VISION COACH: EFFECTS OF STANDING VERSUS SITTING ON VISUAL REACTION TIMES

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Assessment and intervention tools for occupational therapy practice must be evidence-based for appropriate use and include normative data with healthy adults. The overall goal of this research was to collect normative data on healthy adults' visual reaction time when completing the full field 60 light task on a novel device, the Vision Coach. The specific research question in this study was to determine if a change in body positioning in regards to person's base of support will affect a person's reaction time. We hypothesized that reaction times would be significantly different in the positions of standing versus sitting. Reaction times from 121 healthy adults, ages ranging from 21-79 years, were collected. Participants completed eight trials total, four trials in a standing position, and four trials in a sitting position.

There were no significant differences on the factors of body position, gender, height, and wingspan on the averaged visual reaction times. The implication is that clients can be standing or sitting for use of the tool and therapists have normative data available for usage. This research also provides foundational data for further studies on the Vision Coach apparatus as well baseline criteria for the process of standardization of the Vision Coach. Future studies will need to address the limitation of learning to determine the number of practice trials required in both positions.

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Vision Coach: Effects of Standing versus Sitting on Visual Reaction Times

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Chapter 1: Introduction

The focus of occupational therapy is to assist clients in partaking in occupations of their choosing and help improve their overall health and quality of life (American Occupational Therapy Association (AOTA), 2014). Occupations can be categorized as work, leisure, play, social participation, education, sleep and rest, activities of daily living (ADLs) (e.g. bathing, dressing, and feeding), and instrumental activities of daily living (IADLs) (e.g. driving, home management, meal preparation) (AOTA, 2014). Therefore, occupational therapists are educated to provide interventions, education, adaptive equipment, and environmental modifications aimed at providing patients with the knowledge and abilities needed to participate in any occupation and to establish or improve skills to support independence (AOTA, 2014).

Since the focus of occupational therapy practitioners is to enable participation, they are appropriate professionals to address driving and community mobility. Community mobility is defined as planning and moving around the community, using public or private transportation, such as driving, walking, bicycling, or accessing and riding buses, taxi cabs, or other transportation systems" (AOTA, 2014). Transportation can come in a variety of forms such as driving, walking, taking a bus or cab, or riding a bicycle. Community mobility occurs over a lifetime, beginning when we are first passengers in a car seat, when we ride the bus to school, learn how to ride a bike, and learn how to drive (Schold-Davis, 2012).

For many people in the United States, obtaining a driver's license is "a rite of passage" in which teenagers take a step towards becoming a more self-reliant and responsible adult. In fact, driving is one the most valued IADLs for the adult population, especially for stroke survivors because it provides a person with independence, the ability to be free and spontaneous, and forms a sense of identity (Dickerson, Reistetter, & Gaudy, 2013). Driving also provides a way of transport that allows participation in the community and in other occupations. Driving plays such a vital role in everyday life that those who no longer drive or who have trouble driving, may find it hard to complete or feel a part of their community. In Dickerson's et al. (2013) study, participants expressed difficulties with paying bills, managing medication, shopping for groceries, and being involved in the community because going to the bank, pharmacy, grocery store, and other occupations outside of the home requires transportation, usually driving.

Since driving connects individuals to their outside world, the topic of driving cessation is often a difficult topic even if cessation is temporary due to an injury or illness. For example, after someone has a cerebrovascular accident (CVA), there is a period of driving cessation that should occur until the doctor clears them fit to drive. As people age their ability to drive may come into question due to an in increase in various medical conditions and declining cognitive processing. In fact, fifty percent of older adults have at least 2 chronic health conditions and forty percent have a physical, cognitive, or sensory impairment (Dellinger, 2012).

Some of the more common visual deficits include glaucoma, cataracts, and low visual acuity which are generally easier to detect and correct with treatments like surgery or prescription glasses. Deficits in visual perception however involve cognition and are therefore more difficult to assess and treat. Common physical limitations include decreased muscle strength, endurance, range of motion, and coordination. In terms of driving, occupational therapists can assist by providing adaptive equipment or education on compensatory techniques to continue driving. For example, increasing the sensitivity of the steering wheel for those with decreased strength or range of motion that prevents them from being able to turn the wheel far enough, is a compensatory strategy that allows the driver to continue driving safely with their limitation (D'Ambrosio, Coughlin, Pratt, & Mohyde, 2012).

When driving cessation occurs, whether permanently or temporarily there are other various modes of transportation to fulfill its void, however, many people prefer to return to driving than using other methods like walking or taking a bus. In 2006, Adler and Rottunda examined older adults' perspectives on driving cessation and when asked about public transportation, many participants reported that they rarely use public transportation because it was inconvenient, inadequate, unsafe, and not made for older adults. This perception of present day public modes of transport limits older adults in their ability to partake in the community and decreases their sense of freedom.

The population of adults sixty-five and older is expected to increase by eighty-five percent over the next twenty-five years, not only due to the advanced technology in medicine but also because of the aging of the baby boomer generation. The baby boomer generation differs not only in size but also their increase in mobility, particularly their utilization of driving, which is used to greater a greater extent than in previous generations. Additionally, over sixty-six percent of older adults live outside of a main city region or rural area where the community is spaced over a greater amount of land, creating the requirement of driving in order to commute in a timely manner (Administration on Aging, 2013; D'Ambrosio, Coughlin, Pratt, & Mohyde, 2012; Dellinger, 2012).

Occupational therapy practitioners can play a role by providing interventions that may help people get back to driving more quickly after an injury and safely keep older drivers on the road longer. Because driving and community mobility is considered a valued occupation (IADL) it falls under the domain of occupational therapists for assessment and treatment (Dickerson, 2014b). Occupational therapists are trained with a foundation to assess the complex components and skills required for driving such as the mental functions (e.g. higher level cognition, attention, and memory) sensory functions, (e.g. visual, auditory, and vestibular functions) motor skills, (e.g. manipulation, coordination, reaching, and grip) and processing skills (e.g. attends, sequencing, and choosing) (American Occupational Therapy Association, 2014; Womack, & Silverstein, 2012). With this foundation and additional training, occupational therapy practitioners are recognized as ideal professionals to assess driving skills (American Geriatrics Society & Pomidor, Ed., 2016). Some occupational therapists work with driver rehabilitation specialists or gain expertise themselves. "A certified driver rehabilitation specialist is a trained professional who can assess a person's fit to drive by evaluating physical function, vision, perception, attention, motor function, reaction time, and actual on road driving performance" (Association for Driver Rehabilitation Specialists, n.d.).

This collaboration or specialized training allows occupational therapists to assess and construct custom intervention plans that may help drivers lead a more independent life by keeping them on the road longer. However, in order to provide optimal care, occupational therapists need reliable and valid assessment tools to separate and address the components of driving. Due to the complexity of driving there is little evidence of one tool that can assess all of the varying components (Dickerson, 2014b). Therefore, over the years a number of assessment tools have been designed and used collectively to assess driving abilities. The Vision Coach (Vision Coach, 2012a) was recently developed to provide occupational therapists and other professionals another means to assess and offer treatment for clients. The Vision Coach is an interactive light board "designed by an optometric vision therapist to promote and enhance visual function, muscular coordination, and neuromotor abilities" (Vision Coach, 2012a). An optometric vision therapist is a professional "trained to provide a therapy program based on the results of an eye examination and standardized testing to develop, rehabilitate, and enhance visual skills and processing. Specialized instruments and computer programs are an integral part of vision therapy" (American Optometric Association, n.d.).

Furthermore, with the signing of the Improving Medicare Post-Acute Care Transformation Act (IMPACT Act) in September of 2014, there is increased demand on clinical therapists to use standardized assessment tools. "The IMPACT Act requires the development and reporting of measures pertaining to resource use, hospitalization, and discharge to the community" (Centers for Medicare and Medicaid Services (CMS), 2015). This includes the measurement of changes in functional status and cognitive functioning (CMS, 2015), areas assessed by occupational therapists.

Therefore, it is ever more imperative that occupational therapists have access to tools that can provide them with standardized measures, especially occupational therapists involved in driving due to the intricate matrix of overlapping skills required to drive. Occupational therapy practitioners and driver rehabilitation specialists in particular require valid and reliable tools that can truly assess their client's abilities, before they take the risk of performing an on-road evaluation and possibly placing themselves and other in possible danger.

Due to the design and capabilities of the Vision Coach it may prove to be a useful assessment and training tool for therapists; in fact, it is already being used in driving rehabilitation (Vision Coach, 2012c). However, because of the novelty of the Vision Coach, additional data and research are required to further support and enhance its effectiveness.

Chapter 2: Review of Literature

Various tools have been used to assess the skills required in driving. This literature review covers some of those skills as well as some of the tools used to assess and treat them; in particular, tools that address reaction time. Research covers a wide range on effects of body positioning and body mechanics, however the literature review focuses on the effect of body positioning related to reaction time. Additionally, the literature review discusses research conducted on comparable tools to the Vision Coach and their ability to assess and treat skills associated with driving.

Skills Associated with Driving

Physical function, vision, perception, attention, motor function, and reaction time are common abilities tested before actual on-road driving (Association for Driver Rehabilitation Specialists, n.d.). These are a small selection of the many required abilities involved with in driving. The skills occupational therapists focus on for driving are termed client factors comprised of a number of functions including mental, processing, and motor skills.

The term psychomotor an umbrella term used when, referring to the psychological processes associated with muscular movement and to the production of voluntary movements (American Geriatrics Society & Pomidor, Ed., 2016). Psychomotor skills incorporate the commonly tested functions listed above and include fine motor skills for tasks that require precision, manual skills that often involve manipulation, repetitive movements, or hand-eye coordination, and gross motor skills that require large body or muscle movements (Oermann, 1990).

Not only does driving require the physical and visual abilities to be able to operate the vehicle while taking in your surroundings but also cognitive processing. For example, some of the executive functioning skills needed are impulse and emotional control, planning and prioritizing, memory, visual perception, scanning, attention, and visual motor coordination (Classen, Dickerson, & Justiss, 2012; Dickerson, 2013; McCalla, n.d.). One relies on their executive functioning to communicate to other areas of the brain to organize and prioritize information quickly to determine the best action (Bhandan, 2015). As a driver, one must make decisions and react quickly, for instance visually perceiving one's surroundings on the high way when a large semi-truck begins entering your lane while assessing one's options like possibly switching lanes, slowing down, or honking horn, then deciding which reaction is best. This is simply one example of how quickly one must act and how limitations or impairments increase the chances of causing an accident versus staying safe while on the road (Van Zomeren, Brouwer, & Minderhoud, 1987).

Impairments in functional abilities may be reflective of deficits in cognitive processing abilities, vision, or the motor function (American Geriatrics Society & Pomidor, Ed., 2016). People born with mental impairments or who sustain an injury causing deficits are greatly impacted and can have difficulty in performing everyday tasks such as buttoning your shirt, writing, catching a ball, and driving a car. Typically, deficits in executive functioning appear in slower processing speeds and memory which may lead to difficulty remembering where you parked the car, failing to stop, driving too fast or too slow, misjudging the time or distance, and difficulty yielding or staying in the correct lane, and difficulty altering routes or wayfinding due to construction or traffic (Dickerson, 2014a). Due to the interdependent skills required for driving, decline in fundamental skills can lead to multiple areas of difficulty and ultimately making the driver unsafe (American Geriatrics Society & Pomidor, Ed., 2016).

Two commonly assessed functions are visual reaction times and attention; which are used to measure cognitive processing skills and speed (Barbarotto, Laiacona, Frosio, Vecchio, Farinato, & Capitani, 1998). Attention is the ability to concentrate on selected focal points while suppressing irrelevant or unwanted distractions (Barbarotto et al., 1998). People with attention deficits perform more slowly when there is an increase in the number of distractors or an increase in the number of response choices (Barbarotto et al., 1998). Because driving requires continuous attention and quick reaction times, people with attention deficits or other cognitive impairments may find driving difficult and create potentially dangerous situations for other road users.

Training and Assessment Tools

In 1985, Kewman, Seigerman, Kintner, and Chu designed a program for individuals with brain injuries to test the generalizability of training specific functional abilities (psychomotor skills) required for the complex occupation of driving. Kewman et al. (1985) sought to train specific psychomotor skills such as visuomotor and attentional skills that simulated different aspects of driving. They used a control group of participants who sustained a brain injury but did not receive training and an experimental group who also had brain injuries that did receive training. The training program consisted of eight two hour driving sessions which incorporated seven courses using a modified wheelchair (e.g., a straight-a-way, an S curve, a figure eight, a serpentine, a serpentine with visual monitoring, a serpentine with auditory monitoring, and a serpentine with both the visual and auditory monitoring tasks).

The visual monitoring task required subjects to verbally identify four signs placed along the serpentine curve whereas the auditory task required subjects to listen to a tape recording of numbers with one word occurring every two seconds. When they heard a word instead of a digit they signaled to the experimenter. Both groups were evaluated for on-road driving pre and post to the training program. Kewman et al. (1985) found that the experimental group improved on the specific tasks and the on-road driving test whereas the control group's performances for the on-road driving test did not improve. These findings suggest the effectiveness in therapeutic training of functional abilities and specifically to one's ability to attend and to react.

Although the Kewman et al. (1985) study provides good evidence of the ability for a program to re-train psychomotor skills, the program design itself would be difficult for other therapists to copy and therefore may not be a realistic intervention in practice. Furthermore, it may be too complex for other individuals who require an intensive treatment focusing on a specific skill. Tasks like driving require one to possess the cognitive processing skills needed to perceive and interpret one's environment (visual perception), plan a course of action, and then possess the motor abilities to react (visual-motor or psychomotor). While occupational therapists are trained in activity analysis which allows them to cognitively breakdown the interdependent parts of an activity, isolating specific client factors or skills that may be the cause of difficulty when completing a task in interventions is more difficult.

In 1979, Michon developed a tiered system of 3 levels of risk and 3 levels of task performance; now more commonly known as Michon's hierarchy of driving behaviors (Van Zomeren, Brouwer, & Minderhoud, 1987). The hierarchy is comprised of three levels of control and its associated skills: 1.) Strategic Level, 2.) Tactical Level, and 3.) Operational Level. The top level called the strategic level involves the decisions made before driving occurs (e.g. which roads to take and if it is smart or safe to drive in a certain weather condition) and requires executive functioning skills (Transportation Research Board, 2016). The second level is called the tactical level which includes behaviors and risk-related decision making, for example, deciding whether to pass a car or what time of day one should turn on their headlights. This level requires adequate visual perception, scanning, attention, and visual-motor coordination. The third level, named the operational level, is related to the human-machine interaction in order to use the brakes, turn the steering wheel, and change gears (Dickerson, Stressel, Justice, & Luther-Krug, 2012).

This breakdown of driving into separate levels is essential because it allows occupational therapists to focus on and treat more specific skills. Once the specific skill or skills have been targeted it is then important to re-assess with a wider lens to ensure all components of driving or the tasks are being addressed as needed. However, this is a difficult balancing act requiring one to be able to analyze the details while still seeing the whole picture. Van Zomeren et al. (1987) argued that conventional tasks used in driving rehabilitation do not address the underlying multisensory task performance; that is the tasks are not specifically and simultaneously addressing or improving the component-based coordination of visual, auditory, tactile, and cognitive.

There have been more recent programs and devices that attempt to correct deficits on the tactile and operational level while still providing multisensory feedback; particularly devices designed to rehabilitate vision and deficits in visual perception. In 2007, Schmielau & Wong Jr. tested the effect of the Lubeck Reaction Perimeter (LRP) with twenty hemianopic patients to restore the lost visual field (VF). Participants responded by pushing a button whenever they perceived the stimulus of an illuminated LED light. The stimulus began in the intact visual field, moving into the anopic VF area, with a auditory feedback to signal no or delayed response in order to capture and increase the participant's attention (Schmielau & Wong Jr., 2007). Eye movements were monitored with a video camera to track movements into the anopic visual field.

Schmielau and Wong Jr. (2007) found that 17 out of 20 patients had a significant increase of the visual field size and statistically improved their rate of detection in the defective visual field.

DynaVision Research

In an effort to improve visual processing, a device - DynaVision (DynaVision, 2016) was designed to target vision and visual reaction times. The DynaVision was created by a team of ophthalmologists and sports trainers to be used as a dynamic assessment and training tool for a variety of patients including athletes and those who sustained a brain injury (Anderson, Cross, Wynthein, Schmidt, & Grutz, 2011). DynaVision is a large white board with illuminated buttons that are pressed to determine reaction times.

In 1995, Klavora, Gaskovaski, and Forsyth studied the test-retest reliability of three major DynaVision tasks: the *Simple Task*, *Moderate Task* and *Complex Task*. The *Simple Task* is self-paced and the buttons remain lit until pressed whereas the *Moderate Task* is apparatus-paced and the buttons' light is extinguished after one second no matter if it is pressed or not. The *Complex Task* similar to the *Moderate Task* also is apparatus-paced but the light only stays on for half a second no matter if it is pressed or not. Participants were tested five times over the course of two weeks on each task; with a practice trial before each task test. At the end of eight weeks Klavora et al. (1995) found high reliability among all three tests.

In an additional study, Klavora, Gaskovski, Martin, Forsyth, Heslegrave, Young, and Quinn (1995) studied the effects of DynaVision on selected psychomotor skills of individuals after a cerebrovascular accident (CVA). Ten subjects participated in a six week program using the DynaVision three times a week for approximately 20 minutes. Klavora et al. (1995) collected data on nine additional psychomotor skills during a pretest, treatment, posttest, and follow up. The skills recorded included endurance, speed, simple response time, simple visual reaction time, simple movement time, choice response time, choice visual reaction time, choice movement time and anticipation time. The results indicated a significant improvement in all functional abilities except for choice reaction time and anticipation time; supporting the usefulness of DynaVision for improving psychomotor and visual processing abilities.

As an assessment tool, the DynaVision was compared to other psychomotor tests to determine concurrent validity through correlations. Vesia, Esposito, Prime, and Klavora (2008) examined the three DynaVision tasks against 1) simple response time (Vesia et al., 2008), 2) choice response time (Vesia et al., 2008), 3) Pursuit-Rotor Task (Reilly, & Smith, 1986) the 4) Minnesota Manual Dexterity Test (Surrey, Nelson, Delelio, Mathie-Majors, Omel-Edwards, Shumaker, & Thurber, 2003) and the 5) Ring Replacement task (Klavora et al., 1995). Both the simple and choice response time tests measured the time it took to press a telegraph key when a lightbulb was lit (Vesia et al., 2008). The Pursuit-Rotor Task comprised of a rotating platform with a target ten centimeters from the center. The total time the participant was able to hold a stylus on the target was measured. The total time was recorded for two platform rotation rates, 30 rotations per minute and 60 rotations per minute (Vesia et al., 2008). The Minnesota Manual Dexterity Test followed standard instructions for the placing and turning tests. The placing test comprised of moving 60 cylindrical blocks from the bottom board to the top board, grabbing bottom cylinders and placing them up top moving from right to left. The turning test comprised of picking up and turning over a cylinder with one hand then placing it back on its spot with the opposite hand until all blocks are flipped (Vesia et al., 2008). The Ring Replacement task involved moving 20 rings 30 centimeters from a set of five pegs on the opposite side of the screen. Time was measured by the total amount of time it took to move all the rings (Vesia et al., 2008). All participants were given a pretest to learn how to perform each task before testing;

with the task order randomized for each participant at the time of testing. Vesia et al. (2008) found that the DynaVision was significantly correlated with the other six psychomotor tests supporting the effectiveness of DynaVision in assessing components of psychomotor skills.

Additional studies designed to examine DynaVision and its influence as an intervention tool for patients with cerebrovascular accidents (CVA) were conducted by Klavora, Gaskovski, Heslegrave, Quinn, and Young in 1995 and by Anderson, Cross, Wynthein, Schmidt, and Grutz in 2011. The study by Klavora, Gaskovski, Heslegrave, Quinn, and Young (1995) was completed as a case study collecting data on a 71 year old man who had suffered a CVA twelve months before. The subject participated in 16 session treatments using the DynaVision over the course of four weeks (Klavora et al., 1995). To address impairments in his left arm and leg as well as in the left peripheral field including inattention and difficulties in scanning the left visual field smoothly (Klavora et al., 1995). Data from the DynaVision was compiled before and after training along with information on simple response time, choice response time, visual scanning, Pursuit-Rotor and Ring Replacement. At the end of the intervention, the participant improved his times on each task suggesting the effectiveness of DynaVision training on enhancing visuomotor response times, visual attention, and eye scanning capabilities. Also, in interviews held before, during and after the study the participant reported an overall improvement in motor flexibility, energy and attention due to his increase in performance capabilities on everyday activities at home (Klavora et al., 1995).

Another intensive case study was conducted by Anderson et al. (2011) who recorded quantitative data using the DynaVision on bimanual dexterity, standing activity tolerance, reaction time, upper extremity range of motion and unilateral inattention of a 67 year old female who suffered a right hemispheric CVA. Subjective or qualitative data was also gathered from the participant and her husband using guided interviews. Although Anderson et al. (2011) found no significant advances; the subject did make physical improvements according to the quantitative data that was collected overtime and at the posttest, including improvements in standing endurance during leisure tasks. The subject reported more confidence and endurance in completing ADL and IADL tasks such as using the bathroom at night, walking around her home, putting on and taking off her bra, decorating her house for different seasons and loading the dishwasher (Anderson et al. 2011). While the subject reported improvements, it is difficult to conclude that the DynaVision treatment was affective or if the patient improved due to natural return of skills over time as the body heals.

Currently, DynaVision is being used by occupational therapists to improve psychomotor and visualmotor skills with the objective of improving one's overall functioning and ability to participate in activities and occupations including driving. Although evidence has supported the validity and reliability of the DynaVision and suggests it might be used as an assessment and intervention tool, one major drawback of this device is its fixed buttons. The DynaVision illuminates buttons in random sequences but individuals using it can be aware of the possible locations in which the light will appear because the buttons are visible and stationary. Past research on visual searching provides evidence that having a prior knowledge of target locations decreases detection rate and therefore may affect performance (Geng & Behrmann, 2005). Therefore this knowledge could provide an advantage to the subject and affect their performance on DynaVision tasks.

Vision Coach Research

The Vision Coach (Vision Coach, 2012a) is a flat, black touch screen board mounted to a wall or stand. The buttons are hidden and appear randomly anywhere on the board, as a result, participants have no prior knowledge of the possible target locations in which a light might appear. The Vision Coach was produced as an evaluation and intervention tool to assess and enhance psychomotor skills (Xi et al., 2014). Some of the skills that can be evaluated using the Vision Coach are vision, eyesight, tracking, dynamic visual acuity, central-peripheral integration, eye-hand-body coordination and visual reaction time (Donely, 2012). It is currently being used in rehabilitation therapy, vision therapy, sports vision training, driving programs, and tactile training for the police and military (Vision Coach, 2012b).

Since the development of Vision Coach in 2012, only a few studies have examined the device. One study performed by Xi et al. (2014) examined the reliability of the Vision Coach to measure psychomotor skills using the full field task. The full field uses the entire board and can be set to 30, 60, or 120 lights; in this study 120 lights were illuminated. Xi et al. (2014) verified data on the full field 120 task by recording the reaction times of participants, grouped by age and gender, over the course of six trials. Age categories consisted of two groups, younger (age range 18-32 years) and older (age range 50-77 years).

Xi et al. (2014) concluded that the task was found to be reliable for both age groups and genders after the third task due to learning effects in the first two trials. While testing the reliability of the Vision Coach, Xi et al. (2014) also collected normative data that can be used for comparison against other methods or tools and future Vision Coach inquires. Additionally, Xi et al. (2014) also concluded that due to hidden button feature used in the design of the Vision Coach, it may be a more valid tool than DynaVision when measuring on certain tasks.

The Vision Coach also provides choices of two different colors of lights and letters and numbers (Vision Coach, 2012a). The use of red and green lights or letters and numbers in devices like the Vision Coach can be used to increase the cognitive load or total mental processing and cognitive decision making difficulty, depending on how the therapist uses the device (Swick, 2014). Therapists also can add in environmental distractors or situations that make the task harder; for example, having the client sit on a ball versus standing or having a quiet environment versus playing a radio.

Body Positioning

Currently the Vision Coach is already being used in therapy, training, driving programs, and tactile training (Vision Coach, 2012b) despite the DynaVision having a more extension history of literature. Therefore, not only is it essential to further investigate the validity and reliability of Vision Coach in general but also assess the manner in which it is being used in therapy sessions so that clinicians are implementing supported evidence based practices and modifications. A common modification therapists use to grade activities is body positioning. Different positions being used currently with the Vision Coach include the client standing, sitting, sitting on a ball, and hanging upside down (Vision Coach, 2012b). These positions and their effect on performance while using the Vision Coach however have not been supported empirically.

Research that has been conducted on standing versus sitting using other reaction time tasks has resulted in mixed findings. Vuillerme, Forestier, and Noughier (2002) found that subjects performed slower while standing than sitting in a basic reaction time task. Subjects were asked to press a hand held button when they heard an auditory stimulus which occurred at random. Participants' reaction times were longer in the standing position than sitting; this is believed to be due to the attentional demand needed for maintaining an upright posture which increases fatigue and requires a portion of attention (Vuillerme et al., 2002).

Lajoie, Teasdale, Bard, and Fleury (1996) examined subject's reaction times to an auditory stimulus in different positions (sitting, standing with broad support, standing with narrow support, walking double support and walking single support). Similarly, they found that as the base of support was reduced from sitting to standing to walking, subject's reaction times became more delayed. They also found that the elderly age group had a greater delay in reaction time and made more adaptations to their stance like walking slower with a shorter stride length than the young age group; suggesting that aging requires a greater proportion of resources or attention to focus on posture and balance during tasks (Lajoie et al., 1996).

Conversely, Brown, Sleik, and Winder (2002) examined reaction times between subjects who have suffered a stroke and subjects who have not had a stroke and found different results. Participants were asked to verbally signal when they saw a light illuminate and were tested three ways: Sitting, standing with feet together, and standing with feet apart. Brown et al. (2002) found that reaction times were only significantly longer between sitting and standing with feet close together for the subjects who suffered a stroke. These results suggest that body positioning may only significantly impact reaction times of patients who have suffered a stroke. In addition, Brown et al. (2002) discovered that the reaction times of the control group who had no history of a stroke did not change between any of the testing positions. However, upon a closer look, change did occur in the control group but only in the older adults; meaning a potential effect was masked by the variability of ages in the sample. Due to the overall lack in research and incongruent findings, more data needs to be collected on body positions and their effect on reaction times. This insight into positioning can then be used by therapists working with the Vision Coach to customize their interventions, address a variety of deficits, and achieve their client's goals.

Summary

In summary, the potential for the Vision Coach to be an accurate assessment tool of psychomotor and visual processing skills needed for occupational participation and to be an intervention tool that could significantly enhance capabilities required in driving generates a considerable need for further inspection. In addition, the use of modifications in practice settings coupled with the limited data addressing the effects of body positioning on visual reaction times also emphasizes the importance of further research to provide clinicians with evidence on the most effective approaches for treatments.

Therefore, the purpose of this study is to collect normative data on reaction times of healthy adults using the full field 60 Vision Coach task to provide a building block for further studies and standardization of this device. This study specifically tests the possible effects of body positioning on reaction times as to provide clinicians with evidence for the gradation of this task. Our null hypothesis asserts that there will not be a significant difference in visual reaction times for sitting versus standing on the full field 60 single color task.

Chapter 3: Methods

Design

An experimental cross sectional design was used with counterbalance measures and random assignment. Participants completed eight trials on the full field, 60 light task with red lights. This means the Vision Coach displayed 60 lights one at a time, illuminated randomly across the whole board. Participants were randomly assigned to one of two position groups. The “standing” group completed the first half (four) of eight trials while standing and then changed positions to sit for completion of the second half of trials. The “sitting” group completed the first half (four) of eight trials while sitting in a chair and then switched positions to stand to complete the second half of trials. The participants’ reaction times were then grouped by position and trial. Participants’ standing scores were labeled in trials 1-4 and their sitting scores labeled in trials 5-8 for analysis. The visual reaction times are the outcome measure (dependent variable).

Participants

Participants were 121 individuals who volunteered from the local community. Participants’ ages ranged from 21-79 years old. There were 52 participants in the young adult age group (range: 21-45 years) with a median age of 24years (see Table 1 for more data). Sixty participants made up the older adult age group (range: 60-79 years), with a median age of 68 years. All participants were asked to rate their overall health on a five point Likert Scale (i.e., 1 = extremely poor health, 2 = poor health, 3 = moderate health, 4 = good health, and 5 = extremely good health). The health rating scale was used in conjunction with our observations to make sure every participant could physically reach all portions of the board. All participants reported a health rating 3 and above except for one participant with a health rating of 2, whose data was excluded from analysis.

Table 1. *Participant Demographics and Measurements*

Groups	N	Mean Age	SD Age	Mean Height	SD Height	Mean Wingspan	SD Wingspan	Mean Health Rating	SD Health Rating
Young Female	43	25	4.4	65.6	3.1	64.7	3.1	4.1	.5
Young Male	9	25	4.7	71.9	1.7	70.8	3.0	4.3	.7
Older Female	48	68	5.5	64.0	3.8	62.5	4.2	4.1	.6
Older Male	20	68	5.0	70.4	2.7	70.0	3.1	4.3	.6

The older adult participants were recruited from a larger study (See Appendix B) and participated in both studies on the same day. The participants partook in a series of demanding assessments over the course of a two to three hour session with completion of the Vision Coach tasks toward the end of the session. These participants were given frequent rest breaks as needed throughout session and everyone had the option to quit at any time for any reason. Additional information on this larger scaled study can be found in Appendix B.

Researchers gained participant consent through signed consent form approved by the East Carolina University & Medical Center Institutional Review Board. Participants read the form and then signed their consent before beginning Vision Coach trials.

Equipment

The Vision Coach is an interactive light board that subjects use by pressing on illuminated lights with their hand as quickly as possible. The Vision Coach is 50’’ X 34’’ wall mounted board (see Appendix C). It has a counter weight slider that allows for vertical movement to address a range of heights and physical limitations of the subjects or clients. There are 120 lights in the full field test which cannot be seen until illuminated. The light can appear green or red, and as a number or letter (Donley, 2012). For this study, the full field test, with 60 lights, was used with the color red. Each dot or light appears one at a time, randomly across the board, the next light does not illuminate until the current light is pressed. The Vision Coach records and displays the overall reaction time after all 60 lights are pressed.

Procedure

Researchers were trained on data collection, how to use and program the Vision Coach. Demographic data that was recorded included age, gender, height, wingspan, and the participants' self-health rating and any self-reported visual or physical limitations. In order to collect the height and wingspan, participants stood with heels touching a wall with arms held straight out to their sides. Researchers used a wall mounted scale for height and a measuring tape for wingspan. The median height and wingspan for the young adult group were 66 inches in height and 65.4 inches for wingspan. For the older adult group; the median height was 65 inches and the median wingspan was 63.7 inches.

Prior to performance on the Vision Coach, each participant was asked to stand or sit while looking straight ahead at the light board. The researcher adjusted the Vision Coach to their height by using the fixator light on the apparatus. The Vision Coach was moved until the fixator light was level with the participant's eyes as they look directly forward. The participants were asked to move their arms and reach all parts of the board to confirm that they could touch all areas. The fixator light was then turned off, before starting the trials.

The directions of how to perform the task were read to each participant (see Appendix D). The participants were allowed to move any part of their body to complete the task, such as using one or two hands to press the light, or any finger or fingers of their choice. Prior to the trials all participants were asked to confirm their understanding of the task and allowed to ask questions for clarification.

There were a total of eight trials; based on Xi et al.'s (2014) previous study discussed that suggested two practice rounds should be given before the assessment to account for learning that occurs with multiple testing. Eight trials began with the participant either "sitting" or "standing" based on the group the subject was randomly assigned to. Between the trials, participants were given a minimum of a one minute break to drink water, use restroom, and/or rest. The participants' reaction times were recorded by the Vision Coach and were written down on paper after each trial by the researcher (see Appendix E).

Chapter 4: Data Analysis

The main analyses focused on participants' reaction times over the course of 8 trials in different positions (sitting vs. standing) as well as possible learning that occurred with repeated trials. A number of paired t-tests were completed to identify a possible learning curve. The first set of t-tests examined reaction times (RT) in trials 1-8 for the participants who stood for the first four trials then sat for the second four trials. This revealed that repeated practice significantly affected the difference between the first two trials in the standing position with a p value of .001 (see Table 2). The second set of paired t-tests examined RT differences between 8 trials for the participants who sat for the first four trials then changed position and stood for the last four trials. This revealed continued improvement in reaction time speed between trials with many being statistically significant differences (see Table 2). Due to these findings and larger mean values for the first two trials, reaction times from trials 1 and 2 in both sitting and standing were excluded. Although other trials were kept for analysis it is important to note the reaction time patterns occurring with practice and how they differ between the positional order the trials were completed in which are depicted in *Figure 1* (also see Table 2).

After the first two trials were excluded from the eight trials, an average reaction time was calculated for each position in standing and sitting. The average sitting reaction times were then subtracted from the average standing reaction times to calculate the average difference for each person. The averaged reaction times in standing and sitting were analyzed with a one sample t-test to examine the difference between the two positions. *Figure 2* depicts the boxplot of the differences and Table 3 illustrates the mean, median, and interquartile range (IQR) for each position. The t-test revealed a p value of .631 with a 95% confidence interval for the mean difference of -.62 to .38 (see Table 4).

Table 2. *Results of Paired T-tests on Learning Effect*

Position Order	Trial Numbers	Mean	95% CI of Difference Lower	95% CI of Difference Upper	Sig.
Standing then Sitting	Trial 1-2	5.69	4.19	7.19	.001***
	Trial 2-3	1.91	1.0	2.81	.001***
	Trial 3-4	.34	-.55	1.23	.443
	Trial 4-5	.08	-.83	.98	.864
	Trial 5-6	.20	-.49	.90	.561
	Trial 6-7	.64	-.09	1.37	.085
	Trial 7-8	.77	.08	1.45	.029*
Sitting then Standing	Trial 1-2	4.48	3.14	5.83	.001***
	Trial 2-3	1.11	.26	1.95	.011*
	Trial 3-4	1.14	.37	1.92	.005**
	Trial 4-5	-.52	-1.32	.28	.200
	Trial 5-6	.95	.09	1.80	.031*
	Trial 6-7	.52	-.33	1.36	.226
	Trial 7-8	1.13	.47	1.79	.001***
Note = *p = .05, **p = .01, ***p = .001					

Table 3. *Number Summary for Box Plot of Average RT Difference*

	Average RT Difference
N	120
Minimum	-5.50
Q1	-1.938
Median	-.250
Q3	1.438
Maximum	10.25
IQR	3.376
Mean	-.121
Std. Deviation	2.750

Table 4. *Difference Between Average Standing and Average Sitting Reaction Times*

	Mean	Std. Deviation	t	Sig. (2-tailed)	95% Confidence Interval Lower	95% Confidence Interval Upper
Difference	-.1208	2.7503	-.481	.631	-.6180	.3763

The self-reported health ratings were analyzed to determine if it is related to the difference in the averaged reaction times of standing and sitting. Out of all of our participants, one reported poor health (2), while the rest were spread between moderate (3), good (4), and extremely good (5) ratings. Therefore, the data from the person who rated themselves as being in poor health was excluded and a side by side box plot was used to visualize reaction times based on the remaining self-reported health ratings (see *Figure 3*). Table 5 illustrates the mean, median, and interquartile range (IQR) under each health rating.

Table 5. *Number Summary for Box Plot of RT Difference by Health Rating*

	Moderate Health (3)	Good Health (4)	Excellent Health (5)
N	12	74	32
Minimum	-4.75	-4.75	-5.50
Q1	-2.938	-1.50	-2.875
Median	-1.25	.125	-1.125
Q3	1.688	1.75	.438
Maximum	6.50	8.00	10.25
IQR	4.625	3.25	3.3125
Mean	-.375	.186	-.875
Std. Deviation	3.274	2.375	3.043

The possible effect of gender on the difference of the averaged standing and sitting reaction times was visualized with another side by side box plot (see *Figure 4*). The median, mean, and IQR are represented in Table 6. A two sample t-test was then used to further analyze the factor of gender on the difference of averaged reaction times. The resulting significance value or p value of .701, suggested no statistically significant difference (see Table 7).

Table 6. *Number Summary for Box Plot of RT Difference by Gender*

	Male	Female
N	29	91
Minimum	-5.50	-5.00
Q1	-2.125	-2.00
Median	-.250	-.250
Q3	2.250	1.250
Maximum	7.00	10.25
IQR	4.375	3.25
Mean	.0603	-.1786
Std. Deviation	2.961	2.694

Table 7. *Results of Two Sample T-test on RT Difference by Gender*

		Sig. (2-tailed)	95% Cl of the Difference
Averaged RT Difference	Equal variances assumed	.686	-.927 - 1.404
	Equal variances not assumed	.701	-1.007- 1.485

The participants' ages were then categorized into two groups; young adult (ages 21-45) and older adult (ages 60-79). The difference between the average standing and sitting reaction times were visualized using a side by side box plot to examine the difference between positions with the factor of age (see *Figure 5*). Table 8 depicts the number summaries, median, mean, SD, and IQR of both age groups. Two outliers were found in the older adult age group. After comparison of the box plot and number summaries, another two sample t-test was then used, resulting in a p value of .988 (see Table 9).

Table 8. *Number Summary for Box Plot of RT Difference by Age Group*

	Young Adult	Older Adult
N	52	68
Minimum	- 4.75	- 5.50
Q1	-1.50	-2.375
Median	.0000	-.250
Q3	1.250	1.750
Maximum	3.50	10.25
IQR	2.75	4.125
Mean	-.1202	-.1213
Std. Deviation	1.839	3.295

Table 9. *Results of Two Sample T-test on RT Difference by Age Group*

		Sig. (2-tailed)	95% Cl of the Difference
Averaged RT Difference	Equal variances assumed	.998	-1.006 - 1.009
	Equal variances not assumed	.988	-.939 - .941

Scatterplots were used to visualize the factor of height (see *Figure 6*) and wingspan (see *Figure 7*) on the difference between averaged reaction times. Based on these visual representations of the data, it was concluded that further testing was unnecessary.

Chapter 5: Discussion

The specific research question asked - is there a difference in reaction times whether the individual is in standing or sitting when using an interactive light display for assessment or intervention (i.e. Vision Coach). In analyzing the effect of positioning results did not support that the positions of sitting versus standing played a significant role in one's reaction time. Thus, we failed to reject the null hypothesis, there was no difference. Therefore, changing the position of a client may not be an adequate method of upgrading or downgrading the difficulty of the task.

However, since this study consisted of only healthy adults, body position may impact difficulty for those with medical conditions or who have balance, endurance, or strength issues. These findings are congruent with Brown's et al. (2002) study who found that body positioning may only significantly impact reaction times of patients who have suffered a CVA versus Vuillerme's et al. (2002) and Lajoie's et al. (1996) findings that supported significantly slower reaction times in the position of standing. Accordingly, these results do provide the basis of normative data on body position from which practitioners can make more knowledgeable decisions about assessment and intervention. For example, if a client does show variations between standing and sitting, it may indicate there are psychomotor or visual processing delays.

Past research has found that as age increases the amount of time needed to react also increases. Xi et al. (2014) and Lajoie et al. (1996) found a significant increase in reaction time as age also increased. Although our findings do not support this, we did not focus on age and reaction times but rather the factor of age and the difference between reaction times in sitting and standing. Therefore, based on the findings, age does not have a significant effect on reaction time difference in these two particular positions. This means that changing positions from sitting to standing or vice versa will not have a significant effect on reaction times for older adults.

Additionally, analyses also did not support that height, wingspan, or gender played a significant role in one's reaction time. Again, our findings a focused on the averaged reaction time difference between the two positions unlike Xi's et al. (2014) study that focused on simple reaction time. Although Xi et al. (2014) found that gender significantly affected visual reaction times we did not find evidence to support this when comparing the averaged difference.

In analyzing the effect of learning, we anticipated significant effects between the first trial and possibly the second in comparison to the others based on the Xi et al. (2014) study. This expectation was based on the knowledge that as with many tasks, especially novel activities, practice can affect how well one performs, so some differences in reaction times were expected between the trials as the participants became used to the light board. Surprisingly, results suggest continued learning beyond the second trial. This differs from Xi et al. (2014) study, who only found a learning effect in the first two trials when completing the full field 120 light task compared to our full field 60 light task. This difference may be due to the reduction of lights from 120 to 60 or change in position, however further research will be required before this conclusion can be made.

Future Research

As a result of the comparable and conflicting findings between our study and the research conducted by Xi et al. (2002) and Vuillerme et al. (2002), it is evident that further research will be required on the effects of positioning, gender, and age. Additional research will also be needed to determine how many trials are necessary on each numbered light task before learning is no longer significantly affecting reaction times or before fatigue becomes a factor causing reaction times to slow.

Further investigation will lead to larger amounts of normative data that can then be used by researchers and clinicians to more accurately collect and categorize baseline criteria in the process of standardizing the Vision Coach. Additionally, due to the homogenous sample of healthy adults future research will be needed with a more diverse sample to determine if people who rate themselves with poorer health do perform significantly slower than those rated with good health. This can be used in combination with body positioning to further support or reject a possible significant effect of position on those who have a mental or physical limitation versus healthy participants.

Furthermore, comparison of additional study of Vision Coach tasks will be useful to explore relationships between Vision Coach and other assessments. For example, reaction times for this study were reported based on the total time required to hit 60 lights, this task can be changed to report how many lights can be hit in 60 seconds in order to better compare literature on the Dynavision apparatus to Vision Coach. Other tasks on the Vision Coach like divided attention and tracking can be used in comparison to other assessments to better determine the validity and effectiveness of Vision Coach.

Limitations

As with all studies, the source of volunteers can be an issue, though, in this study it is not likely to create a significant difference as education is not likely a factor. However, many of the younger volunteers were females, and therefore our findings may not be representative of a larger population. Additionally, since the health ratings were self-reported, it is possible we may have inaccurate data on the true health status of a participant. Unreported, poor physical or mental health could have affected visual reaction times.

Another limitation that could impact our findings was learning effect. Based on the analysis and findings between all eight trials, the first two trials in both positions were excluded in order to control for a limitation of learning. The first two trials were chosen because their difference in average reaction time was greater. However, all data from all trials, from this study will serve as relevant information in regards to future testing and designing standardized instructions for the Vision Coach.

Finally, our study was composed of eight trials that occurred in conjunction to another study for the older adult group. Participants may have felt fatigued throughout the trials which could have affected their overall performance. In order to minimize the possible influence of fatigue we gave a minimum of a one minute break between each trial and asked the participants if they are ready before beginning the next trial and allowed for longer breaks when needed.

Application to Occupational Therapy Practice

In the future, the standardization of the Vision Coach will be beneficial for occupational therapy practitioners due to the expectation to use standardized assessments (Centers of Medicare and Medicaid Services, 2015). Use of a standardized assessment is a way to incorporate evidenced based research and data to support a clinician's rationale in testing and intervention. These findings will add value to future research as well as provide information that can be built upon to standardize the rules of administration for the 60 light task and normative data that can be used with supplementary information to construct a standardized comparison group.

In practice, it is important for therapists to have access to a variety of tools so they can best plan and implement interventions that are client centered. The development of the Vision Coach has provided a way to objectively collect quantitative data that therapists can use to assess their client's abilities and plan appropriate treatments. This study will add valuable information to future studies exploring the potential of Vision Coach in the treatment of psychomotor skills in the general practice as well as driving rehabilitation.

One of the virtues of tools like the Vision Coach is the ability to start by using an easy task (i.e., one color, reduced field, one task) and building up to the more complex visual motor planning (i.e., full field, two colors, reading letters and/or numbers). As such, this can be used as an assessment or intervention tool for clients with medical conditions with visual processing issues (e.g., stroke, brain injury), critical processes needed for driving. These research results provide a healthy sample baseline therapists can use for comparison when assessing their clients' attention and visual reaction times. These psychomotor skills reflect one's cognitive processing capabilities and speed that are necessary for driving.

Summary

In conclusion, the mean difference in reaction times between sitting and standing was not statistically significant, however based on the 95% confidence interval for the mean difference -.62 to .38, the difference may or may not be clinically significant. The effects of age, gender, wingspan, and height on this mean difference were also not statistically significant. Although there was a difference between age groups (Register, 2016), there was no age affect in the differences between the positions of sitting and standing (young and old showed the same degree of change). Further research is necessary to explore the minimum number of trials required before learning no longer affects reaction times and maximum number of trials before fatigue affects reaction times on this specific Vision Coach 60 light task. The collection of normative data can be used by clinician's as a comparison group in the treatment of attention and visual reaction time, until the Vision Coach is standardized and visual reaction times are compiled and a "typical" baseline criteria or comparison group is developed.

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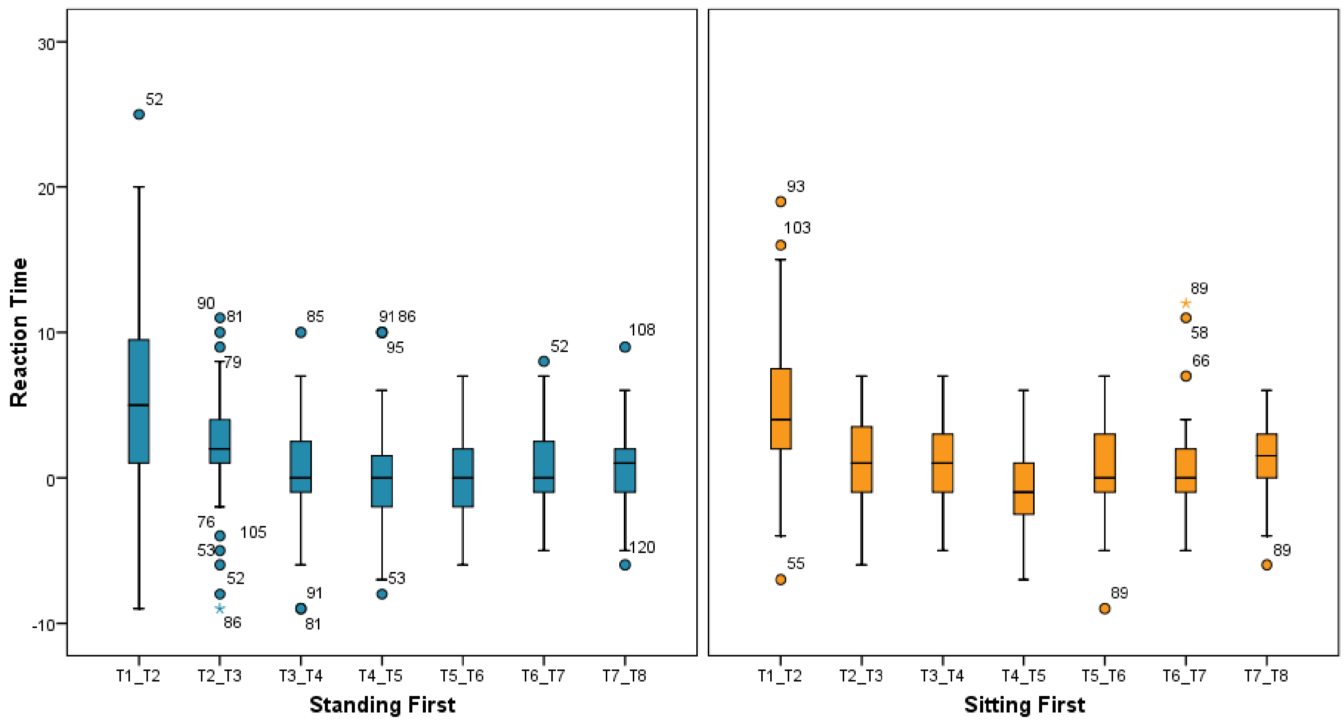

Figure 1. Side by side box plot depicting the difference between reaction times per trial in standing and sitting.

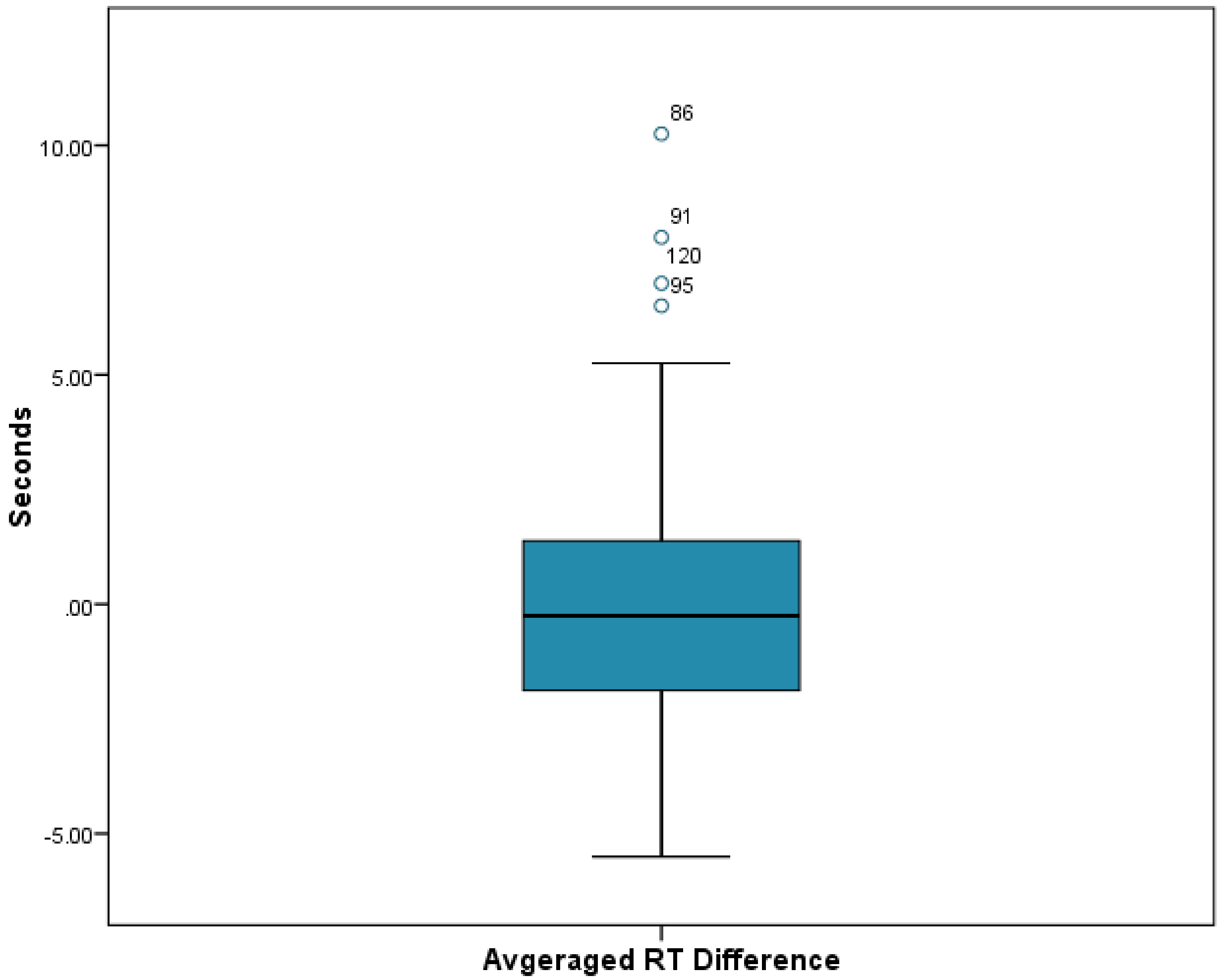

Figure 2. Box plot illustrating the difference of averaged reaction times between the positions of standing and sitting.

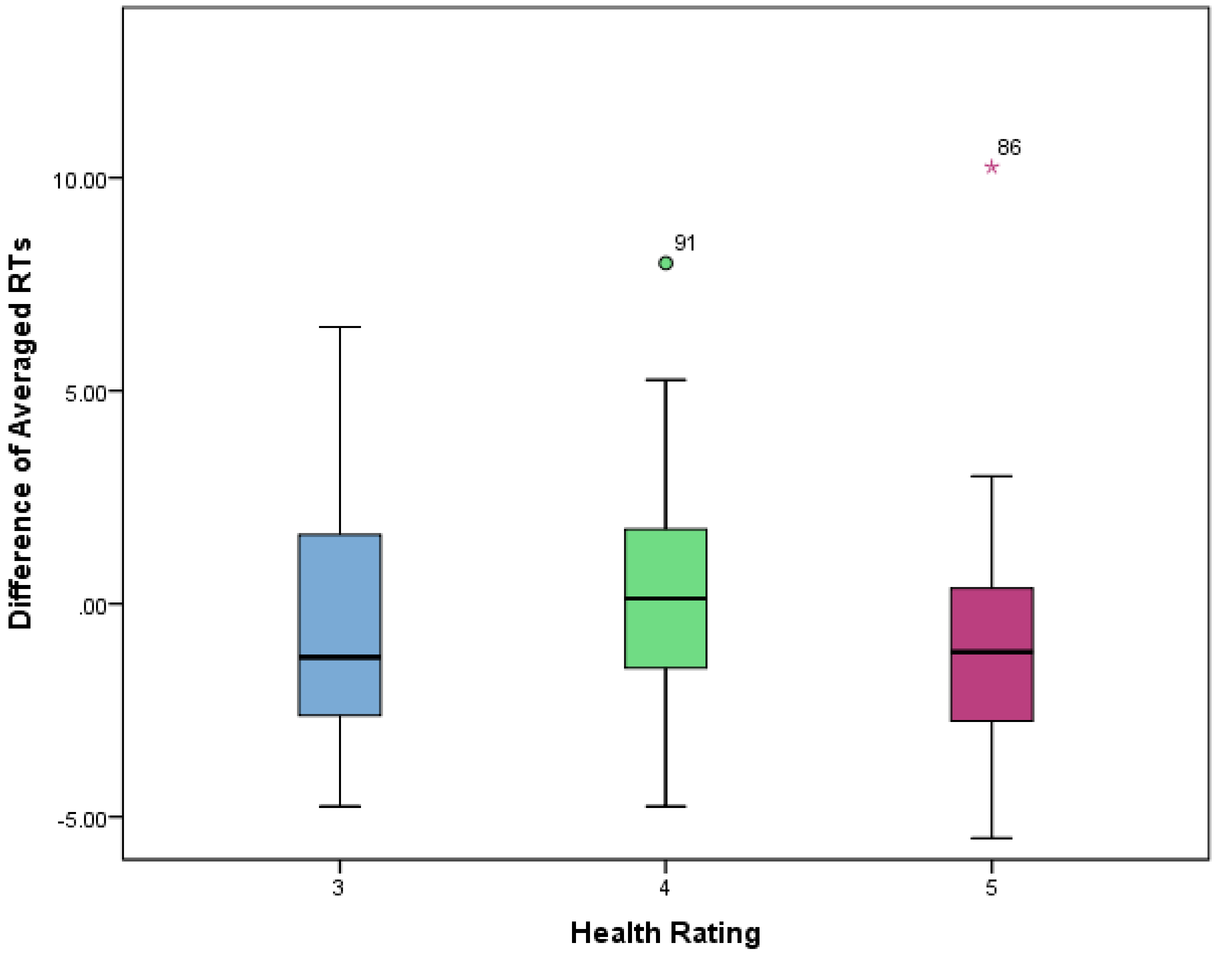

Figure 3. Side by side box plot depicting the difference between averaged standing and sitting reaction times by self-reported health ratings (3 = Moderate Health, 4 = Good Health, 5 = Excellent Health).

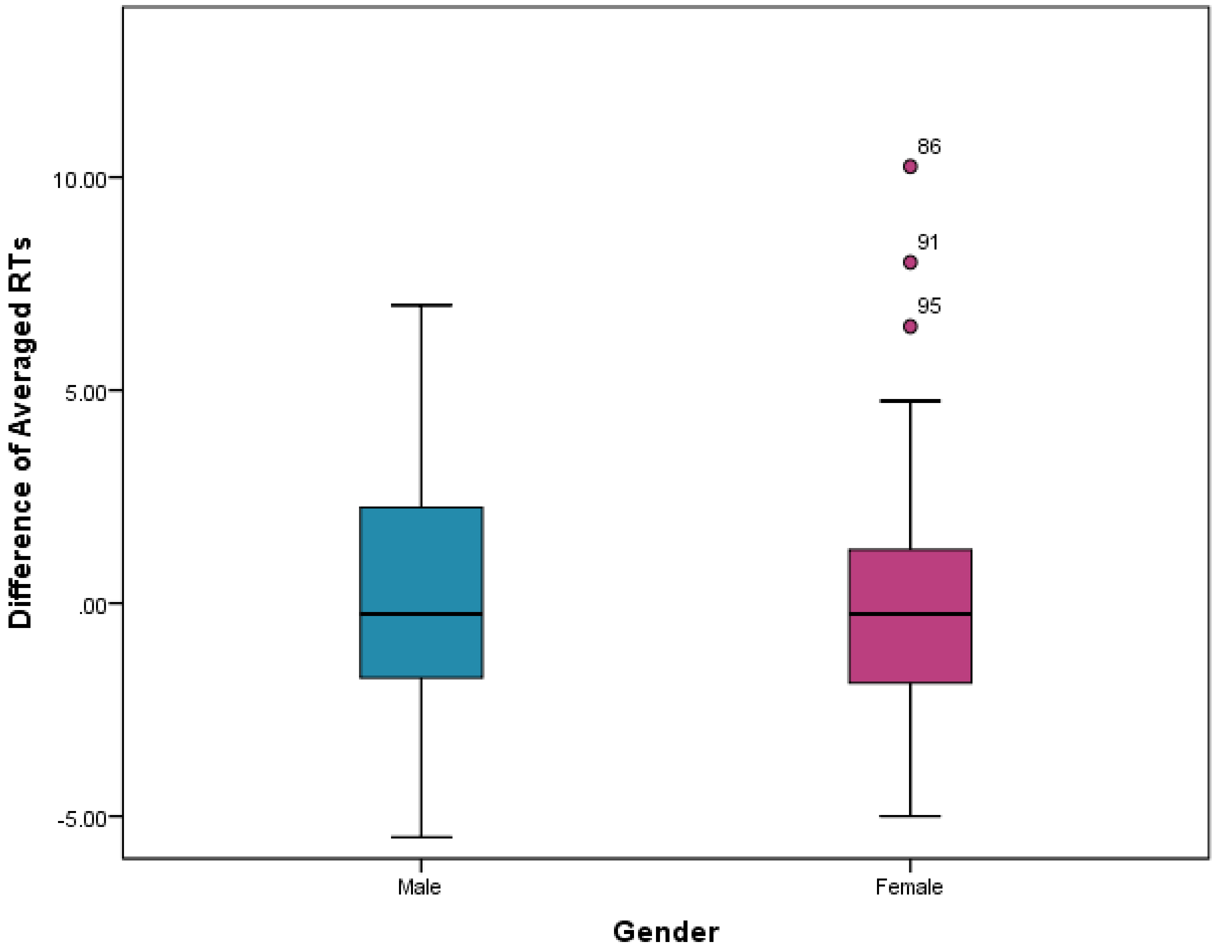

Figure 4. Side by side box plot representing the difference of averaged standing and sitting reaction times by gender.

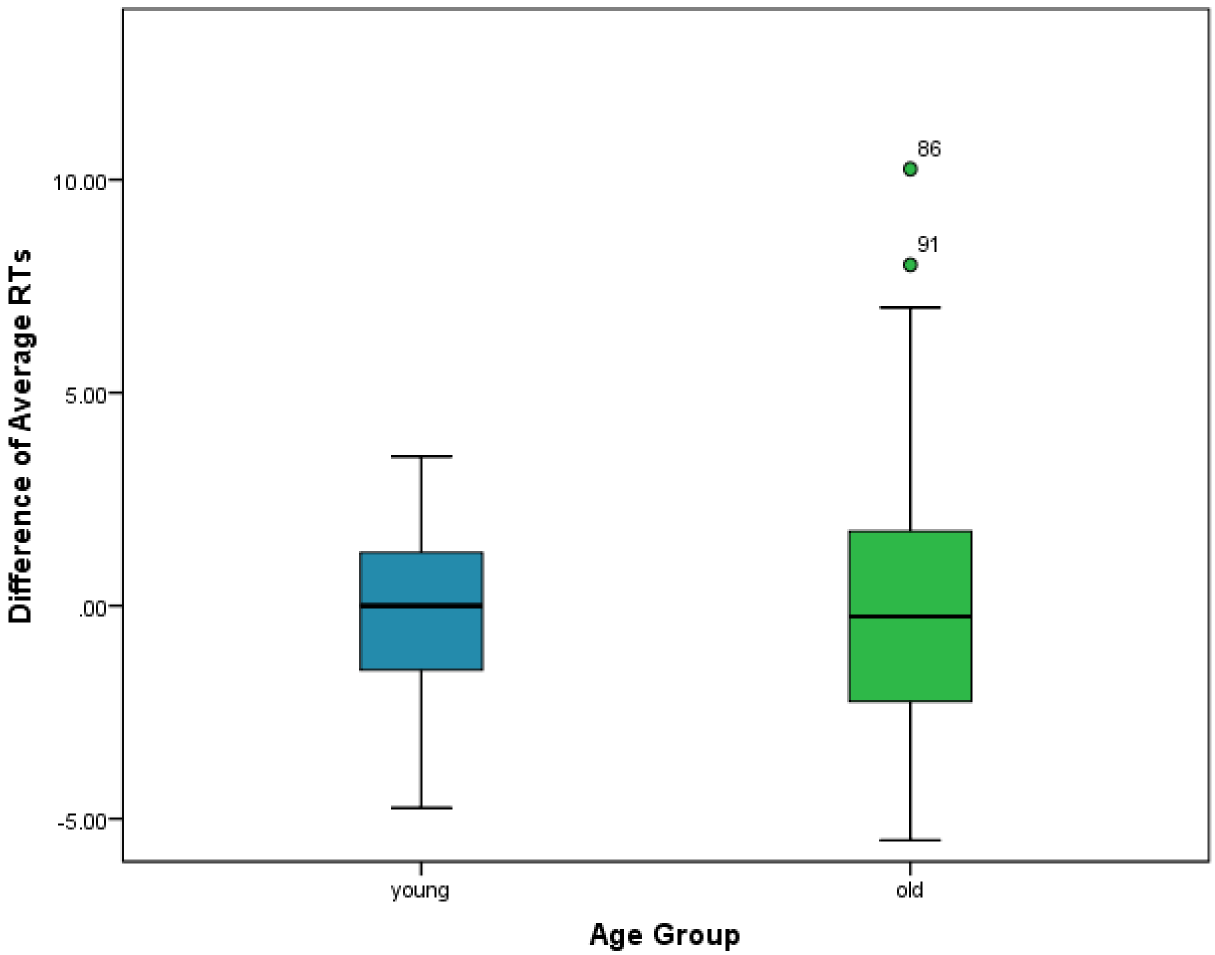

Figure 5. Side by side box plot representing the difference of averaged standing and sitting reaction times by age group.

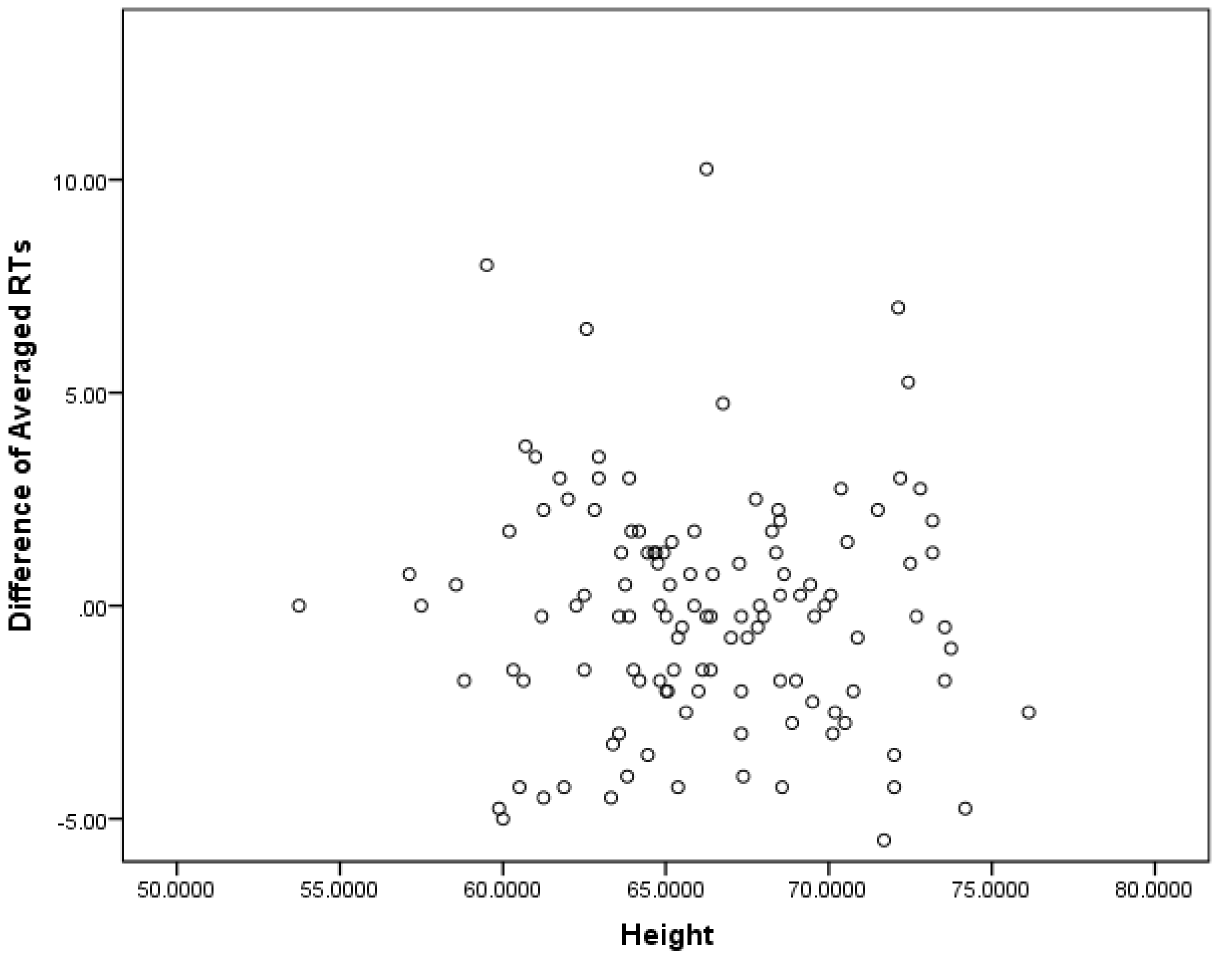

Figure 6. Scatterplot illustrating the difference of averaged standing and sitting reaction times by participants' height.

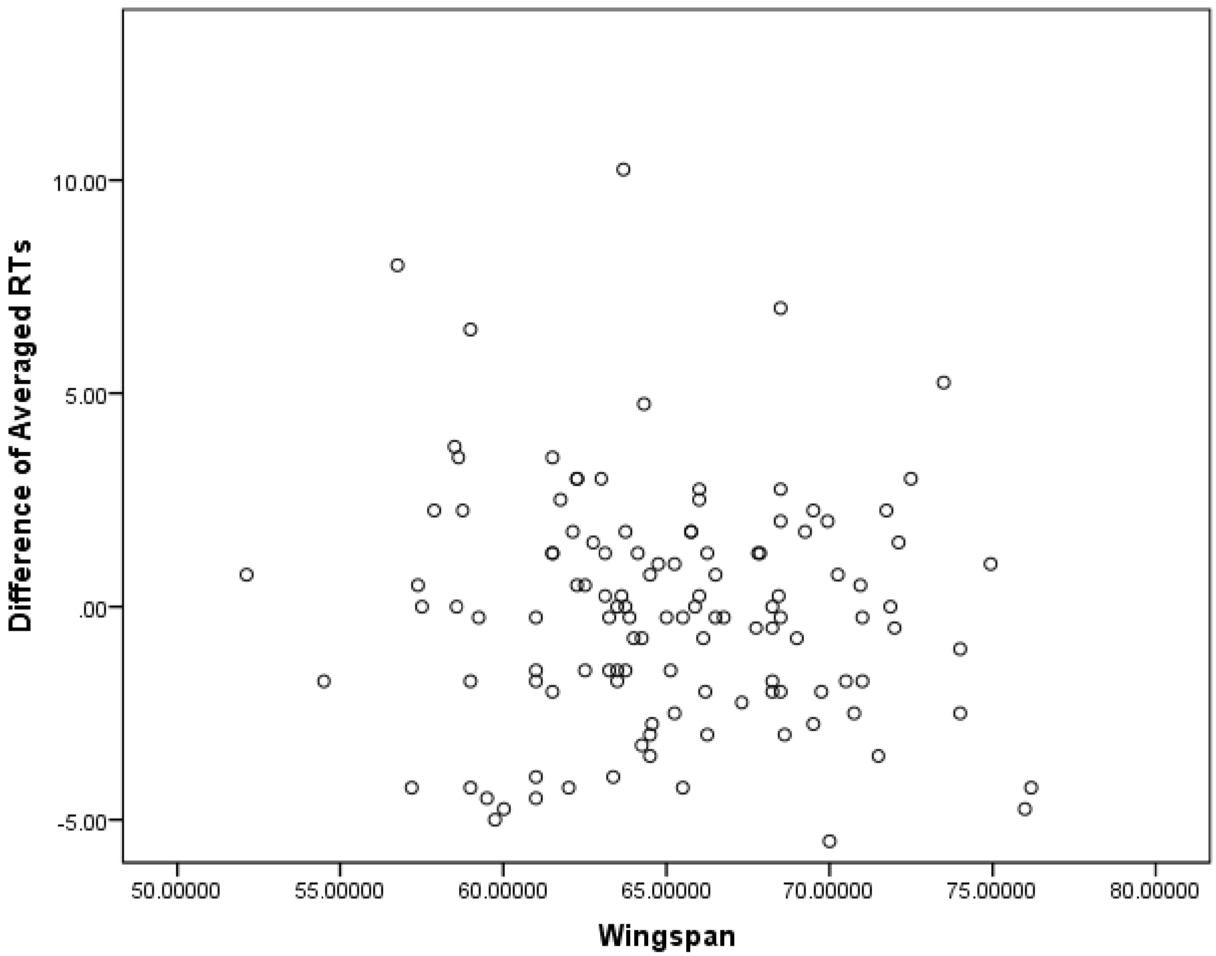

Figure 7. Scatterplot illustrating the difference of averaged standing and sitting reaction times by participants' wingspan.

Appendix A

IRB Approval Letter

EAST CAROLINA UNIVERSITY
University & Medical Center Institutional Review Board Office
4N-70 Brody Medical Sciences Building· Mail Stop 682
600 Moye Boulevard · Greenville, NC 27834
Office **252-744-2914** · Fax **252-744-2284** · **www.ecu.edu/irb**

Notification of Continuing Review Approval: Expedited

From: Biomedical IRB
To: Anne Dickerson
CC:
Date: 1/25/2016
Re: CR00003758
UMCIRB 15-000017
Older Drivers Performance Evaluation

The continuing review of your expedited study was approved. Approval of the study and any consent form(s) is for the period of 1/24/2016 to 1/23/2017. This research study is eligible for review under expedited category # 6, 7. The Chairperson (or designee) deemed this study no more than minimal risk.

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

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

Document	Description
Ad for recruitment (0.02)	Recruitment Documents/Scripts
Break reaction time with sound (0.01)	Standardized/Non-Standardized Instruments/Measures
Consent (0.01)	Consent Forms
Description of Drive Safe/DRive able (0.01)	Standardized/Non-Standardized Instruments/Measures
Driving Habits Questionnaire (0.01)	Surveys and Questionnaires
Mazes tests (0.01)	Standardized/Non-Standardized Instruments/Measures
OT Dora maze (0.01)	Standardized/Non-Standardized Instruments/Measures
P-Drive (0.01)	Standardized/Non-Standardized Instruments/Measures
Post GPS survey (0.01)	Surveys and Questionnaire
Simulator protocols (0.01)	Study Protocol or Grant Application
Trails A&B print.pptx (0.01)	Standardized/Non-Standardized Instruments/Measures

Appendix B

Informed Consent Form

East Carolina University

Informed Consent to Participate in Research

Information to consider before taking part in research that has no more than minimal risk.

Title of Research Study: Older Drivers Performance Evaluation
Principal Investigator (PI): Dr. Anne Dickerson
Institution/Department or Division: Occupational Therapy
Address: 1330 Health Sciences Building
Telephone #: 252-744-6190

Researchers at East Carolina University (ECU) study safety in society and transportation. Our goal is to try to find ways to improve the lives of you and others, such as by assisting older drivers to remain safely on the road as long as they are able. To do this, we need the help of volunteers who are willing to take part in research.

Why is this research being done?

The purpose of this research is to examine differences in the driving performance of older drivers between using an electronic navigation system (ENS) (e.g., GPS) and paper directions to drive to familiar and unfamiliar destinations on the simulator. Driving performance will also be compared to widely used assessment tests or batteries to determine if they predict driving performance. By doing this research, we hope to learn whether the use of technology can extend the length of time older adults can remain driving safely and how to train older drivers to use the technology safely and effectively.

Why am I being invited to take part in this research?

You are being invited to take part in this research because you are a healthy older adult, ages 60-79 years, who expressed an interest in volunteering. If you volunteer to take part in this research, you will be one of about 140 people to do so. The decision to take part in this research is yours alone to make.

Are there reasons I should not take part in this research?

You should not volunteer for this study if you over 80 years of age, do not have a valid drivers license, do not regularly drive at least 3 times per week, or if you have a medical condition that impacts your driving. There is a component of this research that takes place in a simulator. If you develop motion sickness in the simulator, you can participate in the study without completing the driving simulation component.

What other choices do I have if I do not take part in this research?

You can choose not to participate. It is totally your choice.

Where is the research going to take place and how long will it last?

Participation in the study consists of several parts. First, you will have a brief phone or face-to-face survey to see if you quality for the study. The assessments will be conducted in Room 1330 at the Health

Sciences Building on the medical campus of East Carolina University. The total amount of time you will be asked to volunteer for this study is approximately 60-90 minutes scheduled at your convenience.

What will I be asked to do?

You are being asked to do the following:

1. Answer questions about your age, race, education level, and type of vehicle you drive.
2. Complete a survey about recent experience with GPS.
3. Driving Habits Questionnaire – used to get a driving history of when and where you drive.
4. Complete some or all of the following standardized tests for fitness to drive:
   a. Trail Making Tests A and B – a test that demonstrates the ability to switch between two tasks.
   b. Two sets of different Maze Tests – address your ability to problem solve and compare the two tests.
   c. Brake reaction using sound – a test to compare brake reaction with lights versus sound.
   d. Useful Field of Vision (UFOV) – a test of divided attention and processing speed.
   e. Drive Safe/Drive Aware – tests your memory skills in a driving environment as well as testing how well you are aware of any difficulties.
   f. Vision Coach – tests your field of vision using large electronic screen with colored lights.
5. Complete 3-5 scenarios on the driving simulator after getting assimilated on the driving simulator.

All of these assessments will be used to classify you for the group analyses and compare outcomes. Your individual results will not be reported to anyone else, but only analyzed as part of a group.

What possible harms or discomforts might I experience if I take part in the research?

The risks associated with this research are no more than what you would experience in everyday life when doing any of the tasks. It is possible you may get nauseous or dizzy when using the simulator. If you are unusually susceptible to motion sickness, we will not ask you to do this part of the study. We will use several strategies to avoid simulator sickness and the PI will monitor you closely. If you start to feel any nausea or dizziness symptoms and tell us, we will stop the simulator immediately.

What are the possible benefits I may experience from taking part in this research?

We do not know if you will get any personal benefit by taking part in this study. This research will help us learn more about how technology may help older adults continue driving safely as long as they want to. There may be no personal benefit from your participation but the information gained by doing this research may help others in the future.

Will I be paid for taking part in this research?

Yes, you will receive a $25 Target Gift Card for participation when all components are complete.

What will it cost me to take part in this research?

There will be no costs to you.

Who will know that I took part in this research and learn personal information about me?

To do this research, ECU and the people and organizations listed below may know that you took part in this research. They may also see information about you that is normally kept private. With your permission, these people may use but not divulge your private information in order to do this research:

- The research team, including the Principal Investigator and all other research staff (graduate assistants).
- All of the research sites' staff.
- The ECU University & Medical Center Institutional Review Board (UMCIRB) and the staff who have responsibility for overseeing your welfare during this research;
- ECU office staff who oversee this research.

How will you keep the information you collect about me secure? How long will you keep it?
All data will be coded with a number and kept in the locked lab of 1330 in the Health Sciences Building. The data will be separated from your name and identified by a code number known only to the PI. Your name will be retained only on this consent form as well as the on receipt form that indicate you were paid for the study. The consent form and receipt will be retained for 3 years after the completion of the study and then destroyed, and the study data identified only by code number may be kept for future analysis and comparisons to future studies.

What if I decide I do not want to continue in this research?
If you decide you no longer want to be in this research after it has already started, you may stop at any time. You will not be penalized or criticized for stopping. You will be paid for those parts of the study that you have started even if you did not finish them.

Who should I contact if I have questions?
The people conducting this study will be available to answer any questions concerning this research now or in the future. You may contact Dr. Anne Dickerson, the PI at 252-744-6190 Monday through Friday between 9am and 6pm.

If you have questions about your rights as someone taking part in research, you may call the Office of Research Integrity & Compliance (ORIC) at 252-744-2914 (weekdays, 8:00 am—5:00 pm).If you would like to report a complaint or concern about this research study, you may call the Director of the ORIC, at 252-744-1971.

I have decided I want to take part in this research. What should I do now?
The person obtaining informed consent will ask you to read the following and if you agree, you should sign this form and initial each of its pages:

- I have read (or had read to me) all of the above information.
- I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers.
- I know that I can stop taking part in this study at any time.
- By signing this informed consent form, I am not giving up any of my rights.
- I have been given a copy of this consent document, and it is mine to keep.

______________________	______________________	____________
Participant's Name (PRINT)	**Signature**	**Date**

Person Obtaining Informed Consent: I have conducted the initial informed consent process. I have orally reviewed the contents of the consent document with the person who has signed above and answered all of the person's questions about the research.

Person Obtaining Consent (PRINT)	**Signature**	**Date**

Appendix C

Vision Coach Board

Figure C1. Vision Coach Board depicted with wall mount by [Untitled illustration of Vision Coach].

Appendix D

Vision Coach Instructions

Initial Setup

1. Press 'Color' button until 'Red' flashes in upper right hand corner
2. Press 'Area' button until 'Full Fld' appears in upper right hand corner
3. Participant will stand for four trials and sit for four trials.

Information

This is a newer visual-motor tool therapists are using in treatment for people who have suffered a stroke and as a training device for athletics, the police, and military. We are collecting data for future testing of its effectiveness as an assessment and an intervention tool to support its use in clinics.

We will be conducting eight trials. Four will be done in a sitting position and four will be done in a standing position.

Board Setup

4. Have participant face the board in **initial** position (as **circled** on data sheet).
5. Press 'Fixator' button
    a. 'Fix active' should flash in upper right corner
6. Press 'Start'
    a. White fixator light should appear in center of board
7. Adjust height of board so that fixator light is at eye level
    a. Pull out tabs at bottom of board to adjust board height
    b. Participant should be able to reach the top and bottom of the board

8. Close tabs at bottom of board
9. Press ‘Fixator’ button until ‘Fix Off’ appears in upper right corner.
10. Instruct participant, say: “Scan the board and press all red dots on the screen as quickly as possible. You may use both hands.”

Trials 1-4

11. Start participant on **initial, circled**, position.
12. **Press ‘Mode’ button until ‘FF 60’ appears** in upper right hand corner.
13. Ask participant if they feel comfortable and are ready to begin.
14. Press ‘Start’ button.
15. After each Trial, record time displayed in upper right hand corner of board.
16. After each Trial, the participant will be given a minimum of a 1-minute break to rest or get water.
17. After each Trial repeat steps 11-16

Trials 5-8

18. Have participant face the board in the **opposite position of initial position** (i.e. - if initial position was standing, the participant should now be sitting).
19. Readjust board using steps 5-10
20. Start participant on **un-circled** position.
21. **Press ‘Mode’ button until ‘FF 60’ appears** in upper right hand corner.
22. Ask participant if they feel comfortable and are ready to begin.
23. Press ‘Start’ button.
24. After each Trial, record time displayed in upper right hand corner of board.

25. After each Trial, the participant will be given a minimum of a 1-minute break to rest or get water.
26. After each Trial repeat steps 20-25.

Appendix E

Data Recording Form

Participant ID ______________________ Date ______________________

Age_______________ Gender_____________________

Initial Position: Standing Sitting

Trial Number	**Time (seconds)**
1	
2	
3	
4	
5	
6	
7	
8	

Notes: