by many individuals because it can increase independence (Donorfio, D'Ambrosio, Coughlin, & Mohyde, 2009). Without the ability to drive, individuals must rely on others or public transportation for their community mobility. Instead of being able to drive to their desired destination at their own chosen time, they may be limited by others' and public transportation schedules. This limitation also complicates community mobility by requiring additional planning between the individual and the person who will be driving or the local public

transportation schedule. Thus, the inability to travel from one location to another when desired may lead individuals to feel as if they have lost independence.

Older adults who have lost the ability to drive attribute their lower quality of life to their cessation of driving (Smith, Ludwig, Andersen, & Copolillo, 2009). Edwards, Lunsman, Perkins, Rebok, and Roth (2009) completed a correlation study to explore the effects of driving cessation on overall health. The results revealed that following cessation of driving, older adults rated their physical health, ability to complete physical roles, and participation in social occupations significantly lower than they did when they were driving (Edwards, Lunsman, Perkins, Rebok, & Roth, 2009). On the other hand, despite the risk of declining function, many older adult drivers have chosen to quit driving on their own due to safety concerns. Driving is a multifaceted task that requires cognitive function and visual abilities to accurately detect and respond to hazards in the environment (Anstey, Horswill, Wood, & Hatherly, 2012). In a study by MacLeod, Satariano, and Ragland (2014), decreasing physical, cognitive, and visual function significantly correlated to voluntary driving cessation. Therefore, many older adults considered visual function to be one of the most important skills for safe driving performance.

To determine if there is a relationship between age and safe driving, Tefft (2008) conducted a study by collecting information regarding fatal crashes from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System. The researchers analyzed the information by looking at the drivers' ages and those who sustained fatal injuries. The results showed that risk of causing a motor vehicle accident was highly influenced by the age of the driver. Risk of motor vehicle accidents peaked at the age of 19 years old and then decreased throughout adult years until the age of 70 years old, which is when risk began to increase yet again (Tefft, 2008). Although teenagers were more likely to cause motor vehicle accidents

resulting in fatalities of passengers and other road users, drivers 85 years and older were at higher risk of causing harm to themselves while driving. The results also indicated that drivers over 85 years old were twice as likely as teenagers and five times more likely than middle aged adults to cause a motor vehicle accident resulting in their own death (Tefft, 2008). Since older adult drivers are at an increased risk of motor vehicle accidents resulting in harm to themselves, driving assessments can be used to determine fitness to drive, which is the ability to demonstrate safe patterns of behavior while driving and thus assist with decisions about driving cessation (Dickerson, Meuel, Ridenour, & Cooper, 2014).

Driving Assessment

Clinical driving assessments are typically used to evaluate drivers who have medical conditions, such as stroke, brain injury, spinal cord injury, cognitive impairments, or visual impairments that may have affected their driving ability (Korner-Bitensky et al., 2006). The driving assessment process begins with a referral to a driving evaluation service. There are two types of driving evaluation: a pre-driving assessment and on-the-road driving assessment. Both an occupational therapy generalist and a certified driver rehabilitation specialist (CDRS) can administer a pre-driving assessment, but only a CDRS can administer an on-the-road assessment for those who pass the pre-driving assessment (Korner-Bitensky et al., 2006). Pre-driving assessments evaluate the skills required for driving prior to an individual getting behind the wheel. The purpose of a pre-driving assessment is to conduct a comprehensive analysis of cognitive, visual, and sensorimotor skills that are used in driving related tasks and to identify potential at-risk drivers (Justiss, Mann, Stav, & Velozo, 2006). On-the-road assessments evaluate the position of a driver in a vehicle, how a driver operates the equipment within the

vehicle, and a driver's ability to respond to environmental influences (Korner-Bitensky et al., 2006).

On-the-road assessments. The on-the-road driving assessment is a highly accepted method of determining a driver's competency (Justiss et al., 2006). The evaluation is usually performed by a CDRS (Korner-Bitensky et al., 2006). The purpose of on-the-road driving assessments is to discriminate between safe drivers and unsafe drivers (Kay, Bundy, Clemson, & Jolly, 2008). Most driving assessments involve a comprehensive assessment of the vehicle, person-vehicle fit, manipulation of adaptive equipment, and on-the-road performance (Justiss et al., 2006). Researchers agreed that on-the-road assessments should be conducted in a standardized format, meaning that the same tasks and challenges should be presented to each individual, in a vehicle with dual controls (Kay et al., 2008). Although individual protocols have been created in an attempt to standardize the process, the actual driving assessments that are administered may vary (Shechtman, Awadzi, Classen, Lanford, & Joo, 2010). Nevertheless, the assessment should include a safety component and a score for overall driving performance (Kay et al., 2008). Therefore, most of the on-the-road assessments include the following aspects of driving: starting the vehicle, putting the vehicle in motion, using the gas and brake controls, signaling, steering, turning, adjusting speed, changing lanes, parking, and understanding and following instructions (Racette & Casson, 2005). The CDRS evaluates the outcome scores corresponding to each aspect of the driving assessment to determine if an individual is able to drive safely on the road. While on-the-road assessments are effective in determining an individual's fitness to drive, pre-driving assessments evaluate essential skills required for safe driving and optimum performance.

Pre-driving assessments. Since there are a limited number of CDRSs, occupational therapy generalists often perform pre-driving assessments as an alternative method to identify at-risk drivers (Dickerson, 2013). Due to the complex nature of driving, no single assessment is considered to be sufficient to determine fitness to drive in pre-driving assessments (Dickerson et al., 2014). A variety of pre-driving assessments are available, and the assessments used vary depending on the resources of the clinic. Cost effectiveness and time required to administer the assessment may also influence which assessments are included in a clinic-based pre-driving assessment (Korner-Bitensky et al., 2006).

Often times, occupational therapy generalists use pre-driving assessments to evaluate the following key components: cognition, vision, visual perception, and reaction time (Dickerson, 2013). Pre-driving assessments can be used to assess various domains of cognitive function including divided attention, concentration, and executive function (Classen et al., 2012). Commonly used tools to assess cognition during pre-driving assessments include the Mini-Mental State Examination, Montreal Cognitive Assessment, Trail Making Tests A and B, Symbol Digit Modalities Test, Clock Drawing Test, Short Blessed Test, and Letter or Number Cancellation Test (Classen, Dickerson, & Justiss, 2012; Dickerson et al., 2014; Korner-Bitensky et al., 2006).

In addition to cognition, assessment of visual acuity, contrast sensitivity, and visual field can also be used to help identify at-risk-drivers (Elgin, Owsley, & Classen, 2012). Visual acuity, the ability to discriminate details in near reading and from a distance, is included in pre-driving assessments (Chou et al., 2013). Distance acuity is commonly measured by using the Snellen Eye Chart (Elgin et al., 2012). A score of 20/20 on the Snellen Eye Chart means that the individual is able to see what most people can see at a distance of 20 feet. Hence, a score of

20/70 means that an individual standing at 20 feet sees what most other people can see at 70 feet (Duffy, 2016). Visual acuity must be at a minimum specific level to fulfill state licensing requirements (Elgin et al., 2012). For example, in the state of California, the standard for binocular visual acuity is 20/40 with or without corrective lenses to obtain a driver's license (State of California Department of Motor Vehicles, 2016). While no strong evidence correlates visual acuity with motor vehicle collisions, visual acuity is needed to read road signs and detect danger in the environment while driving (Dickerson et al., 2014; State of California Department of Motor Vehicles, 2016).

Contrast sensitivity, the ability to distinguish an object against a similar background, is frequently assessed with the Pelli-Robson chart, or the Optec 2500 or 5500 visual analyzer machine (Elgin et al., 2012; Roche, Vogtle, Warren, & O'Connor, 2014). Contrast sensitivity deficits can reduce the visibility of objects in the environment, especially when driving at night and under low illumination conditions. For instance, drivers with decreased contrast sensitivity may experience difficulty distinguishing hazards, pedestrians, and edges of the roadway against a background when driving in the dark (Elgin et al., 2012; State of California Department of Motor Vehicles, 2016).

Visual field loss can also impair driving performance by impacting peripheral vision. To understand visual field, each eye is divided into four visual quadrants. Each quadrant allows for peripheral vision in four directions, up, down, left, and right (Warren, 2013). Peripheral vision is needed to scan the driving environment to detect hazards, monitor traffic, and maintain the vehicle within the lane boundaries (State of California Department of Motor Vehicles, 2016). Assessments of visual field include the Humphrey Field Analyzer, the Keystone Vision Screener, and the Optec 2500 or 5500 (Elgin et al., 2012; Wood, Horswill, Lacherez, & Anstey, 2013).

Since driving is a highly visual task, deficits in the areas of visual acuity, contrast sensitivity, and peripheral vision can significantly impact safe driving performance.

In a pre-driving assessment, the Motor-Free Visual Perception Test (MVPT), the MVPT-3, and the Clock Drawing Test are also commonly used to assess visual perception abilities. Visual perception is the ability of individuals to recognize and interpret visual information in the surrounding environment (Warren, 2013). The MVPT and the MVPT-3 use shapes, lines, and figures to evaluate visual perceptual abilities in the absence of motor responses through a multiple-choice format (Oswanski et al., 2007). According to Ball et al. (2006), the MVPT Visual Closure subtest is a sensitive performance-based measure that can significantly predict at-fault motor vehicle collisions in older adults. The results of the study by Ball et al. (2006) revealed that participants 78 years and older who made at least four errors on the MVPT Visual Closure subtest were 2.1 times as likely to crash while driving (Ball et al., 2006). Moreover, a study by Stav, Justiss, McCarthy, Mann, and Lanford (2008) concluded that the MVPT Spatial Relationships subtest was significantly correlated with the driving performance for older adult drivers. Additionally, the MVPT was found to be a significant predictor of driving cessation in older adults. In a prospective study by Edwards, Bart, O'Connor, and Cissell (2010), driving cessation in older adults was measured using a battery of assessments over a 10 year period. The purpose of the study was to propose a final model that includes assessments that are significant predictors of driving cessation. According to the results, the MVPT was a good predictor of driving cessation and was included in the final proposed model, which also included the Rapid Walk Test, Trail Making Test B, and the Useful Field of View (UFOV) (Edwards et al., 2010). The UFOV, a cognitive computer-based test that assesses visual processing speed under divided attention and selective attention conditions, has also be used in a pre-driving assessment in a

clinic (Elgin et al., 2012). Although the UFOV is not frequently used, due to its cost, considerable evidence reveals that low scores on the UFOV correlate with increased crash risk in older adults (Korner-Bitensky et al., 2006).

In a study involving 232 older adult drivers, a retrospective analysis revealed that the MVPT and the Clock Drawing Test were effective tools for predicting driving performance in older adults (Oswanski et al., 2007). The Clock Drawing Test assesses visual perception abilities by instructing individuals to draw a clock face and position the hands at 10 after 11 (Oswanski et al., 2007). Hence, the Clock Drawing Test is considered to be a cognitive and perceptual assessment (Dickerson et al., 2014). Additionally, in another study by Kantor, Mauger, Richardson, and Unroe (2004) that analyzed an older driver evaluation program, a secondary analysis revealed that the MVPT and the Traffic Sign Test were significant predictors of driving performance. On the other hand, the results of a study by Zook, Bennett, and Lane (2009) revealed no correlation between the Basic Operator Skills Test, an on-the-road assessment, and the MVPT-3. Nevertheless, although the results of studies remain inconsistent, the MVPT continues to be a commonly used pre-driving assessment that is believed to be able to predict driving performance.

The Hazard Perception Test and Hazard Change Detection Task can also be included in the available battery of pre-driving assessments to measure reaction time. The Hazard Perception Task requires the individual to identify potential traffic conflicts in video clips and respond by touching the computer screen where the incident occurs. Twenty-two traffic conflicts are presented and a response time is recorded for each potential incident (Anstey et al., 2012).

On the other hand, the Hazard Change Detection Task involves pairs of still original and altered images of traffic scenes. The individual presses on the screen to indicate the location of the difference between the two pictures and results are recorded as the average reaction time (Anstey et al., 2012).

In addition, depending on the resources available in a clinic, the Brake Reaction Timer and driving simulators can also be used to assess reaction time (Dickerson, 2013). The Brake Reaction Timer measures the amount of time required for an individual to move his or her foot to the brake pedal in response to the stimulus, a red light. Driving simulators, on the other hand, vary depending on size and cost, and range from a computer screen with a functioning steering wheel and pedals to a more interactive experience that involves a mock vehicle cab and screen (Classen et al., 2012). Thus, occupational therapy generalists can use a variety of cognitive, perceptual, and reaction time pre-driving assessments to assist with predicting on-road driving performance and safety.

Visual Perception

Visual perception is the ability of an individual to interpret visual information when presented with a stimulus (Warren, 2013). There are different components, or skills, that make up visual perception. Five common components of visual perception are figure ground, visual closure, spatial relationship, visual memory, and visual discrimination. Figure ground is the ability to distinguish an object from its surroundings or other objects in the background (Brown, 2011b). Visual closure, is the ability to identify an unknown visual object when only presented with a visual stimulus that is obscure, disconnected, or vague (Newton & McGrew, 2010). Visual memory is the ability to store and recall a visual stimuli after only being exposed to it for a brief period, whereas visual discrimination is the ability to view an object and discriminate its

features such as color, shape, or position (Brown, 2011b; Newton & McGrew, 2010). Lastly, spatial relationship is the ability to mentally manipulate visual stimuli and orient where the body is in relation to the objects in space (Newton & McGrew, 2010). All of these visual perceptual components rely on the integrity of visual foundation skills (Warren, 1993).

Visual foundation skill. Visual foundation skills are the basic abilities that support visual processing as well as visual perception and visual cognition, which is the ability to mentally manipulate visual input and incorporate it with other sensory input for decision making (Warren, 1993). Visual foundation skills include visual acuity, visual fields, and contrast sensitivity. All the components in visual foundation skills may be impacted by the natural aging process of the eyes (Rubin et al., 2007). Age-related changes in vision or visual skills have been found to impact safety and participation in daily activities such as ambulation and driving (Matas, Nettelbeck, & Burns, 2014).

Visual acuity describes an individual's ability to discriminate details either for near reading or far distance. The eyes begin to degenerate with age-related changes due to hardening of the lens, and acquired age-related conditions such as cataracts and macular degeneration (Chou et al., 2013). Decreased visual acuity may impact everyday activities such as reading, writing, cooking, and driving. In addition to visual acuity, natural aging also affects visual accommodation, which is the ability to alternate focus between near and distant objects (Lockhart & Shi, 2010). Changes in visual accommodation may, in turn, impact visual acuity (Warren, 2013). A driver with decreased visual acuity may not be able to alternatively read distant road signs, close up symbols on the dashboard, and then focus back to the overall distant driving environment.

In addition to visual acuity, aging may affect visual fields and prevent the individual from seeing in a particular quadrant. Each of the four quadrants, up, down, left, and right, allows for peripheral vision (Warren, 2013). Decreases in peripheral vision may increase fall risk due to difficulty seeing objects outside of the focus of vision. Driving can also be impacted as an individual may not be able to see pedestrians, nearby vehicles, roadway edges, or other hazards on the road when they are outside of the focus of central vision (Warren, 2013).

Contrast sensitivity is an individual's ability to see an object against a similar background. When an individual ages, this ability decreases which may also increase fall risk (Warren, 2013). For example, contrast sensitivity helps to distinguish where stairs begin and end, to see white pills against a white counter, and to read different colored lettering against a similar colored background. Hence, decreased contrast sensitivity may make daily activities such as medication management, cooking, and driving difficult (Roche et al., 2014). With low contrast sensitivity, reading a dashboard, interpreting road signs and markings, or distinguishing between the road and the road shoulder may become more challenging, especially when driving at night under low illumination conditions.

Vision is used for almost all activities of daily living (ADLs) and IADLs. Visual acuity, visual field, and contrast sensitivity all contribute to how the environment is processed (Racette, & Casson, 2005). Therefore, age-related vision changes and acquired conditions may impact safety and independence in ADLs and IADLs (Smith, et al., 2009). Since age-related changes are usually gradual, older adults may not notice the changes in vision until the specific visual components are assessed, or when significant errors are noted in functional tasks. Hence, in addition to assessing age-related changes in visual foundation skill, visual perceptual skill should also be assessed.

Assessment of Visual Perception

Occupational therapists and other professionals, including ophthalmologists, assess individuals' visual perceptual skills. The Developmental Test of Visual Perception-Adolescent and Adult (DTVP-A), the Test of Visual Perceptual Skills (non-motor)-third edition (TVPS-3), and the MVPT-3 are frequently used to measure visual perception. Although these three assessments measure similar visual perceptual constructs, key distinguishing factors among the tests impact the implications of the results (Brown et al., 2012).

The DTVP-A requires individuals to interpret 49 black and white designs and uses a multiple choice format to assess visual perceptual skills of individuals ages 11 to 74 years. This tool consists of three subscales that require motor responses and three subscales that do not require motor responses. Similarly, the TVPS-3 includes black and white line drawings and uses a multiple-choice format, but consists of seven subscales and is non-motor. The TVPS-3 measures visual perceptual abilities in individuals ages four to 18 years, but can be used with older adults as well (Brown et al., 2012). The DTVP-A and TVPS-3 are unique because they both include individual subscales, and therefore may be used to identify deficits in specific visual perceptual sub-skills.

On the other hand, the MVPT-3 does not include separate subscales. The test authors asserted that the MVPT-3 should be used to assess an individual's overall visual perceptual ability instead of sub-skills (Brown et al., 2012). The MVPT-3 includes 65 items, uses a visual multiple-choice format, and is suitable for individuals ages four to 84 years and older (Brown, 2011a). The MVPT-3 includes line drawings and figures, requires no motor involvement, and measures five constructs of visual perception, which are figure ground, visual closure, spatial relationship, visual memory, and visual discrimination (Brown et al., 2012; Brown & Elliot,

2011). Though the authors of the MVPT-3 intended for the test to be used as a unidimensional test of a single construct, visual perception, Brown and Elliott (2011) found that the MVPT-3 is multi-dimensional. Through their analysis, they found that the MVPT-3 total scale appeared to measure 11 different constructs (Brown & Elliott, 2011). Therefore, a discrepancy exists between the 11 identified constructs and the test author's five identified visual perceptual constructs (Brown & Elliott, 2011).

The MVPT-3 is a valid and reliable assessment that can be used to measure visual perception abilities (Brown, 2011a; Colarusso & Hammill, 2003). Brown (2011a) analyzed the construct validity of the MVPT-3 using Rasch analysis (RA) with a sample of 221 participants. Eight of the 65 items within the MVPT-3 did not meet RA requirements, three of which showed differential item functioning based on gender. The author, however, concluded that the overall internal structure of the MVPT-3 assessment shows construct validity (Brown, 2011a). In another study, Colarusso and Hammill (2003) also tested for criterion-related validity by comparing the MVPT-3 to the Developmental Test of Visual Perception, Developmental Test of Visual Perception Second Edition, Metropolitan Readiness Test, and Durell Analysis of Reading Difficulties. Correlation between the MVPT-3 and these other assessments ranged from .27 to .82. Therefore, this study revealed that MVPT-3's criterion-related validity is not consistent when compared to other assessment that include motor components (Colarusso & Hammill, 2003).

In addition to assessing validity, the level of reliability of the MVPT-3 was determined using Cronbach's coefficient alpha with a standardization sample (Colarusso & Hammill, 2003). Since the MVPT-3 tests several types of visual perception, the coefficient was expected to be slightly lower than .90. Colarusso and Hammill (2003) found that the MVPT-3 has coefficients

ranging from .76 to .90. Hence, the researchers concluded that the MVPT-3 can be used with confidence for individuals five years and older (Colarusso & Hammill, 2003). Furthermore, a sample of 103 participants were assessed with the MVPT-3 and then reassessed an average of 34 days later to examine temporal stability. Results indicated that the MVPT-3 provides stability over time with correlations of .87 for ages four to 10 years old and .92 for ages 11 to 84 years old and older (Colarusso & Hammill, 2003). Hence, the MVPT-3 exhibits good validity and reliability and is one of the pre-driving assessments commonly used to assess visual perception abilities. In addition to visual perception abilities, visual processing speed can also impact driving performance.

Visual Processing Speed and Response Time

Through visual processing, an individual can detect the presence of a target, discriminate between targets, recognize a target as familiar, identify what a target is, indicate its spatial location, and make decisions about visually complex events (Owsley, 2013). Hence, visual processing speed is the amount of time needed to make a correct interpretation about a visual stimulus (Owsley, 2013). Age-related changes that may decrease the overall visual processing speed include central neural processing delay and decreased sensitivity of the cone photoreceptors (Lockhart & Shi, 2010).

A significant decrease in visual processing speed can be seen between the ages of 70 years old and 85 years old (Habekost et al., 2013). Visual processing speed can decrease as much as half within these 15 years (Habekost et al., 2013). Liu et al. (2014) also examined the visual processing speed of 52 children ages six to 11 years, 12 younger adults 24 years and older, and 24 older adults 76 years and older through cursor pointing and choice response time (CRT) tasks with a computer mouse. The visuomotor skills addressed were the speed at which information was visually processed and the speed at which the participant moved the cursor in the CRT task. Results from the CRT tasks confirmed that

the older adults' group performance was slower compared to the younger adults' group performance (Liu et al., 2014). Overall, the researchers explained that the CRT score decline may have been due to decline of cognitive and sensory abilities in the older adults (Liu et al., 2014).

On the other hand, a study by Wiegand, Finke, Müller, and Töllner (2013) found contrary results. In their study, the researchers compared a visual task search assessment between 18 younger adults' and 18 older adults' response times. The visual task search consisted of eight colored shape stimuli presented in a circular array against a black background. The participant uses their left or right index finger to press the response button on a computer. Though the younger adults had faster response times than the older adults, results detected no significant difference in error rate between the older adults and younger adults (Wiegand et al., 2013).

Researchers also studied visual processing changes with age using the UFOV and event-related potential (ERP) task components (O'Brien, Lister, Peronto, & Edwards, 2015). The UFOV assesses visual processing speed under divided attention and selective attention conditions. An ERP involves an electrophysiological response to an internal or external stimulus which can be reliably measured using electroencephalography (O'Brien et al., 2015). The results of the study supported that visual processing speed declines with age when analyzing the individual tasks (O'Brien et al., 2015).

Another study assessed 342 older adults' visual foundation skills and response time through the use of 17 visual everyday tasks (Owsley, McGwin, Sloane, Stalvey, & Wells, 2001). Tasks included IADLs such as reading ingredients on canned food and medicine bottles, and locating items in a drawer. The results revealed that the older adults took longer to complete visual timed IADLs. The researchers also asserted that the increase in response time may be attributed to age-related changes in visual acuity, contrast sensitivity, and visual field (Owsley et al., 2001). Moreover, since IADL tasks require visual processing to interpret visual information

received, age-related changes in visual processing speed may impact how long it takes individuals to complete IADLs such as driving (Matas et al., 2014). In order to measure age-related changes in visual processing speed, the MVPT-3 contains a separate *Response Time Index* to assess visual processing skills used in IADLs (Martin, 2003).

MVPT-3 *Response Time Index*

In addition to obtaining the total score on the MVPT-3, item response times can be recorded. The *Response Time Index* is based on the response times from the first 10 correct answers in items 14-40 in MVPT-3. The MVPT-3 *Response Time Index* exhibits reliability and validity. According to Martin (2003), the reliability of the *Response Time Index* was established during the MVPT-3 normative study. During the study, timing data were recorded for 87 individuals and the test-retest correlation was found to be .91 (Martin, 2003). Therefore, the *Response Time Index* has a high degree of reliability. In addition to reliability, the validity of the *Response Time Index* was confirmed through an analysis of the mean *Response Time Index* of age-matched samples living in the United States and Canada. The results, using t-test, indicated no significant difference between individuals living in the United States and Canada (Martin, 2003).

Analysis of the *Response Time Indices*, calculated for the normative sample, revealed changes over the lifespan (Martin, 2003). Martin (2003) noted, “Item response times were faster from ages 4-35 and then slowed down somewhat after age 35; that slowing is especially noticeable after age 70” (p. 6).

Therefore, the *Response Time Index* can be used to provide information about visual processing speed, which changes with age. Since driving requires the ability to quickly and accurately respond to objects in the environment, slow visual processing speed can be problematic and clinically significant when assessing fitness to drive (Martin, 2003).

A new version of the MVPT-3, the MVPT-4 was published in 2015 (Calorusso & Hammill, 2015). This new assessment uses the same motor-free multiple choice format that the MVPT-3 does and assesses the same five components of visual perception. The changes made to the assessment include regrouping of the test items sequence and removing 20 test items. Hence, there are only 45 test items in the MVPT-4. Unlike the MVPT-3, the MVPT-4 does not yet have a *Response Time Index*, making it unable to measure visual processing speed (Calorusso & Hammill, 2015). Without a *Response Time Index* in this newer version of the MVPT-4, its utility as a pre-driving assessment tool cannot be confirmed.

Summary and Conclusions

Although driving can be an occupation of high value to older adults, research has shown that older adult drivers often give up driving due to safety concerns. These concerns are valid considering older adult drivers are at a higher risk of motor vehicle accidents resulting in their own harm or fatality. Driving is a task that requires various skills that are susceptible to age-related changes including visual acuity, visual field, contrast sensitivity, and visual perception. Although on-the-road assessments can accurately determine fitness to drive, they are often not readily available and costly. Hence, many occupational therapists utilize pre-driving assessments to evaluate the individual components of driving such as cognition, vision, and visual perception.

One commonly used visual perception assessment in the adult population is the MVPT-3. The MVPT-3 also has an additional *Response Time Index* to measure visual processing speed. Current evidence reveals that visual processing speed decreases with age, which may impact driving. A new version of the MVPT-3, called the MVPT-4, was released in 2015, however, it does not include a *Response Time Index* (Calorusso & Hammill, 2015). Due to the lack of a *Response Time Index*, the MVPT-4 cannot yet be used to measure visual processing speed and the changes that may occur with age.

Statement of Purpose

The MVPT-4 is an updated version of the MVPT-3 that includes fewer questions. The questions are also arranged differently in the MVPT-4, making the MVPT-3 *Response Time Index* invalid for the MVPT-4. Therefore, the purpose of this research study was to explore if differences in visual processing speed between younger adults and older adults could be detected using the new MVPT-4. If the MVPT-4 is proven to be sensitive enough to detect these changes in response time, occupational therapists may be able to use the MVPT-4 in pre-driving assessments to help in determining older adults' fitness to drive. This study aimed to answer the question: Do younger adults between the ages of 20-35 years have faster visual processing speeds than older adults ages 70 years and older when measured by the MVPT-4? The null hypothesis for this study was that there is no difference in visual processing speed between younger adults and older adults when measured by the MVPT-4. The alternative hypothesis was that there is a difference in visual processing speed between younger adults and older adults when measured by the MVPT-4.

Definitions and Variables

Definitions

Figure ground. Figure ground is the ability to distinguish an object from its surroundings or other objects that are in the background (Brown, 2011b).

Spatial relationship. Spatial relationship is the ability to mentally manipulate visual stimuli and orient where the body is in relation to the objects in space (Newton & McGrew, 2010).

Visual closure. Visual closure is the ability to identify an unknown visual object when only presented with a visual stimulus that is obscure, disconnected, incomplete, or vague (Newton & McGrew, 2010).

Visual discrimination. Visual discrimination is the ability to view an object and discriminate its features such as color, shape, or position (Brown, 2011b).

Visual memory. Visual memory is the ability to store and recall a visual stimuli after only being exposed to it for a brief period (Newton & McGrew, 2010).

Visual perception. Visual perception is the ability to interpret visual information when presented with a stimuli (Warren, 2013).

Older adults. For the purpose of this study, older adults are defined as individuals age 70 years old and older.

Younger adults. For the purpose of this study, younger adults are defined as individuals between the ages of 20 years old and 35 years old.

Variables

Independent. The independent variable was the age group of the participants.

Dependent. The dependent variable was the participant's response time, or visual processing speed, determined by the MVPT-4.

Theoretical Framework

The theoretical framework chosen for this research study was the Visual Perception Hierarchy. The Visual Perception Hierarchy focuses on the levels of visual skills an individual needs to perceive visual stimuli to form visual cognition (Warren, 1993). In the hierarchy, there are six levels of skills: visual foundation skills, visual attention, scanning, pattern recognition, visual memory, and visual cognition. Higher level skills in the Visual Perception Hierarchy are dependent on the integrity of the basic skills at the bottom of the hierarchy (Warren, 1993).

An individual with impaired visual foundation skills may not be able to master skills in the higher levels of the hierarchy. For example, visual foundation skills, including visual acuity, visual field, and ocular motor control, are required for an individual to ascend to the next level, visual attention. Visual attention allows an individual to focus on a particular stimulus, or voluntarily shift visual attention to another stimulus (Warren, 1993). For instance, without the skills to control eye movements, an individual would not be able to voluntarily focus on a stimulus. In the MVPT-4, visual attention is required for a person to focus on the different aspects of the material presented to them. After mastering visual attention, the individual will be able to scan the environment for essential information and disregard irrelevant stimuli. Once scanning is mastered, the individual will then be able to recognize patterns.

Pattern recognition is the ability to identify features of an object such as its shape, specific details, color, or texture (Warren, 1993). Recognition of pattern requires the individual

to perceive the shape, size, and lines to formulate an understanding of the pattern. An example of pattern recognition is when a person recognizes a red hexagon as a stop sign. In the MVPT-4, individuals need to be able to identify and match objects using pattern recognition skill. After an individual is able to recognize patterns, he or she will then be able to mentally recall the object using a skill known as visual memory (Warren, 1993).

The highest level of the hierarchy is visual cognition. Visual cognition allows an individual to mentally manipulate visual input and incorporate it with other sensory input for problem solving and decision making. This skill is the most complex and is the foundation for many daily activities including reading, writing, and driving (Warren, 1993).

The Visual Perception Hierarchy discusses the different skills required for visual perception and visual cognition. This theoretical framework supports visual skills that are used in the MVPT-4. The MVPT-4 assesses five components of visual perception which are figure ground, visual closure, spatial relationship, visual memory, and visual discrimination. Each of the components in visual perception being assessed in the MVPT-4 are related to the Visual Perception Hierarchy. Starting at the bottom of the Visual Perception Hierarchy are visual foundation skills including visual acuity, visual field, and contrast sensitivity. These are also the foundation skills that are required to complete the MVPT-4 test items. Age-related changes in these foundation skills that affect the basic ability to see and progress in visual perceptual skills may affect an individual's response time visually.

Visual attention and visual memory are the next skills that are necessary to complete the MVPT-4. The individual is required to focus on the visual stimuli and remember the images to complete test items on the MVPT-4, but also for daily activities such as driving. Spatial relationship, pattern recognition and visual closure are also being assessed in the MVPT-4. For

example, in the MVPT-4, individuals must recognize and identify shapes and patterns that are partially obscured. These skills are useful when driving because they allow the individual to attend to the road environment, problem solve, recognize sign patterns or other hazards such as vehicles in the adjacent lane that may be partially obscured on the road. As individuals age, visual foundation skills and visual perceptual skills may be negatively impacted by age and age-related conditions. These changes in visual skills may decrease older adults' visual processing speed and may be reflected in the MVPT-4 assessment.

Ethical and Legal Considerations

The investigators acquired approval through the Institutional Review Board for the Protection of Human Participants (IRBPHP) at Dominican University of California (DUC) prior to the study (#10523) (Appendix A). Agreements between the investigators, Tamalpais of Marin (Appendix B), and programs at DUC (Appendix C) were established before recruiting participants for the study. Flyers were then placed at each location to recruit participants (Appendix D). All participants were able to understand and provide their own legal consent by signing the Consent To Be a Research Subject Form (Appendix E). The participants also received a copy of the Bill of Rights (Appendix F) so that they had a complete understanding of what was to be expected of them and what they were entitled to. Every participant had the right to know the purpose of the study, to be informed of the risks and benefits of the study, and to be allowed to refuse to participate at any point throughout the duration of the study.

The investigators in this study followed the American Occupational Therapy Association (AOTA) Code of Ethics, published in 2015, by protecting each individual's rights and abiding by the principles of beneficence, justice, autonomy, confidentiality, and veracity. Beneficence involves promoting good and preventing harm from occurring (AOTA, 2015). Though

participants were encouraged to finish the assessment, the investigators were aware that circumstances may come up throughout the duration of the study that would lead a participant to feel overwhelmed, distracted, or request to discontinue the study. Participants were able to withdraw from the study, reschedule the assessment, or simply take a break, if needed.

Justice, autonomy, and confidentiality are all interrelated principles. Justice is providing fair, equitable, and appropriate treatment of individuals (AOTA, 2015). In this study, participants were all treated in the same manner, with respect and gratitude. The investigators administered the MVPT-4 in a standardized format, ensuring that each participant had equal opportunity for completion of the assessment. Each participant determined a comfortable pace to complete the assessment, so that he or she was not hurried or rushed.

Autonomy acknowledges individuals' rights to make choices and take action based on their own beliefs and values (AOTA, 2015). The participants voluntarily chose to participate in this study to gain knowledge about their own visual processing skills, and also to aid the investigators in gathering new information about the differences among visual processing speed between younger adults and older adults.

Confidentiality is the protection of an individual's personal information (AOTA, 2015). Other than what was gathered in the demographic form, participants' names were not used in the data collection process. A number was assigned to each participant to ensure protection of his or her privacy. The participants' identifying information was also kept in the faculty advisor's locked office to prevent breaches in confidentiality. The research assistants that were utilized throughout the study signed a confidentiality agreement, stating that they would not share the participants' personal information (Appendix G) .

Veracity is a principle based on truthfulness and honesty (AOTA, 2015). The investigators truthfully described each component of the study to interested participants in the recruitment process. Additionally, the investigators objectively and accurately recorded and interpreted the information obtained throughout the study. The collected data were not skewed or altered to manipulate the results.

Methodology

Research Design

The study required a one-time assessment to compare visual processing speed between the two populations, younger adults and older adults. Since participants were only tested once and were not followed over an extended period of time, this study employed a cross-sectional research design. This quantitative study took place over a period of two-months in continuous recruitment fashion.

Subjects Recruitment

English-speaking young adult drivers, between the ages of 20 years old to 35 years old, and older adult drivers age, 70 years and older, were included in this study. There were no gender, racial, or ethnic-based enrollment restrictions. Individuals were excluded from the study if they were not currently driving, were unable to read the Snellen Reading Chart with or without corrective eyewear, or could not follow instructions to complete the five sample MVPT-3 test items.

The investigators used convenience sampling to recruit participants. The investigators planned to recruit a minimum of 25 younger adult participants and 25 older adult participants. The young adult population was comprised of college students attending DUC. Older adults were participants in the DUC Occupational Therapy Healthy Seniors Program or members of the

Osher Lifelong Learning Institute (OLLI) at DUC. Initially, the investigators also planned to recruit older adults from the Tamalpais of Marin. However, the administrator at the Tamalpais of Marin did not respond to the investigators' request to distribute printed information to the residents. As a result, older adults were not recruited from the Tamalpais of Marin.

The investigators obtained permission from faculty to make an announcement at one of the Healthy Seniors meetings, during OLLI seminars, and during occupational therapy class meetings. Occupational therapy students were recruited from the Occupations of Adults and Seniors II class and two Research in the Health Professions classes. Along with the announcement, printed information was distributed to the Healthy Seniors, OLLI members, and occupational therapy students. Printed information was also posted on campus with contact information for college students to contact the investigators for enrollment. Interested adults contacted the investigators via phone or by email to set-up a time for screening and assessment at DUC. On the assessment day, the investigators provided an explanation of the Bill of Rights and participants were asked to sign a consent form prior to the screening assessments.

Data Collection Procedures

Instruments. The Snellen Reading Chart and five MVPT-3 sample questions were used to screen participants while the MVPT-4 was used as the main assessment. All three of these instruments are owned by DUC Occupational Therapy Department. The Snellen Reading Chart is a chart with lines of various letters printed in different sizes. Reading visual acuity was assessed by observing which lines participants were able to read on the chart when it was placed 16 inches away from the eyes. Reading visual acuity was assessed, instead of distance acuity, to determine if the participant was able to clearly see the figures presented directly in front of them at reading distance during the MVPT-3 sample questions and the MVPT-4 assessment.

Both the MVPT-3 and MVPT-4 are standardized and scripted assessments that assess five components of visual perception including figure ground, spatial relationships, visual closure, visual discrimination, and visual memory. The MVPT-3 assessment consists of 65 test items in which an individual is presented with a black and white figure drawing and asked to identify the correct corresponding image. Four multiple choice options, labeled "a" through "d", are given. The MVPT-3 requires no motor component, therefore, the participant was only required to verbally provide the answer he/she considers to be the correct answer to the test item. The MVPT-4 is the updated version of the MVPT-3, and is also motor-free. Since 20 items were eliminated, the MVPT-4 is comprised of 45 test items taken from the MVPT-3. The test items are also arranged in a different order than the MVPT-3. For screening purposes, five sample questions were selected from the 20 discarded items from the MVPT-3. In order to demonstrate that the participants were able to follow the instructions, they had to be able to answer these sample test items before completing the full MVPT-4.

Procedures. After participants completed the consent procedures, information was gathered using a demographic form (Appendix H). Once this form was completed, the Snellen Reading Chart and the five selected sample test items from the MVPT-3 were administered by the investigators to determine eligibility of the participant to proceed to the MVPT-4 assessment. If the participant was unable to pass the Snellen Reading Chart at a score of 20/40 or better or complete the five sample MVPT-3 test items, the participant would not qualify to move to the next phase of the assessment. Each participant was assessed individually in a quiet room on DUC campus.

To administer the MVPT-4, the administrator, sat across from the participant, read the scripted instructions, and recorded the answers given. Two trained timers timed and recorded the response time for each test item. Each test item was timed individually and the timers started once the administrator finished reading the instructions and stopped once the participant verbalized or pointed to an answer. The whole process from consent to completion of the assessment took approximately one hour.

In order to control threats to inter-rater reliability, both the assessment administrators and the timers were trained and practiced the process of accurate timing prior to data collection. Two timers were used during every assessment and their recorded times were averaged during data analysis for better accuracy in timing the response time.

Data Analysis

Descriptive statistics were used to compare the younger adult and older adult populations' demographic information. A sample t-test compared the younger adults' and older adults' total amount of time required to complete the whole assessment of 45 test items. Another sample t-test compared visual processing speed between older and younger adults on correct answers. Finally, t-tests were also used to compare group homogeneity.

Results

A total of 45 participants participated in this study (Table 1). The younger adult group consisted of 24 participants, including 22 females and two males. The older adult group comprised of 21 participants, including 13 females and eight males.

Table 1

Participant demographic data

	Older Adults (n = 21)	**Younger Adults (n = 24)**
Mean Age *(SD)*	76.90 (5.47)	22.96 (3.42)
Eye Disease/Condition	8	0
Reading Glasses	16	8
Glasses to Drive	12	11
Drive in Dark	19	24
Drive on Freeway	21	24
Drive in the City	21	24
Average Distance in One Trip *(SD)*	14.83 (10.62)	16.60 (13.41)

Note. Age reported in years and distance reported in miles.

In order to compare the results of the MVPT-4 in its entirety, investigators compared older adults' and younger adults' total time taken to respond to all 45 items (Figure 1). Three of the older adults did not answer all the items. Hence, the unanswered items were marked as incorrect and group mean replacement procedure was used in which the average time the other older adults took to answer the same test items were assigned to the untimed items due to failure to respond. Results revealed a significant difference between older adults' and younger adults' time to complete the entire MVPT-4 (p<.001). In order to analyze how participants performed in relation to their own age group, raw scores were translated to standard scores and then T-scores. Raw scores ranged from 22 to 41 (M = 34.10, *SD* = 4.27) in the older adult group and from 28 to

45 in the younger adult group (M = 38.5, *SD* = 4.06). Respectively, older adults had a mean T-score of 54.38 (*SD* = 6.93) and the younger adults had a mean T-score of 53 (*SD* = 8.54). Therefore, younger adults' and older adults' mean T-scores were not significantly different. Hence, the two groups are considered relatively homogenous within their own age group when compared to the normative sample. Additionally, when analyzing all participants, data revealed a Cohen's *d* value of 1.72.

The investigators used a sample t-test to compare the older adults' visual processing speed to the younger adults' visual processing speed when answering correctly to the test items in the MVPT-4 (Table 2). When the total times in which it took the participants to answer their first five correct test items were analyzed, the results revealed no significant difference between the two groups (p=.055) (Figure 2). However, when the visual processing speed of the participants' in getting the next 10, 15, 20, and 25 correct test items were analyzed, the results revealed significant difference between the older adults' and the younger adults' response times. Hence, there are significant differences in the visual processing speed between the older adults and the younger adults for the first 10 correct answers (p=.001), first 15 correct answers (p<.001), first 20 correct answers (p<.001), and first 25 correct answers (p<.001) when the first five test items were removed.

Table 2

Results comparing younger adults' time to older adults' time to answer items

	Older adult average time *(SD)*	**Younger adult average time *(SD)***	***t***	***p***
Full MVPT-4	623.65 (255.69)	271.67 (140.09)	5.82411	<.001*
First 5 Correct	11.66 (16.51)	4.87 (3.37)	1.9711	.055
First 10 Correct	161.08 (101.67)	80.74 (51.39)	3.40907	.001*
First 15 Correct	184.38 (102.16)	96.61 (54.51)	3.65943	<.001*
First 20 Correct	224.81 (97.10)	112.92 (59.99)	4.67977	<.001*
First 25 Correct	306.73 (139.21)	144.72 (84.49)	4.64707	<.001*

Note. "First 10 Correct", "First 15 Correct", "First 20 Correct", and "First 25 Correct" after removal of the first 5 test items of the MVPT-4. *P* <.05* indicates statistical significance.

The investigators also utilized the t-test to determine if there were group differences in performance on the MVPT-4 between those with or without reading glasses, presence or absence of eye conditions in older adults, and sex in older adults. The t-test revealed that older adults' and younger adults' performance on the MVPT-4 was not impacted by these demographic factors. Older adult eye conditions were only analyzed because eye conditions were not present in the younger adult group. Similarly, sexes in the younger adults were not analyzed since there were 22 females and only two males in the younger adult group.

Figure 1. *All participants' time to complete the full MVPT-4*

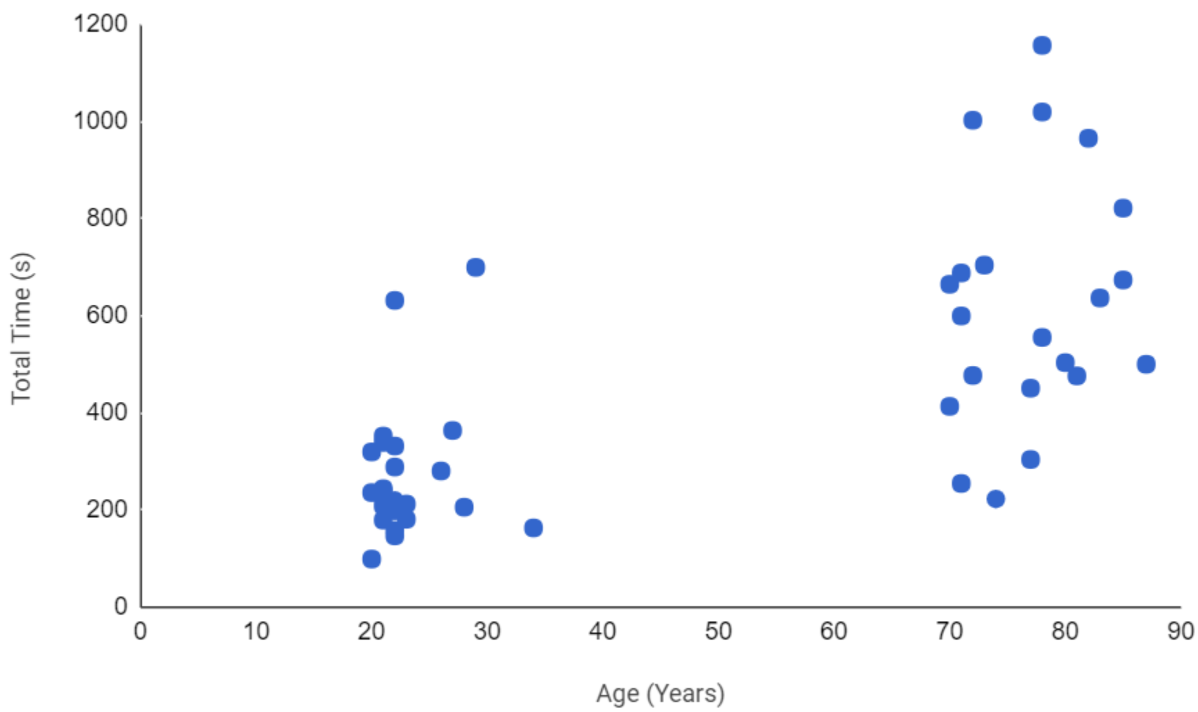
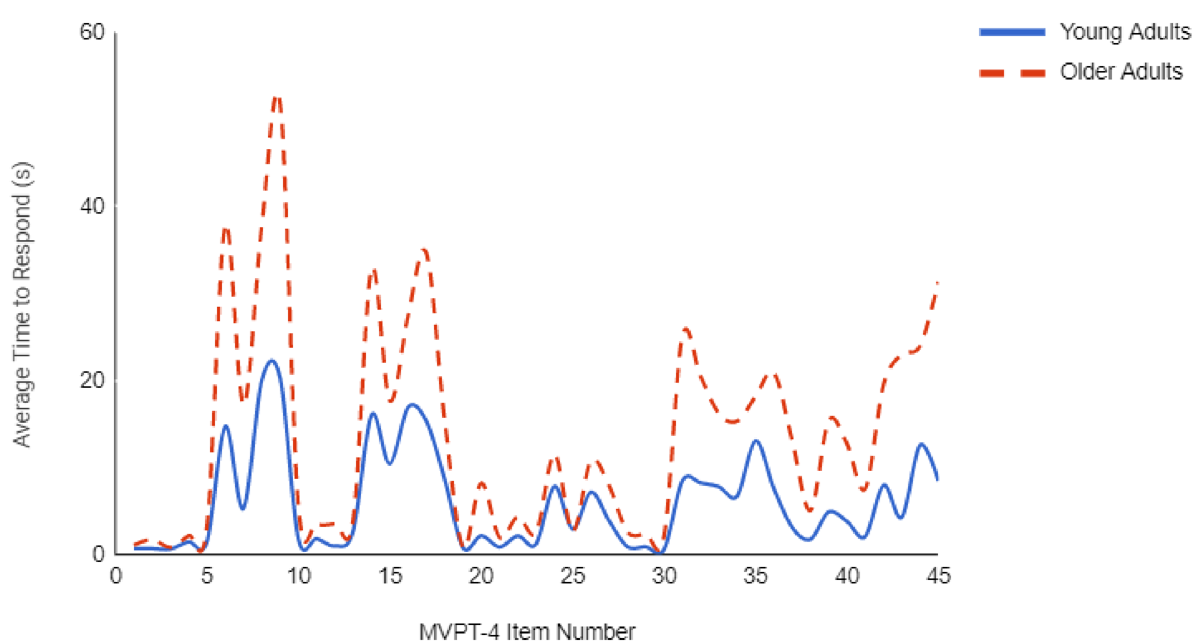


Figure 2. Comparison of younger and older adults' average time to answer each test item



Discussion

The purpose of the study was to explore if a difference in visual processing speed between younger adults aged 20-35 years old and older adults age 70 years or older can be detected using the MVPT-4. These two age groups were chosen because after age 35 adults may begin to exhibit some decrease in response time, but adults over the age of 70 may exhibit a noticeable decrease in response time (Martin, 2003). Data analysis was used to answer the research question: Do younger adults between the ages of 20-35 have faster visual processing speeds than older adults ages 70 years and older when measured by the MVPT-4? Based on the results, there was a significant difference in performance between younger adults' time and older adults' time in answering all 45 test items in the MVPT-4 assessment. Hence, the null hypothesis was rejected and the alternative hypothesis was accepted that there is a difference in visual processing speed between younger adults and older adults when measured by the MVPT-4. Hence, the results of this study reveal that the MVPT-4 may be able to detect younger adults' faster visual processing speeds compared to older adults. This finding supports previous research evidence that visual processing speed decreases with age (Martin, 2003). The Cohen's *d* value at 1.72 indicates that there is a large effect size and hence, regardless of sample size, the likelihood that the younger adults have faster response times is strong.

The MVPT-3 has an additional *Response Time Index* which is norm values for visual processing speed across age groups from four years to 70 years and over. The MVPT-3 *Response Time Index* is based on the response times from the first 10 correct answers in items 14-40 (Martin, 2003). In close examination of the results from this study, there is no difference in visual processing speed between younger adults and older adults in responding correctly for the first five items. Since the first five items are relatively easy, they do not require high visual

perceptual skill to process. Thus, the first five items are just simply too easy to be sensitive in detecting age-related changes in response time. However, after removing the first five items, a series of t-tests reveal differences between the two groups for the first 10, 15, 20, and 25 correct answers as the test items in the MVPT-4 become progressively more challenging and complex. Therefore, it is concluded that the MVPT-4 is better able to discriminate between younger adults' and older adults' response times as the test items become more difficult and require more visual perceptual skill. Although the findings indicate that the total response time for the first 10 items, starting at item six, is as sensitive as the first 15, first 20, and first 25 items when used to discriminate differences in visual processing speed between the younger and older age groups, it is our recommendation that a *Response Time Index* for the MVPT-4 should be taken as the sum of the first 15 correct items, instead of the first 10 correct items, from test items six to 45.

To come to this conclusion, the test items in the MVPT-4 were compared against test items 14-40 in the MVPT-3 *Response Time Index*. In the MVPT-3, the *Response Time Index* includes visual memory test items. In the MVPT-4, the visual memory test items begin with item 19. Hence, if the first 10 correct items in the MVPT-4 are used, they do not include visual memory test items, whereas if the first 15 correct items are used, two of the original visual memory test items from the MVPT-3 will be included. Additionally, given the time constraint in clinical practice, our criteria for efficiency in clinical utility includes being able to complete the assessment in a reasonable amount of time, and hence about five to 10 minutes. Hence, our recommendation does not include the first 20 correct items or more because the time required to complete the test items would be more than 10 minutes, therefore, less feasible in the clinical environment. On the other hand, administering 15 test items would only require about five to 10

minutes. Therefore, our recommendation is to use the first 15 correct items in the MVPT-4 to provide sensitive results in the current clinical environment.

The MVPT-4 assesses five components of visual perception including figure ground, spatial relationships, visual closure, visual discrimination, and visual memory. To further investigate the items that may require more visual perceptual skill, examination of the test items that 60% or more of the participants answered incorrectly was completed. Our analysis also reveals important differences in visual processing skills between the two age groups. Twelve or more older adults incorrectly answered test items 14, 15, 16, 17, 35, 40, and 45. As compared to 14 or more younger adults incorrectly answered test items 16 and 17. Test items 14 to 17 assess figure ground. As the figure ground test items become progressively more complex and difficult, increased demands were placed on older adults' visual processing and visual perceptual skills. Similarly, since the MVPT-4 has the more difficult test items at the end of each subsection, the older adults found it challenging to correctly process the information for test item 35, which assesses spatial relationships, and test items 40 and 45, which both assess visual closure.

Age-related changes may impact visual perception and visual processing speed, which are essential skills required for safe driving. Older adults' decreased visual perceptual ability in figure ground and visual closure presents significant implications for driving. Decreased ability in visual closure may make it challenging to read road signs that are only partially visible. Since the older adults had more difficulty with the visual closure test items, our results support the study by Ball et al. (2006) that the MVPT Visual Closure subtest is a sensitive measure that can significantly predict at-fault motor vehicle accidents in older adults. Also, decreased ability in figure ground may impact older adults' ability to distinguish objects or potholes against the

surface of the road. Therefore, decreased accuracy in visual closure and figure ground may compromise older adults' driving safety.

In addition to visual perceptual skills, fast visual processing speed is also needed to avoid accidents. The underlying factors that lead to motor vehicle crashes may also be associated with age-related changes in visual processing speed. Based on the results, visual processing speed decreases with age. Since the MVPT-4 may be able to detect age-related changes in visual processing speed, our results support the study by Liu et al. (2014) in which the older adults' group exhibited slower visual processing speed compared to the younger adults' group. Slower visual processing speed, together with the decreased ability in visual closure and figure ground, may increase the risk of motor vehicle accidents as the adult drivers may not be able to correctly interpret and respond to visual stimuli fast enough to avoid accidents in a dynamic environment during driving. Our results indicate that there is a decrease in response time in adults age 70 years and older, which may correlate with Tefft (2008) that at the age of 70 years old, risk of motor vehicle accidents increased and continued to increase with older age.

To sum, the MVPT-4 appears to be a sensitive tool in detecting changes in visual processing speed. Using the first 15 correct items may be adequate to detect the differences in visual processing speed between younger adults and older adults. Therefore, occupational therapists may be able to use the MVPT-4 as a clinical tool in pre-driving assessment.

Limitations and Recommendations

The limitations in this pilot study include using a convenience sample to recruit participants and a small sample size. Since convenient samples included younger adults age 20-35 years and older adults age 70 years or older, this may limit generalizability of the study to other age groups and the larger population. Due to the cut off ages for the younger adults and

older adults, the results only support that there is a decrease in response time between younger adults aged 20-35 years old and older adults age 70 years or older. Furthermore, the sample size lacked diversity in regards to sex and age. The younger adult group included 22 females and two males whereas the older adult group included 13 females and eight males. Also, the younger adult age group is clustered around 20's with only one outlying participant over the age of 30 years (Figure 1).

Additional limitation was related to recording the corresponding response times for each test item. For each participant, two timers recorded the amount of time it took the participant to answer each test item. The response times recorded by the two timers were then averaged for each test item. Two timers were used for every assessment for better accuracy in recording the response time. However, due to scheduling difficulty, 10 trained timers were used throughout the study. Therefore, differences in each timer's performance may have contributed to variance in some of the test items. To investigate the degree of consistency between the two timers, data were randomly selected from nine participants, five younger adults and four older adults. Differences in the two timers' recorded data were analyzed with 40% difference considered to be significantly different. Forty percent is a reasonable difference as most of the answers for each test item were made within seconds. The results revealed an agreement of 92.84% between the timers.

One other limitation relates to three older adults who chose not to complete all the test items. A group mean replacement procedure was used to avoid lost data. This may skew the results because these participants may have been struggling to answer the test items and therefore may have taken longer than the average time to answer had they responded.

Based on this pilot study, a larger normative sample needs to be recruited and further research is needed to include all age groups to develop a complete *Response Time Index* for the MVPT-4. Also, including a more diverse sample size with even distribution of males and female would increase the overall generalizability of the results. Generalizability could also be improved by recruiting participants from a broader geographical area.

Conclusion

Visual processing speed declines with age. Older adults over the age of 70 years old exhibit a noticeable decrease in response time, which may compromise driving safety. The MVPT is commonly used to assess visual perception abilities in a pre-driving assessment. The MVPT-3 includes a *Response Time Index* that measures visual processing speed, but the newer version, the MVPT-4, does not yet include a *Response Time Index*. Therefore, the purpose of this research study was to explore if differences in visual processing speed between younger adults and older adults can be detected using the MVPT-4.

Despite the small sample size, the results of this pilot study indicate that the MVPT-4 may be able to detect age-related changes in visual processing speed. Furthermore, the total response time of the first 15 correct items from test items six to 45 in the MVPT-4 may be used to detect the differences in visual processing speed between younger adults and older adults. If the MVPT-4 has the sensitivity to differentiate visual processing speed between younger adults and older adults, it may have a clinical utility to detect the risk for automobile accidents.

References

American Occupational Therapy Association. (2014). Occupational therapy practice framework: Domain and process (3rd ed.). *American Journal of Occupational Therapy*, *68*(Suppl. 1), S1–S48. http://dx.doi.org/10.5014/ajot.2014.682006

American Occupational Therapy Association. (2015). Occupational therapy code of ethics. *American Journal of Occupational Therapy*, 69(Suppl. 3).

Anstey, K. J., Horswill, M. S., Wood, J. M., & Hatherly, C. (2012). The role of cognitive and visual abilities as predictors in the multifactorial model of driving safety. *Accident Analysis And Prevention*, *45*, 766-774. doi:10.1016/j.aap.2011.10.006

Ball, K., Roenker, D., Wadley, V., Edwards, J., Roth, D., McGwin G, J., & ... Dube, T. (2006). Can high-risk older drivers be identified through performance-based measures in a department of motor vehicles setting?. *Journal of The American Geriatrics Society*, *54*(1), 77-84. doi:10.1111/j.1532-5415.2005.00568.x

Ball, K., & Wahl, H. (2002). Driving in old age: Use of technology to promote independence. *Gerontechnology, 1*(4), 217-219. doi:10.4017/gt.2002.01.04.001.00

Brown, T. (2011a). An examination of the construct validity of the Motor-Free Visual Perceptual Test–Third Edition (MVPT-3) using Rasch analysis with adult participants. *The Occupational Therapy Journal of Research: Occupation, Participation, Health*, *31*(2), 73-80. doi:10.3928/15394492-20100422-01

Brown, T. (2011b). Construct validity of the three motor-reduced subscales of the Developmental Test of Visual Perception – Adolescent and Adult (DTVP-A): A Rasch analysis model evaluation. *The British Journal of Occupational Therapy,74*(2), 66-77. doi:10.4276/030802211x12971689814007

Brown, T., & Elliott, S. (2011). Factor structure of the Motor-Free Visual Perception Test–3rd edition (MVPT-3). *Canadian Journal of Occupational Therapy/Revue Canadienne D'ergothérapie*, *78*(1), 26-36. doi:10.2182/cjot.2011.78.1.4

Brown, T., Elliot, S., Bourne, R., Sutton, E., Wigg, S., Morgan, D., & ... Lalor, A. (2012). The convergent validity of the Developmental Test of Visual Perception - Adolescent and Adult, Motor-Free Visual Perception Test - third edition and Test of Visual Perceptual Skills (non-motor) - third edition when used with adults. *British Journal of Occupational Therapy*, *75*(3), 134-143. doi:10.4276/030802212X13311219571783

Chou, C., Cotch, M. F., Vitale, S., Zhang, X., Klein, R., Friedman, D. S., Klein, B.E., Saaddine, J. B. (2013). Age-related eye diseases and visual impairment among U.S. adults. *American Journal of Preventive Medicine*, *45*(1), 29-35. doi:10.1016/j.amepre.2013.02.018

Classen, S., Dickerson, A., & Justiss, M. (2012). Occupational therapy driving evaluation: Using evidence-based screening and assessment tools. In M. J. McGuire & E. S. Davis (Eds.), *Driving and community mobility: Occupational therapy strategies across the lifespan* (pp.173-210). Bethesda, MD: American Occupational Therapy Association, Inc.

Colarusso, R. P., & Hammill, D. D. (2003). *Motor-Free Visual Perception Test Third Edition*. Novato, CA: Academic Therapy Publications.

Colarusso, R. P., & Hammill, D. D. (2015). *Motor-Free Visual Perception Test 4*. Novato, CA: Academic Therapy Publications.

Dickerson, A. (2013). Driving assessment tools used by driver rehabilitation specialists: Survey of use and implications for practice. *American Journal of Occupational Therapy*, *67*(5), 564-573. doi: 10.5014/ajot.2013.007823

Dickerson, A., Meuel, D., Ridenour, C., & Cooper, K. (2014). Assessment tools predicting fitness to drive in older adults: Systematic review. *American Journal of Occupational Therapy, 68*(6), 670-680. doi: 10.5014/ajot.2014.011833

Donorfio, L. K., D'ambrosio, L. A., Coughlin, J. F., & Mohyde, M. (2009). To drive or not to drive, that isn't the question—the meaning of self-regulation among older drivers. *Journal of Safety Research*, *40*(3), 221-226. doi:10.1016/j.jsr.2009.04.002

Duffy, M. A. (2016). Low vision and legal blindness terms and descriptions. *American Foundation for the Blind.* Retrieved from: http://www.visionaware.org/info/your-eye-condition/eye-health/low-vision/low-vision-terms-and-descriptions/1235

Edwards, J. D., Bart, E., O'Connor, M. L., & Cissell, G. (2010). Ten years down the road: Predictors of driving cessation. *The Gerontologist, 50*(3), 393-399. doi:10.1093/geront/gnp127

Edwards, J. D., Lunsman, M., Perkins, M., Rebok, G. W., & Roth, D. L. (2009). Driving cessation and health trajectories in older adults. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences, 64*(12), 1290-1295. doi:10.1093/gerona/glp114

Elgin, J., Owsley, C., & Classen, S. (2012). Vision and driving. In M. J. McGuire & E. S. Davis (Eds.), *Driving and community mobility: Occupational therapy strategies across the lifespan* (pp.173-210). Bethesda, MD: American Occupational Therapy Association, Inc.

Habekost, T., Vogel, A., Rostrup, E., Bundesen, C., KyllingsbÆK, S., Garde, E., & …Waldemar, G. (2013). Visual processing speed in old age. *Scandinavian Journal Of Psychology*, *54*(2), 89-94. doi:10.1111/sjop.12008

Justiss, M. D., Mann, W. C., Stav, W., & Velozo, C. (2006). Development of a behind-the-wheel driving performance assessment for older adults. *Topics in Geriatric Rehabilitation*, *22*(2), 121-128. doi: 10.1097/00013614-200604000-00004

Kantor, B., Mauger, L., Richardson, V. E., & Unroe, K. T. (2004). An analysis of an older driver evaluation program. *Journal of the American Geriatrics Society, 52*(8), 1326-1330. doi:10.1111/j.1532-5415.2004.52363.x

Kay, L., Bundy, A., Clemson, L., & Jolly, N. (2008). Validity and reliability of the on-road driving assessment with senior drivers. *Accident Analysis & Prevention*, *40*(2), 751-759. doi: 10.1016/j.aap.2007.09.012

Korner-Bitensky, N., Bitensky, J., Sofer, S., Man-Son-Hing, M., & Gelinas, I. (2006). Driving evaluation practices of clinicians working in the United States and Canada. *American Journal of Occupational Therapy, 60*(4), 428-434. doi: 10.5014/ajot.60.4.428

Liu, G., Chan, J. Y., Chen, D. D., Peng, K., Qin, C., & Yan, J. H. (2014). Visuomotor control in continuous response time tasks across different age groups. *Perceptual And Motor Skills, 119*(1), 169-182. doi:10.2466/25.10.PMS.119c13z8

Lockhart, T. E., & Shi, W. (2010). Effects of age on dynamic accommodation. *Ergonomics*, *53*(7), 892-903. doi:10.1080/00140139.2010.489968

MacLeod, K. E., Satariano, W. A., & Ragland, D. R. (2014). The impact of health problems on driving status among older adults. *Journal Of Transport & Health*, *1*86-94. doi:10.1016/j.jth.2014.03.001

Martin, N.A. (2003). *MVPT-3 use of Response Time Index with the Motor-Free Visual Perception Test 3rd edition.* Novato, California: Academic Therapy Publications.

Matas, N. A., Nettelbeck, T., & Burns, N. R. (2014). Cognitive and visual predictors of UFOV performance in older adults. *Accident Analysis And Prevention*, *70*, 74-83. doi:10.1016/j.aap.2014.03.011

Newton, J. H., & McGrew, K. S. (2010). Introduction to the special issue: Current research in Cattell-Horn–Carroll–based assessment. *Psychology in the Schools,47*(7), 621-634. doi: 10.1002/pits.20495

O'Brien, J. L., Lister, J. J., Peronto, C. L., & Edwards, J. D. (2015). Research report: Perceptual and cognitive neural correlates of the useful field of view test in older adults. *Brain Research*, *16*(24),167-174. doi:10.1016/j.brainres.2015.07.032

Oswanski, M. F., Sharma, O. P., Raj, S. S., Vassar, L. A., Woods, K. L., Sargent, W. M., & Pitock, R. J. (2007). Evaluation of two assessment tools in predicting driving ability of senior drivers. *American Journal of Physical Medicine & Rehabilitation*, *86*(3), 190-199. doi:10.1097/phm.0b013e31802b7de5

Owsley, C. (2013). Visual processing speed. *Vision Research*, *90*, 52-56. doi:10.1016/j.visres.2012.11.014

Owsley, C., McGwin, G., Sloane, M., Stalvey, B., & Wells, J., (2001). Timed instrumental activities of daily living tasks: Relationship to visual function in older adults. *Optometry and Vision Science. 8*(5), 350-359. doi: 1040.5488/01/7805035070

Racette, L., & Casson, E. J. (2005). The impact of visual field loss on driving performance: Evidence from on-road driving assessments. *Optometry & Vision Science*, *82*(8), 668-674.

Roche, S., Vogtle, L., Warren, M., & O'Connor, K. A. (2014). Assessment of the visual status of older adults on an orthopedic unit. *American Journal Of Occupational Therapy*, *68*(4), 465-471. doi:10.5014/ajot.2014.010231

Rubin, G., S., Ng ,E., S., W., Bandeen-Roche, K., Keyl, P., M., Freeman, E., E., West, S., K. (2007). A prospective, population-based study of the role of visual impairment in motor vehicle crashes among older drivers: The SEE study. *Investigative Ophthalmology & Visual Science Invest, 48*(4), 1483-1491. doi: 10.1167/iovs.06-0474

Shechtman, O., Awadzi, K., Classen, S., Lanford, D., & Joo, Y. (2010). Validity and critical driving errors of on-road assessment for older drivers. *American Journal of Occupational Therapy*, 64(2), 242-251. doi: 10.5014/ajot.64.2.242

Smith, T., Ludwig, F., Andersen, L., & Copolillo, A. (2009). Engagement in occupation and adaptation to low vision. *Occupational Therapy In Health Care*, *23*(2), 119-133. doi: 10.1080/07380570902788782

State of California Department of Motor Vehicles. (2016). Vision conditions. Vision standards. *State of California Department of Motor Vehicles*. Retrieved from https://www.dmv.ca.gov/portal/dmv/detail/dl/driversafety/vision_cond

Stav, W. B., Justiss, M. D., McCarthy, D. P., Mann, W. C., & Lanford, D. N. (2008). Predictability of clinical assessments for driving performance. *Journal of Safety Research, 39*(1), 1-7. doi:10.1016/j.jsr.2007.10.004

Tefft, B. C. (2008). Risks older drivers pose to themselves and to other road users. *Journal of Safety Research, 39*(6), 577-582. doi:10.1016/j.jsr.2008.10.002

Warren, M. (2013). Evaluation and Treatment of Visual Deficits Following Brain Injury. In L. W. Pedretti, H. H. Pendleton, & W. Schultz-Krohn (Eds.), Pedretti's occupational therapy: Practice skills for physical dysfunction (pp. 590-630). St. Louis, MO: Elsevier.

Warren, M. (1993). A hierarchical model for evaluation and treatment of visual perceptual dysfunction in adult acquired brain injury, part 1. *American Journal of Occupational Therapy*, *47*(1), 42-54. doi:10.5014/ajot.47.1.42

Wiegand, I., Finke, K., Müller, H. J., & Töllner, T. (2013). Event-related potentials dissociate perceptual from response-related age effects in visual search. *Neurobiology Of Aging*, *34*(3), 973-985. doi:10.1016/j.neurobiolaging.2012.08.002

Wood, J. M., Horswill, M. S., Lacherez, P. F., & Anstey, K. J. (2013). Evaluation of screening tests for predicting older driver performance and safety assessed by an on-road test. *Accident Analysis And Prevention*, *50*, 1161-1168. doi:10.1016/j.aap.2012.09.009

World Health Organization. (2006). The right to sight. Global initiative for the elimination of avoidable blindness. *World Health Organization.* Retrieved from http://www.who.int/blindness/Vision2020_report.pdf

Zook, N. A., Bennett, T. L., & Lane, M. (2009). Identifying at-risk older adult community-dwelling drivers through neuropsychological evaluation. *Applied Neuropsychology*, *16*(4), 281-287. doi:10.1080/09084280903297826

Appendix A: IRB Approval Letter

DOMINICAN UNIVERSITY of CALIFORNIA 1890

December 9, 2016

Kassidy Ha
50 Acacia Ave.
San Rafael, CA 94901

Dear Kassidy:

I have reviewed your proposal entitled *Age-Related Changes in Visual Processing Speed* submitted to the Dominican University Institutional Review Board for the Protection of Human Participants (IRBPHP Application, 10523). I am approving it as having met the requirements for minimizing risk and protecting the rights of the participants in your research.

In your final report or paper please indicate that your project was approved by the IRBPHP and indicate the identification number.

I wish you well in your very interesting research effort.

Sincerely,

Randall Hall, Ph.D.
Chair, IRBPHP

cc: Kitsum Li

Institutional Review Board for the Protection of Human Participants
Office of Academic Affairs • 50 Acacia Avenue, San Rafael, California 95901-2298 • 415-257-1310 *www.dominican.edu*

Appendix B: Letter of Permission from Agency Directors

Mr. Goerzen
Administrator, The Tamalpais
501 Via Casitas
Greenbrae, CA 94904

Dear Mr. Goerzen,

This letter confirms that you have been provided with a brief description of our Master's capstone research study, which involves understanding how vision changes with age, and that you give your consent for us to provide you with printed information to be distributed to the Tamalpais residents. We, Amber Zadravecz, Kassidy Ha, Lauren Gollnick, Stephanie Pawek, and Zoe Studer, are students of the occupational therapy program at Dominican University of California. This research study is part of our Master's degree requirements as occupational therapy students, and is being supervised by Dr. Kitsum Li, Assistant Professor of the Occupational Therapy Department at Dominican University of California.

After our research study has been completed in December 2017, we will be glad to send you a summary of the research results.

If our request to provide printed information for you to distribute to the residents meets your approval, please sign and date this letter. Please feel free to contact Dr. Kitsum Li if you have any questions about this research study. She can be reached via email (kitsum.li@dominican.edu) or by phone (415-458-3753).

Thank you very much for your time and cooperation.

Sincerely,

Amber Zadravecz on behalf of
Kassidy Ha, Lauren Gollnick,
Stephanie Pawek, and Zoe Studer
Dominican University of California
San Rafael, CA 94901
amber.zadravecz@students.dominican.edu

I agree with the above request

_______________________________ 10/22/16

Signature Date

Appendix C: Email of Permission to Dominican Faculty

RE: Presentation of Capstone Research Study

Dear Professor:

Our Master's capstone research study involves understanding how visual processing speed changes with age. The purpose of this study is to explore if the Motor-Free Visual Perception Test-Fourth Edition (MVPT-4) can detect differences in visual processing speed between younger adults and older adults. We, Amber Zadravecz, Kassidy Ha, Lauren Gollnick, Stephanie Pawek, and Zoe Studer, would like to request permission to come to your class to make an announcement to describe our study and distribute printed information.

This project is an important part of our Master's degree requirements as occupational therapy students, and is being supervised by Dr. Kitsum Li, Assistant Professor of the Occupational Therapy Department at Dominican. If you have questions about the research study please email us at mvptstudy@gmail.com. If you have further questions you may contact Dr. Kitsum Li via email (kitsum.li@dominican.edu) or by phone (415-458-3753), or the Institutional Review Board for the Protection of Human Participants (415-482-3547).

If our request to make an announcement and distribute printed information to your class meets with your approval, please contact us to arrange a convenient time for us (or for one of us) to visit your class.

Thanks for your assistance.

Sincerely,

Amber Zadravecz, Kassidy Ha,
Lauren Gollnick, Zoe Studer
and Stephanie Pawek
Email address: mvptstudy@gmail.com

Appendix D: Recruitment Flyer

Appendix E: Consent To Be a Research Subject Form

DOMINICAN UNIVERSITY of CALIFORNIA
CONSENT TO BE A RESEARCH SUBJECT

Purpose and Background

Occupational Therapy students Amber Zadravecz, Kassidy Ha, Stephanie Pawek, Lauren Gollnick, and Zoe Studer at Dominican University of California, are conducting a research study to understand how visual processing speed changes with age. Visual processing speed is the amount of time it takes to interpret images visually. This research is part of our Master's capstone research study and is being supervised by Dr. Kitsum Li, assistant professor, Department of Occupational Therapy, Dominican University of California.

Procedures:

If I agree to participate in this study, the following will happen:

1. I understand that I am being asked to participate as a participant in a research study designed to explore if the Motor-Free Visual Perception Test-Fourth Edition (MVPT-4) can detect differences in visual processing speed between younger adults and older adults.

2. I understand that participation in this research study will involve completing a form regarding known eye diseases/conditions and driving habits. Following the completion of the form will be two screening assessments, Snellen Reading Chart and five sample questions. These screenings will determine my eligibility to participate in the study. If I am eligible, I will then spend approximately 20-25 minutes to complete the MVPT-4 assessment.

3. I understand that my participation in this study is completely voluntary and I am free to withdraw my participation at any time.

4. I have been made aware that the results gathered from the form and MVPT-4 will be recorded. All personal references and identifying information will be eliminated when the data are collected, and all participants will be identified by numerical codes only; the master list for these codes will be kept by Dr. Kitsum Li in a locked file in a locked office. Coded information will be seen only by the student researchers, research assistants, and the faculty advisor. One year after the completion of the research, all written and recorded materials will be destroyed.

5. I am aware that the results of the study will be available at Occupational Therapy Poster Presentation in November 2017.

6. I understand that I have the right to withhold any information and that I may refuse to answer any question on the form. I may elect to stop completing the form or the assessment, and/or withdraw from participation at any time.

Appendix E: Consent To Be a Research Subject Form

7. I understand that although there is no physical risk, the consent and testing process may take about an hour to complete, and that I may become fatigued, at which time the student researchers will allow me to take rest breaks or re-schedule the assessment. I may also choose to withdraw from participation.

8. All procedures related to this research study have been satisfactorily explained to me prior to my voluntary election to participate.

Benefits
There will be no direct benefit to me in this study. The anticipated benefit of this study is to contribute to the research study, and to learn more about my own ability to process images visually.

Cost to the Participants:
Potential costs in this study include personal time, payment for transportation to the testing site at Dominican University of California, and effort. I provide my own transportation to and from the testing site. The assessment testing will take approximately 1 hour to complete.

Payment/Reimbursement to Participants:
If I wish to, I can enter in a drawing to win a $15 gift card. Otherwise, there will be no other payment or reimbursement.

Questions
I have talked to the Occupational Therapy student researchers about this study and have had all my questions answered. If I have further questions about the study, I may contact the student researchers at mvptstudy@gmail.com or the faculty advisor, Dr. Kitsum Li via email (kitsum.li@dominican.edu) or by phone (415-458-3753).

Consent
I have been given a copy of this consent form, signed and dated, to keep.
PARTICIPATION IN RESEARCH IS VOLUNTARY. I am free to decline to be in this study or withdraw my participation at any time without fear of adverse consequences.

My signature below indicates that I agree to participate in this study.

____

PARTICIPANT'S SIGNATURE **DATE**

____

PARTICIPANT'S NAME (PRINT)

____

WITNESS SIGNATURE **DATE**

Appendix F: Bill of Rights

CONSENT FOR RESEARCH PARTICIPATION

DOMINICAN UNIVERSITY of CALIFORNIA
RESEARCH PARTICIPANT'S BILL OF RIGHTS

Every person who is asked to be in a research study has the following rights:

1. To be told the purpose of the study.

2. To be told what will happen in the study.

3. To be told about the risks of the study.

4. To be allowed to ask any questions concerning the study both before agreeing to participate in the study and during the course of the study.

5. To refuse to participate at all before or after the study is completed.

6. To receive a signed and dated copy of the consent form.

7. To be free of pressure when considering whether s/he wishes to agree to participate in the study.

If you have other questions regarding the research study, you can contact the faculty advisor, Dr. Kitsum Li via email (kitsum.li@dominican.edu) or by phone (415-458-3753) or email mvptstudy@gmail.com. You may also contact The Dominican University of California Institutional Review Board for the Protection of Human Subjects by telephoning the Office of Academic Affairs at (415) 257-0168 or by writing to the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA. 94901.

Appendix G: Research Assistant Confidentiality Agreement

Research Assistant Confidentiality Agreement
Dominican University of California

I, _________________________________ [name of research assistant], agree to assist the research team with this study by entering numbered data into a Microsoft Excel sheet. I agree to maintain complete confidentiality when performing this task.

Specifically, I agree to:

1. Keep all research information shared with me confidential by not discussing or sharing the information in any form or format (e.g., flash drives) with anyone other than the research team, Lauren Gollnick, Kassidy Ha, Stephanie Pawek, Zoe Studer, Amber Zadravecz, and Dr. Kitsum Li.
2. Hold in strictest confidence the identification of any individual that may be revealed during the course of performing the research tasks;
3. Not make copies of any raw data in any form or format (e.g., flash drive, Microsoft Excel chart), unless specifically requested to do so by the research team.
4. Keep all raw data that contains identifying information in any form or format (e.g., flash drive, Microsoft Excel chart) secure while it is in my possession. This includes:
    - Keeping all digitized raw data in computer password-protected files and other raw data in a locked file.
    - Closing any computer programs and documents containing the raw data when temporarily away from the computer.
5. Give, all raw data in any form or format (e.g., flash drive, Microsoft Excel chart) to the research team when I have completed the research tasks.
6. Destroy all research information in any form or format that is not returnable to the research team (e.g., information stored on computer hard drive) upon completion of the research tasks.

I agree to the above statements to maintain complete confidentiality.

____

RESEARCH ASSISTANT'S SIGNATURE **DATE**

____

RESEARCH ASSISTANT'S NAME (PRINT)

____

WITNESS SIGNATURE **DATE**

Appendix H: Demographic Form

Dominican University of California
Demographic Form

Name:_______________________________________ **Participant #_____________**

Gender: M / F (Circle One) **Date of Assessment (mm/dd/yyyy)**:____/_____/_______

Date of Birth (mm/dd/yyyy) _____/_____/_________

Known eye diseases/conditions (Please check all boxes that apply):

☐ Cataracts
☐ Glaucoma
☐ Macular Degeneration
☐ Diabetic Retinopathy
☐ Other:__________________
☐ N/A

Do you use reading glasses?

☐ Yes ☐ No

Do you wear corrective glasses or contact lens when you drive?

☐Yes ☐ No

Do you drive after dark?

☐ Yes ☐ No

Do you drive on the freeway?

☐Yes ☐ No

Do you drive around the city?

☐Yes ☐ No

Average distance you drive in one trip on an average day (please estimate)? ________miles

Would you like to participate in a drawing to win a $15 gift card?

☐Yes ☐ No

Please provide contact information if you checked "Yes" to participate in the drawing:

Phone #: (_____)________-_________________
Email:______________________________________

Mailing address: ____